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Ref: 10CFR50.90

CPSES-200402431
Log # TXX-04167
File # 00236

October 28, 2004

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKET NOS. 50-445 AND 50-446
LICENSE AMENDMENT REQUEST (LAR) 04-011
REVISION TO TECHNICAL SPECIFICATION (TS 3.3.3) POST ACCIDENT MONITORING (PAM) INSTRUMENTATION AND 3.6.8 HYDROGEN RECOMBINERS

Gentlemen:

Pursuant to 10CFR50.90, TXU Generation Company LP (TXU Power) hereby requests an amendment to the CPSES Unit 1 Operating License (NPF-87) and CPSES Unit 2 Operating License (NPF-89) by incorporating the attached change into the CPSES Unit 1 and 2 Technical Specifications. This change request applies to both units

The proposed change will delete Technical Specification (TS) 3.6.8, "Hydrogen Recombiners," and references to the hydrogen monitors in TS 3.3.3, "Post Accident Monitoring (PAM) Instrumentation." The proposed TS changes support implementation of the revisions to 10 CFR 50.44, "Standards for Combustible Gas Control System in Light-Water-Cooled Power Reactors," that became effective on October 16, 2003. (The deletion of the requirements for the hydrogen recombiner and references to hydrogen monitors resulted in numbering and formatting changes to other TS, which were otherwise unaffected by this proposed amendment.)

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Attachment 1 provides a detailed description of the proposed changes, a safety analysis of the proposed changes, TXU Generation Company LP's determination that the proposed changes do not involve a significant hazard consideration, a regulatory analysis of the proposed changes and an environmental evaluation. Attachment 2 provides the affected Technical Specification pages marked-up to reflect the proposed changes. Attachment 3 provides proposed changes to the Technical Specification Bases for information only. These changes will be processed per CPSES site procedures. Attachment 4 provides retyped Technical Specification pages that incorporate the requested changes. Attachment 5 provides retyped Technical Specification Bases pages that incorporate the proposed changes. Attachment 6 provides preliminary marked-up pages of the Final Safety Analysis Report (for information only) to reflect the proposed changes to the FSAR.

TXU Generation Company LP requests approval of the proposed License Amendment by November 1, 2005, to be implemented within 120 days of the issuance of the license amendment. The approval date was administratively selected to allow for NRC review but the plant does not require this amendment to allow continued safe full power operations.

In accordance with 10CFR50.91(b), TXU Generation Company LP is providing the State of Texas with a copy of this proposed amendment.

This communication contains the following new commitment which will be completed as noted:

Commitment Number	Commitment
27324	TXU Power has verified that a hydrogen monitoring system capable of diagnosing beyond design-basis accidents is installed at CPSES and is making a regulatory commitment to maintain that capability. The hydrogen monitors will be retained in the CPSES Final Safety Analysis Report (FSAR). This regulatory commitment will be implemented within 120 days of issuance of the license amendment.

Should you have any questions, please contact Mr. J. D. Seawright at (254) 897-0140.

I state under penalty of perjury that the foregoing is true and correct.

Executed on October 28, 2004.

Sincerely,

TXU Generation Company LP

By: TXU Generation Management Company LLC,
Its General Partner

Mike Blevins

By: Fred W. Madden
Director, Regulatory Affairs

jds

Attachments
1. Description and Assessment
2. Markup of Technical Specifications pages
3. Markup of Technical Specifications Bases pages (for information)
4. Retyped Technical Specification Pages
5. Retyped Technical Specification Bases Pages (for information)
6. Proposed FSAR changes (for information)

c - B. S. Mallett, Region IV
W. D. Johnson, Region IV
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Resident Inspectors, CPSES

Ms. Alice Rogers
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1100 West 49th Street
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ATTACHMENT 1 to TXX-04167

DESCRIPTION AND ASSESSMENT

LICENSEE'S EVALUATION

1. DESCRIPTION

2. PROPOSED CHANGE

3. BACKGROUND

4. TECHNICAL ANALYSIS

5. REGULATORY SAFETY ANALYSIS

   5.1. No Significant Hazards Consideration

   5.2 Applicable Regulatory Requirements/criteria

6. ENVIRONMENTAL CONSIDERATION

7. PRECEDENT

8. REFERENCES

1.0 DESCRIPTION

By this letter, TXU Generation Company LP requests an amendment to the CPSES Unit 1 Operating License (NPF-87) and CPSES Unit 2 Operating License (NPF-89) by incorporating the attached change into the CPSES Unit 1 and 2 Technical Specifications. Proposed change LAR 04-011 deletes Technical Specification (TS) 3.6.8, "Hydrogen Recombiners," and references to the hydrogen monitors in TS 3.3.3, "Post Accident Monitoring (PAM) Instrumentation." The proposed TS changes support implementation of the revisions to 10 CFR 50.44, "Standards for Combustible Gas Control System in Light-Water-Cooled Power Reactors," that became effective on October 16, 2003. (The deletion of the requirements for the hydrogen recombiner and references to hydrogen monitors resulted in numbering and formatting changes to other TS, which were otherwise unaffected by this proposed amendment.)

The changes are consistent with Revision 1 of NRC-approved Industry/Technical Specification Task Force (TSTF) Standard Technical Specification Change Traveler, TSTF-447, "Elimination of Hydrogen Recombiners and Change to Hydrogen and Oxygen Monitors." The availability of this TS improvement was announced in the Federal Register on September 25, 2003 as part of the Consolidated Line Item Improvement Process (CLIIP).

The initial preliminary proposed FSAR changes are also included for information only (See Attachment 6). These changes reflect that Regulatory Guide 1.7 no longer applies to CPSES, that the hydrogen recombiners no longer have a design function, and that calculations of hydrogen post-LOCA are no longer required. The changes also reflect the reduced requirements for the hydrogen monitors.

2.0 PROPOSED CHANGE

Consistent with the NRC-approved Revision 1 of TSTF-447, the proposed TS changes include:

TS 3.3.3, Condition C	Note: Reference to Hydrogen Monitors	Deleted
TS 3.3.3, Condition D	Inoperable Hydrogen Monitors	Deleted
SR 3.3.3.2	Sensor Module Calibration for Hydrogen Monitors	Deleted
Table 3.3.3-1	Item 11, Hydrogen Monitors	Deleted
TS 3.6.8	Hydrogen Recombiners	Deleted

(Other TS changes included in this application are limited to renumbering and formatting changes that resulted directly from the deletion of the above requirements related to hydrogen recombiners and hydrogen monitors.)

As described in NRC-approved Revision 1 of TSTF-447, the changes to TS requirements (and associated renumbering of other TSs) result in changes to various TS Bases sections. Proposed changes to the TS Bases are provided for information only in Attachment 4. The TS Bases changes will be submitted with a future update in accordance with TS 5.5.14, "Technical Specifications Bases Control Program."

3.0 BACKGROUND

The background for this application is adequately addressed by the NRC Notice of Availability published on September 25, 2003 (68 FR 55416), TSTF-447, Revision 1, the documentation associated with the 10 CFR 50.44 rulemaking, and other related documents.

4.0 TECHNICAL ANALYSIS

TXU Power has reviewed the safety evaluation (SE) published on September 25, 2003 (68 FR 55416), as part of the CLIIP Notice of Availability. This verification included a review of the NRC staff's SE, as well as the information provided to support TSTF-447, Revision 1. TXU Power has concluded that the justifications presented in the TSTF proposal and the SE prepared by the NRC staff are applicable to Comanche Peak Steam Electric Station (CPSES), Units 1 and 2, and justify this amendment for the incorporation of the changes to the CPSES TS.

4.1 Verification and Commitments

As discussed in the model SE published in the Federal Register on September 25, 2003 (68 FR 55416), for this TS improvement, TXU Power is making the following verifications and regulatory commitments:

1. TXU Power has verified that a hydrogen monitoring system capable of diagnosing beyond design-basis accidents is installed at CPSES and is making a regulatory commitment to maintain that capability. The hydrogen monitors will be retained in the CPSES Final Safety Analysis Report (FSAR). This regulatory commitment will be implemented within 120 days of issuance of the license amendment.

2. CPSES does not have an inerted containment.

5.0 REGULATORY SAFETY ANALYSIS

5.1 No Significant Hazards Consideration

TXU Power has reviewed the proposed no significant hazards consideration determination published on September 25, 2003 (68 FR 55416), as part of the CLIIP. TXU Power has concluded that the proposed determination presented in the notice is applicable to CPSES

Units 1 and 2 and the determination is hereby incorporated by reference to satisfy the requirement of 10 CFR 50.91(a).

5.2 Applicable Regulatory Requirements/Criteria

The applicable regulatory requirements and guidance associated with this application are adequately addressed by the NRC Notice of Availability published on September 25, 2003 (68 FR 55416), TSTF-447, Revision 1, the documentation associated with the 10 CFR 50.44 rulemaking, and other related documents.

6.0 ENVIRONMENTAL CONSIDERATION

TXU Power has reviewed the environmental evaluation included in the model SE published on September 25, 2003 (68 FR 55416), as part of the CLIIP. TXU Power has concluded that the staff's finding's presented in that evaluation are applicable to CPSES and the evaluation is hereby incorporated by reference for this application.

7.0. PRECEDENT

This application is being made in accordance with the CLIIP. TXU Power is not proposing variations or deviations from the TS changes described in TSTF-447, Revision 1, or the NRC staff's model SE published on September 25, 2003 (68 FR 55416).

8.0 REFERENCES

Federal Register Notice: Notice of Availability of Model Application Concerning Technical Specification Improvement to Eliminate Hydrogen Recombiner Requirement and Relax the Hydrogen and Oxygen Monitor Requirements for Light Water Reactors Using Consolidated Line Item Improvement Process, published September 25, 2003 (68 FR 55416).

ATTACHMENT 2 to TXX-04167

PROPOSED TECHNICAL SPECIFICATION CHANGES (MARK-UP)

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	3.3-37
	3.3-38
	3.3-39
	3.6-22
	3.6-23

3.4 REACTOR COOLANT SYSTEM (RCS) 3.4-1
3.4.1 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits 3.4-1
3.4.2 RCS Minimum Temperature for Criticality 3.4-4
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3.4.4 RCS Loops - MODES 1 and 2 ..... 3.4-7
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3.4.12 Low Temperature Overpressure Protection (LTOP) System 3.4-27
3.4.13 RCS Operational LEAKAGE 3.4-33
3.4.14 RCS Pressure Isolation Valve (PIV) Leakage 3.4-35
3.4.15 RCS Leakage Detection Instrumentation 3.4-40
3.4.16 RCS Specific Activity 3.4-44

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS) 3.5-1
3.5.1 Accumulators 3.5-1
3.5.2 ECCS - Operating 3.5-4
3.5.3 ECCS - Shutdown 3.5-8
3.5.4 Refueling Water Storage Tank (RWST) 3.5-10
3.5.5 Seal Injection Flow 3.5-12

3.6 CONTAINMENT SYSTEMS 3.6-1
3.6.1 Containment 3.6-1
3.6.2 Containment Air Locks 3.6-2
3.6.3 Containment Isolation Valves 3.6-7
3.6.4 Containment Pressure 3.6-16
3.6.5 Containment Air Temperature 3.6-17
3.6.6 Containment Spray System 3.6-18
3.6.7 Spray Additive System 3.6-20
~~3.6.8 Hydrogen Recombiners ..... 3.6-22~~

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. ~~NOTE Not applicable to hydrogen monitor channels.~~ One or more Functions with two required channels inoperable. OR One required T_{hot} channel and one required Core Exit Temperature channel inoperable. OR One required T_{cold} channel and one required Steam Line Pressure channel for the associated loop inoperable.	C.1 Restore one channel to OPERABLE status.	7 days
~~D. Two hydrogen monitor channels inoperable.~~	~~D.1 Restore one hydrogen monitor channel to OPERABLE status.~~	~~72 hours~~
~~E~~D. Required Action and associated Completion Time of Condition C ~~or D~~ not met.	~~E~~D.1 Enter the Condition referenced in Table 3.3.3-1 for the channel.	Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
~~F~~E. As required by Required Action ~~E~~D.1 and referenced in Table 3.3.3-1.	~~F~~E.1	Be in MODE 3.	6 hours
	AND		
	~~F~~E.2	Be in MODE 4.	12 hours
~~G~~F. As required by Required Action ~~E~~D.1 and referenced in Table 3.3.3-1.	~~G~~F.1	Initiate action in accordance with Specification 5.6.8.	Immediately

SURVEILLANCE REQUIREMENTS

----------NOTE----------
SR 3.3.3.1 and SR 3.3.3.3 apply to each PAM instrumentation Function in Table 3.3.3-1.

SURVEILLANCE		FREQUENCY
SR 3.3.3.1	Perform CHANNEL CHECK for each required instrumentation channel that is normally energized.	31 days
SR 3.3.3.2 Deleted	~~----------NOTE----------~~ ~~Applicable to hydrogen monitor channels only.~~ ~~Perform a sensor module calibration.~~	~~92 days~~
SR 3.3.3.3	Perform CHANNEL CALIBRATION.	18 months

Table 3.3.3-1 (page 1 of 2)
Post Accident Monitoring Instrumentation

FUNCTION	REQUIRED CHANNELS	CONDITION REFERENCED FROM REQUIRED ACTION D~~E~~.1
1. Refueling Water Storage Tank Level	2	~~F~~E
2. Subcooling Monitors	2	~~F~~E
3. Reactor Coolant System (RCS) Hot Leg Temperature (Wide Range) (T_{hot})	1 per loop	~~F~~E
4. RCS Cold Leg Temperature (Wide Range) (T_{cold})	1 per loop	~~F~~E
5. RCS Pressure (Wide Range)	2	~~F~~E
6. Reactor Vessel Water Level	2(a)	~~G~~F
7. Containment Sump Water Level (Wide Range)	2	~~F~~E
8. Containment Pressure (Intermediate Range)	2	~~F~~E
9. Steam Line Pressure	2 per steam line	~~F~~E
10. Containment Area Radiation (High Range)	2	~~G~~F
11. ~~Hydrogen Monitors~~Deleted	~~2(b)~~	~~F~~
12. Pressurizer Water Level	2	~~F~~E
13. Steam Generator Water Level (Narrow Range)	2 per steam generator	~~F~~E
14. Condensate Storage Tank Level	2	~~F~~E

(continued)

(a) A channel is eight sensors in a probe. A channel is OPERABLE if four or more sensors, one or more in the upper section and three or more in the lower section, are OPERABLE.

~~(b) A channel consists of two sensors per train. A channel is considered OPERABLE if one sensor is OPERABLE.~~ Deleted

Table 3.3.3-1 (page 2 of 2)
Post Accident Monitoring Instrumentation

FUNCTION	REQUIRED CHANNELS	CONDITION REFERENCED FROM REQUIRED ACTION D~~E~~.1
15. Core Exit Temperature - Quadrant 1	2(c)	~~F~~E
16. Core Exit Temperature - Quadrant 2	2(c)	~~F~~E
17. Core Exit Temperature - Quadrant 3	2(c)	~~F~~E
18. Core Exit Temperature - Quadrant 4	2(c)	~~F~~E
19. Auxiliary Feedwater Flow		
a. AFW Flow	2 per steam generator	~~F~~E
OR		
b. AFW Flow and Steam Generator Water Level (Wide Range)	1 each per steam generator	~~F~~E

(c) A channel consists of two core exit thermocouples (CETs).

~~3.6 CONTAINMENT SYSTEMS~~

~~3.6.8 Hydrogen Recombiners~~

~~LCO 3.6.8 Two hydrogen recombiners shall be OPERABLE.~~

~~APPLICABILITY: MODES 1 and 2~~

~~ACTIONS~~

~~CONDITION~~	~~REQUIRED ACTION~~	~~COMPLETION TIME~~
~~A. One hydrogen recombiner inoperable.~~	~~A.1 Restore hydrogen recombiner to OPERABLE status.~~	~~30 days~~
~~B. Two hydrogen recombiners inoperable.~~	~~B.1 Verify by administrative means that the hydrogen control function is maintained.~~ ~~AND~~ ~~B.2 Restore one hydrogen recombiner to OPERABLE status.~~	~~1 hour~~ ~~AND~~ ~~Once per 12 hours thereafter~~ ~~7 days~~

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~~(continued)~~

ACTIONS (continued)

~~CONDITION~~	~~REQUIRED ACTION~~	~~COMPLETION TIME~~
~~C. Required Action and associated Completion Time not met.~~	~~C.1 Be in MODE 3.~~	~~6 hours~~

~~SURVEILLANCE REQUIREMENTS~~

~~SURVEILLANCE~~	~~FREQUENCY~~
~~SR 3.6.8.1 Perform a system functional test for each hydrogen recombiner.~~	~~18 months~~
~~SR 3.6.8.2 Visually examine each hydrogen recombiner enclosure and verify there is no evidence of abnormal conditions.~~	~~18 months~~
~~SR 3.6.8.3 Perform a resistance to ground test for each heater phase.~~	~~18 months~~

ATTACHMENT 3 to TXX-04167

PROPOSED TECHNICAL SPECIFICATION BASES CHANGES (MARK-UP)
(For Information Only)

Pages B 3.3-124
B 3.3-131
B 3.3-138
B 3.3-139
B 3.3-141
B 3.6-52
B 3.6-53
B 3.6-54
B 3.6-55
B 3.6-56
B 3.6-57
B 3.6-58

BASES (continued)

BACKGROUND (continued)

- Determine whether other systems important to safety are performing their intended functions;
- Provide information to the operators that will enable them to determine the likelihood of a gross breach of the barriers to radioactivity release; and
- Provide information regarding the potential release of radioactive materials to allow for early indication of the need to initiate action necessary to protect the public, and to estimate the magnitude of any impending threat.

These variables are identified by the unit specific Regulatory Guide 1.97 analyses (Ref. 1). These analyses identify the unit specific Type A and non-Type A Category 1 variables and provide justification for deviating from the NRC proposed list of Category 1 variables.

The selected non-Type A Category 1 variables are Reactor Vessel Water Level, and Containment Area Radiation (High Range)~~, and Hydrogen~~ Monitors. These selected variables are considered essential to the operator for LOCA management. Non-Type A Category 1 variables that are not included are Neutron Flux, Containment Pressure (Wide Range), Steam Generator Water Level (Wide Range), and Containment Isolation Valve Status. Although they are important variables, effectiveness of the operator response to a DBA would not be reduced because other variables provide sufficient in formation for operator response. Neutron Flux is not required since reactor coolant temperatures provide sufficient confirmation of subcriticality. Containment Pressure (WR) is not required since the Containment Pressure intermediate range exceeds the containment design pressure and would provide sufficient confirmation of peak containment pressure. Steam Generator Water Level (WR) is not required since the Steam Generator water level narrow range would provide sufficient confirmation of level. The Wide range level is included as an alternative to auxiliary feedwater flow. Containment Isolation Valve Status is not a CPSES Category 1 variable.

The specific instrument Functions listed in Table 3.3.3-1 are discussed in the LCO section.

(continued)

BASES (continued)

LCO (continued)

9. Main Steam Line Pressure (Steam Generator Pressure)

Main Steam Line Pressure (Steam Generator Pressure) is a Type A Category 1 variable for event diagnosis, natural circulation, and RCP trip criteria. It is also a Type B Category 1 variable for monitoring heat sink status tree. It is a variable for determining if a secondary pipe rupture has occurred. This indication is provided to aid the operator in the identification of the faulted steam generator and to verify natural circulation.

10. Containment Area Radiation (High Range)

Containment Area Radiation Level (High Range) is a Type E Category 1 variable used to determine if an adverse containment environment exists due to a high containment radiation level. Containment Area Radiation is provided to monitor for the potential of significant radiation releases and to provide release assessment for use by operators in determining the need to invoke site emergency plans.

11. ~~Hydrogen Monitors~~Deleted

~~Hydrogen Monitors are Type B Category 1 variables for hydrogen recombiner operation. It is also a Type C Category 1 variable for detection of potential breach of containment boundary. Hydrogen Monitors are provided to detect high hydrogen concentration conditions that represent a potential for containment breach from a hydrogen explosion. This variable is also important in verifying the adequacy of mitigating actions.~~

12. Pressurizer Water Level

Pressurizer Water Level is Type A Category 1 variable for SI termination/reinitiation. It is also Type B Category 1 for monitoring RCS inventory status tree. Pressurizer Level is used to determine

(continued)

BASES (continued)

ACTIONS

C.1 (continued)

Continuous operation with two required channels inoperable in a Function is not acceptable because the alternate indications may not fully meet all performance qualification requirements applied to the PAM instrumentation. Therefore, requiring restoration of one inoperable channel of the Function limits the risk that the PAM Function will be in a degraded condition should an accident occur. ~~Condition C is modified by a Note that excludes hydrogen monitor channels.~~

~~D.1~~

~~Condition D applies when two hydrogen monitor channels are inoperable. Required Action D.1 requires restoring one hydrogen monitor channel to OPERABLE status within 72 hours. The 72 hour Completion Time is reasonable based on the backup capability of the contingency sampling plan to monitor the hydrogen concentration for evaluation of core damage or other core damage assessment capabilities available (e.g. core exit thermocouples, containment radiation monitors) and to provide information for operator decisions. Also, it is unlikely that a LOCA (which would cause core damage) would occur during this time.~~ 26

~~E~~D.1

Condition ~~E~~D applies when the Required Action and associated Completion Time of Condition C ~~or D are~~ is not met. Required Action ~~E~~D.1 requires entering the appropriate Condition referenced in Table 3.3.3-1 for the channel immediately. The applicable Condition referenced in the Table is Function dependent. Each time an inoperable channel has not met any Required Action of Condition C ~~or D~~, and the associated Completion Time has expired, Condition ~~E~~D is entered for that channel and provides for transfer to the appropriate subsequent Condition.

(continued)

BASES (continued)

ACTIONS (continued)

~~F~~E.1 and ~~F~~E.2

If the Required Action and associated Completion Time of Condition~~s~~ C ~~or D are~~ is not met and Table 3.3.3-1 directs entry into Condition ~~F~~E, the unit must be brought to a MODE where the requirements of this LCO do not apply. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours and MODE 4 within 12 hours.

The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

~~G~~F.1

Alternate means of monitoring Reactor Vessel Water Level and Containment Area Radiation have been developed. These alternate means may be temporarily used if the normal PAM channel cannot be restored to OPERABLE status within the allotted time. If these alternate means are used, the Required Action is not to shut down the unit but rather to follow the directions of Specification 5.6.8, in the Administrative Controls section of the TS. The report provided to the NRC should discuss the alternate means used, describe the degree to which the alternate means are equivalent to the installed PAM channels, justify the areas in which they are not equivalent, and provide a schedule for restoring the normal PAM channels.

SURVEILLANCE REQUIREMENTS

A Note has been added to the SR Table to clarify that SR 3.3.3.1 and SR 3.3.3.3 apply to each PAM instrumentation Function in Table 3.3.3-1. ~~SR 3.3.3.2 applies only to the hydrogen monitors.~~

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.3.2 Deleted

~~For the hydrogen monitors, a sensor module calibration is performed every 92 days. The calibration sequence uses sample gas in accordance with the manufacturer's recommendations and verifies that the current calibration constants are contained in the microprocessor database. This SR is modified by a Note indicating that this SR is only applicable to the hydrogen monitors. The Frequency is based on manufacturer's recommendations.~~

SR 3.3.3.3

A CHANNEL CALIBRATION is performed every 18 months, or approximately at every refueling. CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to measured parameter with the necessary range and accuracy. The calibration method for neutron detectors is specified in the Bases of LCO 3.3.1, "Reactor Trip System (RTS) Instrumentation." Whenever an RTD is replaced in Function 3 or 4, the next required CHANNEL CALIBRATION of the RTDs is accomplished by an inplace cross calibration that compares other sensing elements with the recently installed element. Whenever a core exit thermocouple replaced in Functions 15 thru 18, the next required CHANNEL CALIBRATION of the core exit thermocouples is accomplished by an in-place cross calibration that compares the other sensing elements with the recently installed sensing element. The Frequency is based on operating experience and consistency with the typical industry refueling cycle. Containment Radiation Level (High Range) CHANNEL CALIBRATION may consist of an electronic calibration of the channel, not including the detector, for range decades above 10R/hr and a one point calibration check of the detector below 10R/hr with an installed or portable gamma source. 9 9

(continued)

B 3.6 CONTAINMENT SYSTEMS

~~B 3.6.8 Hydrogen Recombiners~~

~~BASES~~

~~BACKGROUND~~ ~~The function of the hydrogen recombiners is to eliminate the potential breach of containment due to a hydrogen-oxygen reaction.~~

~~Per 10 CFR 50.44, "Standards for Combustible Gas Control Systems in Light-Water-Cooled Reactors" (Ref. 1), and GDC 41, "Containment Atmosphere Cleanup" (Ref. 2), hydrogen recombiners are required to reduce the hydrogen concentration in the containment following a loss of coolant accident (LOCA). The recombiners accomplish this by recombining hydrogen and oxygen to form water vapor. The vapor remains in containment, thus eliminating any discharge to the environment. The hydrogen recombiners are manually initiated since flammable limits would not be reached until several days after a Design Basis Accident (DBA).~~

~~Two 100% capacity independent hydrogen recombiner systems are provided. Each consists of controls, located in accessible areas outside containment (Ref. 6), a power supply and a recombiner. Recombination is accomplished by heating a hydrogen-air mixture above 1150°F. The resulting water vapor and discharge gases are cooled prior to discharge from the recombiner. A single recombiner is capable of maintaining the hydrogen concentration in containment below the 4.0 volume percent (v/o) flammability limit. Two recombiners are provided to meet the requirement for redundancy and independence. Each recombiner is powered from a separate Engineered Safety Features bus, and is provided with a separate power panel and control panel.~~

~~(continued)~~

~~BASES (continued)~~

~~APPLICABLE SAFETY ANALYSES~~

~~The hydrogen recombiners provide for the capability of controlling the bulk hydrogen concentration in containment to less than the lower flammable concentration of 4.0 v/o following a DBA. This control would prevent a containment wide hydrogen burn, thus ensuring the pressure and temperature assumed in the analyses are not exceeded. The limiting DBA relative to hydrogen generation is a LOCA.~~

~~Hydrogen may accumulate in containment following a LOCA as a result of:~~

~~a. A metal steam reaction between the zirconium fuel rod cladding and the reactor coolant;~~

~~b. Radiolytic decomposition of water in the Reactor Coolant System (RCS) and the containment sump;~~

~~c. Hydrogen in the RCS at the time of the LOCA (i.e., hydrogen dissolved in the reactor coolant and hydrogen gas in the pressurizer vapor space); or~~

~~d. Corrosion of metals exposed to containment spray and Emergency Core Cooling System solutions.~~

~~To evaluate the potential for hydrogen accumulation in containment following a LOCA, the hydrogen generation as a function of time following the initiation of the accident is calculated. Conservative assumptions recommended by Reference 3 are used to maximize the amount of hydrogen calculated.~~

~~Based on the conservative assumptions used to calculate the hydrogen concentration versus time after a LOCA, the hydrogen concentration in the primary containment would reach 3.5 v/o about 3 days after the LOCA and 4.0 v/o about 3 days later if no recombiner was functioning (Ref. 5). Initiating the hydrogen recombiners when the primary containment hydrogen concentration reaches 3.5 v/o will maintain the hydrogen concentration in the primary containment below flammability limits.~~

~~(continued)~~

~~BASES~~

~~APPLICABLE SAFETY ANALYSES (continued)~~

~~The hydrogen recombiners are designed such that, with the conservatively calculated hydrogen generation rates discussed above, a single recombiner is capable of limiting the peak hydrogen concentration in containment to less than 4.0 v/o (Ref. 4). The Hydrogen Purge System is similarly designed such that one of two redundant trains is an adequate backup to the redundant hydrogen recombiners.~~

~~The hydrogen recombiners satisfy Criterion 3 of 10CFR50.36(c)(2)(ii).~~

~~LCO~~

~~Two hydrogen recombiners must be OPERABLE. This ensures operation of at least one hydrogen recombiner in the event of a worst case single active failure.~~

~~Operation with at least one hydrogen recombiner ensures that the post LOCA hydrogen concentration can be prevented from exceeding the flammability limit.~~

~~APPLICABILITY~~

~~In MODES 1 and 2, two hydrogen recombiners are required to control the hydrogen concentration within containment below its flammability limit of 4.0 v/o following a LOCA, assuming a worst case single failure.~~

~~In MODES 3 and 4, both the hydrogen production rate and the total hydrogen produced after a LOCA would be less than that calculated for the DBA LOCA. Also, because of the limited time in these MODES, the probability of an accident requiring the hydrogen recombiners is low. Therefore, the hydrogen recombiners are not required in MODE 3 or 4.~~

~~In MODES 5 and 6, the probability and consequences of a LOCA are low, due to the pressure and temperature limitations in these MODES. Therefore, hydrogen recombiners are not required in these MODES.~~

~~(continued)~~

~~BASES (continued)~~

~~ACTIONS~~ ~~A.1~~

~~With one containment hydrogen recombiner inoperable, the inoperable recombiner must be restored to OPERABLE status within 30 days. In this condition, the remaining OPERABLE hydrogen recombiner is adequate to perform the hydrogen control function. However, the overall reliability is reduced because a single failure in the OPERABLE recombiner could result in reduced hydrogen control capability. The 30 day Completion Time is based on the availability of the other hydrogen recombiner, the small probability of a LOCA occurring (that would generate an amount of hydrogen that exceeds the flammability limit), and the amount of time available after a LOCA (should one occur) for operator action to prevent hydrogen accumulation from exceeding the flammability limit.~~

34

~~(continued)~~

~~BASES~~

~~ACTIONS (continued)~~

~~B.1 and B.2~~

~~With two hydrogen recombiners inoperable, the ability to perform the hydrogen control function via alternate capabilities must be verified by administrative means within 1 hour. The alternate hydrogen control capabilities are provided by the containment Hydrogen Purge System. The 1 hour Completion Time allows a reasonable period of time to verify that a loss of hydrogen control function does not exist. In addition, the alternate hydrogen control system capability must be verified once per 12 hours thereafter to ensure its continued availability. Both the initial verification and all subsequent verifications may be performed as an administrative check by examining logs or other information to determine the availability of the alternate hydrogen control system. It does not mean to perform the Surveillances needed to demonstrate OPERABILITY of the alternate hydrogen control system. If the ability to perform the hydrogen control function is maintained, continued operation is permitted with two hydrogen recombiners inoperable for up to 7 days. Seven days is a reasonable time to allow two hydrogen recombiners to be inoperable because the hydrogen control function is maintained and because of the low probability of the occurrence of a LOCA that would generate hydrogen in the amounts capable of exceeding the flammability limit.~~

~~C.1~~

~~If the inoperable hydrogen recombiner(s) cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours. The Completion Time of 6 hours is reasonable, based on operating experience, to reach MODE 3 from full power conditions in an orderly manner and without challenging plant systems.~~

~~(continued)~~

~~BASES (continued)~~

~~SURVEILLANCE REQUIREMENTS~~

~~SR 3.6.8.1~~

~~Performance of a system functional test for each hydrogen recombiner ensures the recombiners are operational and can attain and sustain the temperature necessary for hydrogen recombination. In particular, this SR verifies that the minimum heater sheath temperature increases to ≥ 700°F in ≤ 90 minutes. After reaching 700°F, the power is increased to maximum power for approximately 2 minutes and power is verified to be ≥ 60 kW.~~

~~Operating experience has shown that these components usually pass the Surveillance when performed at the 18 month Frequency. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.~~

~~SR 3.6.8.2~~

~~This SR ensures there are no physical problems that could affect recombiner operation. Since the recombiners are mechanically passive, they are not subject to mechanical failure. The only credible failure involves loss of power, blockage of the internal flow, missile impact, etc.~~

~~A visual inspection is sufficient to determine abnormal conditions that could cause such failures (i.e., loose wiring or structural connections, deposits of foreign materials, etc.). The 18 month Frequency for this SR was developed considering the incidence of hydrogen recombiners failing the SR in the past is low.~~

~~SR 3.6.8.3~~

~~This SR, which is performed following the functional test of SR 3.6.8.1, requires performance of a resistance to ground test for each heater phase to ensure that there are no detectable grounds in any heater phase. This is accomplished by verifying that the resistance to ground for any heater phase is ≥ 10,000 ohms.~~

~~The 18 month Frequency for this Surveillance was developed considering the incidence of hydrogen recombiners failing the SR in the past is low.~~

~~(continued)~~

~~BASES (continued)~~

~~REFERENCES~~

~~1. 10 CFR 50.44.~~

~~2. 10 CFR 50, Appendix A, GDC 41.~~

~~3. Regulatory Guide 1.7, Revision 2.~~

~~4. FSAR Section 6.2.5.~~

~~5. FSAR Section 6.2.5A.~~

~~6. FSAR, Section II.B.2~~

ATTACHMENT 4 to TXX-04167

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(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One or more Functions with two required channels inoperable. OR One required T_{hot} channel and one required Core Exit Temperature channel inoperable. OR One required T_{cold} channel and one required Steam Line Pressure channel for the associated loop inoperable.	C.1 Restore one channel to OPERABLE status.	7 days
D. Required Action and associated Completion Time of Condition C not met.	D.1 Enter the Condition referenced in Table 3.3.3-1 for the channel.	Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
E. As required by Required Action D.1 and referenced in Table 3.3.3-1.	E.1	Be in MODE 3.	6 hours
	AND		
	E.2	Be in MODE 4.	12 hours
F. As required by Required Action D.1 and referenced in Table 3.3.3-1.	F.1	Initiate action in accordance with Specification 5.6.8.	Immediately

SURVEILLANCE REQUIREMENTS

----------NOTE----------
SR 3.3.3.1 and SR 3.3.3.3 apply to each PAM instrumentation Function in Table 3.3.3-1.

SURVEILLANCE		FREQUENCY
SR 3.3.3.1	Perform CHANNEL CHECK for each required instrumentation channel that is normally energized.	31 days
SR 3.3.3.2	Deleted	
SR 3.3.3.3	Perform CHANNEL CALIBRATION.	18 months

Table 3.3.3-1 (page 1 of 2)
Post Accident Monitoring Instrumentation

FUNCTION	REQUIRED CHANNELS	CONDITION REFERENCED FROM REQUIRED ACTION D.1
1. Refueling Water Storage Tank Level	2	E
2. Subcooling Monitors	2	E
3. Reactor Coolant System (RCS) Hot Leg Temperature (Wide Range) (T_{hot})	1 per loop	E
4. RCS Cold Leg Temperature (Wide Range) (T_{cold})	1 per loop	E
5. RCS Pressure (Wide Range)	2	E
6. Reactor Vessel Water Level	2(a)	F
7. Containment Sump Water Level (Wide Range)	2	E
8. Containment Pressure (Intermediate Range)	2	E
9. Steam Line Pressure	2 per steam line	E
10. Containment Area Radiation (High Range)	2	F
11. Deleted		
12. Pressurizer Water Level	2	E
13. Steam Generator Water Level (Narrow Range)	2 per steam generator	E
14. Condensate Storage Tank Level	2	E

(continued)

(a) A channel is eight sensors in a probe. A channel is OPERABLE if four or more sensors, one or more in the upper section and three or more in the lower section, are OPERABLE.
(b) Deleted

Table 3.3.3-1 (page 2 of 2)
Post Accident Monitoring Instrumentation

FUNCTION	REQUIRED CHANNELS	CONDITION REFERENCED FROM REQUIRED ACTION D.1
15. Core Exit Temperature - Quadrant 1	2(c)	E
16. Core Exit Temperature - Quadrant 2	2(c)	E
17. Core Exit Temperature - Quadrant 3	2(c)	E
18. Core Exit Temperature - Quadrant 4	2(c)	E
19. Auxiliary Feedwater Flow		
a. AFW Flow	2 per steam generator	E
OR		
b. AFW Flow and Steam Generator Water Level (Wide Range)	1 each per steam generator	E

(c) A channel consists of two core exit thermocouples (CETs).

ATTACHMENT 5 to TXX-04167

RETYPED TECHNICAL SPECIFICATION BASES PAGES
(For Information Only)

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BASES (continued)

BACKGROUND (continued)

- Determine whether other systems important to safety are performing their intended functions;
- Provide information to the operators that will enable them to determine the likelihood of a gross breach of the barriers to radioactivity release; and
- Provide information regarding the potential release of radioactive materials to allow for early indication of the need to initiate action necessary to protect the public, and to estimate the magnitude of any impending threat.

These variables are identified by the unit specific Regulatory Guide 1.97 analyses (Ref. 1). These analyses identify the unit specific Type A and non-Type A Category 1 variables and provide justification for deviating from the NRC proposed list of Category 1 variables.

The selected non-Type A Category 1 variables are Reactor Vessel Water Level, and Containment Area Radiation (High Range) Monitors. These selected variables are considered essential to the operator for LOCA management. Non-Type A Category 1 variables that are not included are Neutron Flux, Containment Pressure (Wide Range), Steam Generator Water Level (Wide Range), and Containment Isolation Valve Status. Although they are important variables, effectiveness of the operator response to a DBA would not be reduced because other variables provide sufficient in formation for operator response. Neutron Flux is not required since reactor coolant temperatures provide sufficient confirmation of subcriticality. Containment Pressure (WR) is not required since the Containment Pressure intermediate range exceeds the containment design pressure and would provide sufficient confirmation of peak containment pressure. Steam Generator Water Level (WR) is not required since the Steam Generator water level narrow range would provide sufficient confirmation of level. The Wide range level is included as an alternative to auxiliary feedwater flow. Containment Isolation Valve Status is not a CPSES Category 1 variable.

The specific instrument Functions listed in Table 3.3.3-1 are discussed in the LCO section.

(continued)

BASES (continued)

LCO (continued)

9. Main Steam Line Pressure (Steam Generator Pressure)

Main Steam Line Pressure (Steam Generator Pressure) is a Type A Category 1 variable for event diagnosis, natural circulation, and RCP trip criteria. It is also a Type B Category 1 variable for monitoring heat sink status tree. It is a variable for determining if a secondary pipe rupture has occurred. This indication is provided to aid the operator in the identification of the faulted steam generator and to verify natural circulation.

10. Containment Area Radiation (High Range)

Containment Area Radiation Level (High Range) is a Type E Category 1 variable used to determine if an adverse containment environment exists due to a high containment radiation level. Containment Area Radiation is provided to monitor for the potential of significant radiation releases and to provide release assessment for use by operators in determining the need to invoke site emergency plans.

11. Deleted

12. Pressurizer Water Level

Pressurizer Water Level is Type A Category 1 variable for SI termination/reinitiation. It is also Type B Category 1 for monitoring RCS inventory status tree. Pressurizer Level is used to determine

(continued)

BASES (continued)

ACTIONS

C.1 (continued)

Continuous operation with two required channels inoperable in a Function is not acceptable because the alternate indications may not fully meet all performance qualification requirements applied to the PAM instrumentation. Therefore, requiring restoration of one inoperable channel of the Function limits the risk that the PAM Function will be in a degraded condition should an accident occur.

D.1

Condition D applies when the Required Action and associated Completion Time of Condition C is not met. Required Action D.1 requires entering the appropriate Condition referenced in Table 3.3.3-1 for the channel immediately. The applicable Condition referenced in the Table is Function dependent. Each time an inoperable channel has not met any Required Action of Condition C, and the associated Completion Time has expired, Condition D is entered for that channel and provides for transfer to the appropriate subsequent Condition.

(continued)

BASES (continued)

ACTIONS (continued)

E.1 and E.2

If the Required Action and associated Completion Time of Condition C is not met and Table 3.3.3-1 directs entry into Condition E, the unit must be brought to a MODE where the requirements of this LCO do not apply. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours and MODE 4 within 12 hours.

The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

F.1

Alternate means of monitoring Reactor Vessel Water Level and Containment Area Radiation have been developed. These alternate means may be temporarily used if the normal PAM channel cannot be restored to OPERABLE status within the allotted time. If these alternate means are used, the Required Action is not to shut down the unit but rather to follow the directions of Specification 5.6.8, in the Administrative Controls section of the TS. The report provided to the NRC should discuss the alternate means used, describe the degree to which the alternate means are equivalent to the installed PAM channels, justify the areas in which they are not equivalent, and provide a schedule for restoring the normal PAM channels.

SURVEILLANCE REQUIREMENTS

A Note has been added to the SR Table to clarify that SR 3.3.3.1 and SR 3.3.3.3 apply to each PAM instrumentation Function in Table 3.3.3-1.

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.3.2

Deleted

SR 3.3.3.3

A CHANNEL CALIBRATION is performed every 18 months, or approximately at every refueling. CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to measured parameter with the necessary range and accuracy. The calibration method for neutron detectors is specified in the Bases of LCO 3.3.1, "Reactor Trip System (RTS) Instrumentation." Whenever an RTD is replaced in Function 3 or 4, the next required CHANNEL CALIBRATION of the RTDs is accomplished by an inplace cross calibration that compares other sensing elements with the recently installed element. Whenever a core exit thermocouple replaced in Functions 15 thru 18, the next required CHANNEL CALIBRATION of the core exit thermocouples is accomplished by an in-place cross calibration that compares the other sensing elements with the recently installed sensing element. The Frequency is based on operating experience and consistency with the typical industry refueling cycle. Containment Radiation Level (High Range) CHANNEL CALIBRATION may consist of an electronic calibration of the channel, not including the detector, for range decades above 10R/hr and a one point calibration check of the detector below 10R/hr with an installed or portable gamma source. 9 9

(continued)

ATTACHMENT 6 to TXX-04167

PROPOSED FINAL SAFETY ANALYSIS REPORT CHANGES
(For Information Only)

1.2.2.3.4 Containment Isolation System

In the event of postulated accidents, the Containment Isolation System is designed to minimize the leakage of radioactive materials through fluid lines penetrating Containment.

This design objective is achieved by the use of double isolation barriers. The use of double isolation barriers ensures that no single failure of any active or passive component renders the Containment Isolation System partially or wholly inoperable. The isolation valves are checked regularly during normal unit operation and are designed to assume a fail-safe position.

The Containment Isolation System ensures that the offsite radiological consequences of a main steam line rupture or LOCA are within the guidelines of 10 CFR Part 100.

1.2.2.3.5 Combustible Gas Control Systems

Two systems are provided to control the concentration of combustible gases in the Containment: the Hydrogen Recombiner System and the Hydrogen Purge System.

See Section 6.2.5 for details.

~~The Hydrogen Recombiner System consists of two redundant electric hydrogen recombiners. The system is designed to remove hydrogen produced during a LOCA from the containment atmosphere and to limit its concentration to the levels specified in NRC Regulatory Guide 1.7. The electric hydrogen recombiners receive air containing hydrogen and induce a reaction between the hydrogen and the oxygen present in air. The controls for the recombiners are located outside the Containment in an area accessible after a LOCA.~~

~~Working as a supplementary system for the hydrogen recombiners, the Hydrogen Purge System is designed to provide an independent means of controlling the hydrogen concentration in the Containment after a LOCA, in accordance with NRC Regulatory Guide 1.7. This system purges the containment atmosphere through filters which reduce radioactive releases.~~

~~The Hydrogen Recombiner System is designed to withstand all loads associated with normal operations and accident conditions, including the SSE and the pressure and coincident temperature of a LOCA. Protection from missiles is also provided.~~

~~The hydrogen purge system, a non-safety system, is designed to meet seismic category II requirements.~~

1.2.2.3.6 Emergency Core Cooling System

The ECCS, with active and passive subsystems, is designed to perform the following functions:

Discussion

Refer to Appendix 1A(B).

Regulatory Guide 1.5

Assumptions Used for Evaluating Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors

Discussion

This regulatory guide is not applicable to the CPSES.

Regulatory Guide 1.6

Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

Discussion

Refer to Appendix 1A(B).

Regulatory Guide 1.7

Control of Combustible Gas Concentrations in Containment Following a Loss of Coolant Accident

Discussion

Based on a revision to 10CFR50.44, Regulatory Guide 1.7 no longer applies to CPSES. See Section 6.2.5 for a description of combustable gas control.

~~CPSES utilizes the assumptions of Revision 1 (9/76) of this guide in calculating the hydrogen contribution from the various nuclear steam supply system and other potential sources as discussed in Section 6.2.5A.~~

Also refer to Appendix 1A(B).

Regulatory Guide 1.8

Personnel Selection and Training

Discussion

Refer to Appendix 1A(B).

Regulatory Guide 1.9

Selection of Diesel Generator Set Capacity for Standby Power Supplies

Discussion

Refer to Appendix 1A(B).

Regulatory Guide 1.4

Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors.

Discussion

The analysis of the radiological consequences of the loss-of-coolant accident presented in Section 15.6.5 complies with the requirements of Revision 2 (6/74) of this regulatory guide except that only gamma radiation contribution is taken into account in the determination of whole body exposures.

Regulatory Guide 1.5

Assumptions Used for Evaluating Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors.

Discussion

This regulatory guide is not applicable to the CPSES which has pressurized water reactor steam supply systems.

Regulatory Guide 1.6

Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

Discussion

The CPSES design complies with the requirements of Safety Guide 6 (3/10/71). For details see Section 8.3.

Regulatory Guide 1.7

Control of Combustible Gas Concentrations in Containment Following a Loss of Coolant Accident

Based on a revision to 10CFR50.44, Regulatory Guide 1.7 no longer applies to CPSES. See Section 6.2.5 for a description of combustable gas control.

Discussion

~~The CPSES design of the hydrogen recombiners and Hydrogen Purge System meet the requirements of Revision 2 (11/78) of this regulatory guide as discussed in Section 6.2.5, with the following exceptions and justifications.~~

~~Part C.4~~

~~The CPSES design takes exception to this regulatory position by de-classifying portions of the Hydrogen Purge System (HPS) which contain filters to seismic category II. This means that the filter unit is not required to be functional after a seismic event but it must remain in place. This is consistent with the accident scenarios postulated at CPSES. A LOCA is not postulated to occur coincidentally with a seismic event.~~

~~Also refer to Appendix 1A(N) for further discussion.~~

Regulatory Guide 1.8

Personnel Selection and Training

Discussion

Minimum qualifications of unit staffs, with the exception of licensed Senior Reactor Operators and Reactor Operators, will be in accordance with Regulatory Guide 1.8, Revision 2. Minimum qualifications for licensed Senior Reactor Operators and Reactor Operators will be in accordance with Regulatory Guide 1.8, Revision 3.

The training requirements of Regulatory Guide 1.8, Revision 2 have been superseded by the provisions of 10CFR parts 50 and 55.

Regulatory Guide 1.9

Selection of diesel Generator Set Capacity for Standby Power Supplies

Discussion

The CPSES Diesel generator sets comply with the requirements of Safety Guide 9 (3/10/71) with the following comment:

The voltage may dip below 75 percent of nominal voltage when the diesel generator breaker closes and energizes the two 2000/2666 kVA, 6.9 kV/480 V unit substation transformers supplied from each diesel generator. The dip is due to transformer magnetizing inrush current which exists for two to three cycles. The diesel generator sets are designed to recover to 80 percent of nominal voltage within 10 cycles for this transient. The effect on the first load groups (see Tables 8.3-1 and 8.3-2) therefore would be a maximum possible delay in motor starting of 12-13 cycles after closure of the diesel generator circuit breaker. However, the objective of the first load group and subsequent load groups is not affected. For details see Section 8.3.

Regulatory Guide 1.10

Mechanical (Cadweld) Splices in Reinforcing Bars of Category I Concrete Structures

Discussion

Testing and sampling of Mechanical (Cadweld) Splices in Reinforcing Bars of the CPSES Concrete Containment Structure complies with the requirements of Revision 1 (1/2/73) of this regulatory guide. For other seismic Category I concrete structures, the testing and sampling of Mechanical (Cadweld) splices complies with the requirements of this guide except that the location of all splices are not recorded and shown in as-built drawings.

Also refer to Section 3.8.

ruptures in the primary coolant loop piping, as discussed in Section 3.6B.2.5.1. Implementation of this technology eliminates the need for primary coolant loop piping whip restraints and jet impingement barriers. Containment design, emergency core cooling and environmental qualification requirements are not influenced by this modification.

The system is protected from overpressure by means of pressure-relieving devices as required by applicable codes.

In conclusion, the RCS boundary has provisions for inspection, testing, and surveillance of critical areas to assess the structural and leaktight integrity (Section 5.2). For the reactor vessel, a material surveillance program conforming to applicable codes is provided (Section 5.3).

3.1.2.6 Criterion 15 - Reactor Coolant System Design

"The reactor coolant system and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences [1]."

Discussion

The design pressure and temperature for each component in the RCS and associated auxiliary, control, and protection systems are selected to be above the maximum coolant pressure and temperature under all normal and anticipated transient load conditions.

In addition, RCPB components achieve a large margin of safety by the use of proven American Society of Mechanical Engineers (ASME) materials and design codes, use of proven fabrication techniques, nondestructive shop testing, and of integrated hydrostatic testing of assembled components.

Chapter 5 discusses the RCS design.

3.1.2.7 Criterion 16 - Containment Design

"Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require [1]."

Discussion

A steel-lined, reinforced concrete containment structure encloses the entire RCS and is designed to withstand the pressures and temperatures resulting from a spectrum of postulated LOCAs and secondary system breaks.

The Emergency Core Cooling System cools the reactor core and limits the release of radioactive materials to the environment.

Next, to ensure its integrity, the Containment Spray System ~~and hydrogen removal system are~~ is incorporated in the containment design.

The Containment Spray System is designed to function after a LOCA to reduce the pressure inside the containment to near atmospheric pressure and to remove fission product activity from the containment atmosphere.

~~The hydrogen removal system consists of hydrogen recombiners designed to prevent hydrogen gas from reaching a combustible concentration in the Containment Building as specified in NRC Regulatory Guide 1.7, Control of Combustible Gas Concentrations in the Containment Following a Loss-of-Coolant Accident.~~

~~Moreover, the Hydrogen Purge System acts as a backup system for the hydrogen removal system. This system can be used to periodically purge fractions of the Containment Building atmosphere to the environment to reduce the concentration of hydrogen gas to within the limits specified in NRC Regulatory Guide 1.7.~~

To sum up, the Containment structure and ESF systems are designed to safely sustain internal and external environmental conditions that may reasonably be expected to occur during the life of the plant, including both short- and long-term effects following a LOCA (See Sections 6.2, 6.5, 15.6, and 3.8.1).

3.1.2.8 Criterion 17 - Electric Power Systems

"An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences, and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

"The onsite electric power sources, including the batteries, and the onsite electrical distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions, assuming a single failure.

"Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable. Each of these circuits shall be designed to be available in sufficient time following a loss of all onsite alternating current power supplies and the other offsite electrical power circuit, to

isolation valve before the spray nozzles. The delivery capability of the spray nozzles is tested periodically by blowing low pressure air through the nozzles and verifying the flow. The Containment Spray Systems are tested for operational sequence as close to the design as practical (see Section 6.2.2).

3.1.4.12 Criterion 41 - Containment Atmosphere Cleanup

"Systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quantity of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

"Each system shall have suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities to assure that for onsite electrical power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) its safety function can be accomplished, assuming a single failure [1]."

Discussion

The Containment Spray System includes a chemical additive subsystem using a basic sodium hydroxide solution to enhance post-accident fission product removal efficiency as described in Section 6.5.2. The unit is equipped with two independent spray systems supplied from separate buses, as described in Chapter 8, and either system alone can provide the iodine removal capacity for which credit is taken as described in Section 15.6.

Post-accident combustible gas control is ensured by hydrogen recombiners located inside the Containment Building, and by a Hydrogen Purge System. ~~Hydrogen recombiners include redundancy of vital components so that a single failure does not prevent timely operation or cause failure of the system.~~ These plant systems are described in ~~Sections 6.5.3 and~~ Section 6.2.5.

3.1.4.13 Criterion 42 - Inspection of Containment Atmosphere Cleanup Systems

"The containment atmosphere cleanup systems shall be designed to permit appropriate periodic inspection of important components, such as filter frames, ducts, and piping to assure the integrity and capability of the systems [1]."

Discussion

The containment atmosphere cleanup systems are designed and located so that they can be inspected periodically, as detailed in ~~Sections 6.2.5 and~~ Section 6.5.

3.1.4.14 Criterion 43 - Testing of Containment Atmosphere Cleanup Systems

"The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the systems such as fans, filters, dampers, pumps, and valves and (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the systems into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of associated systems [1]."

Discussion

The containment atmosphere cleanup system can be tested as follows:

~~1.~~ The operation of the spray pumps can be tested by recirculation through a test line to the Refueling Water Storage Tank (RWST). The system valves can be operated through their full travel, and the system can be checked for leaktightness during testing. See Section 6.5 for details. Power transfer is described in Chapter 8.

~~2. The hydrogen recombiners can be tested during refueling operations or approximate annual intervals and the Hydrogen Purge System can be tested periodically to demonstrate its ability to function. See Section 6.2.5 for details.~~

3.1.4.15 Criterion 44 - Cooling Water

"A system to transfer heat from structures, systems, and components important to safety to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

"Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electrical power system operation (assuming offsite power is not available) and for offsite electrical power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure [1]."

Discussion

The cooling water system for safety-related functions consists of the Station Service Water System (SSWS) and the Component Cooling Water System (CCWS).

The SSWS removes heat from the component cooling heat exchangers.

The CCWS is a closed system. It is designed to remove residual heat from the RCS, cool the letdown flow to the CVCS, cool safety-feature heat loads, and dissipate rejected heat from various plant components. The ultimate heat sink used to dissipate rejected heat

1. In valve arrangements 18, 19, 20, and 21 of Figure 6.2.4-1, the butterfly valves inside the Containment are tested towards the center of the Containment. Butterfly valve disc leakage is the same in either direction due to the symmetrical design of the valve.

2. In valve arrangement 22 of Figure 6.2.4-1, the diaphragm valve inside Containment will be tested toward the center of the Containment. Diaphragm valve leakage is the same in either direction due to the symmetrical design of the valve.

3. In valve arrangements 41 and 42 of Figure 6.2.4-1, the ball valves on the inboard side of the personnel and emergency airlocks are tested toward the center of the Containment. Ball valve leakage is the same in either direction due to the symmetrical design of the valve.

4. In valve arrangement 45, the manual spring closed valves are tested as part of the barrel test and the two valves on the containment side are tested in the direction away from the reactor due to the valves being unsymmetrical. Under DBA conditions, all of these manual spring closed valves are oriented in the direction which results in increasing seating force (i.e. DBA pressure loads the discharge side). Therefore, leak testing as part of the barrel test is conservative.

Containment isolation valve leakage rates are evaluated by methods discussed in Section 6.2.6.3.

Environmental qualification tests performed on the Containment Isolation System components are discussed in Section 3.11.

6.2.5 COMBUSTIBLE GAS CONTROL IN CONTAINMENT

Following a DBA, hydrogen gas may be generated inside the Containment by reactions such as zirconium metal with water, corrosion of materials of construction, exposure of the organic cable materials to radiation and radiolysis of aqueous solution in the core and sump. In addition a small amount of methane is generated by the irradiation of the cables as discussed, in Section 6.1B.2. The following section is presented to describe the design of the Combustible Gas Control System. ~~To ensure that the hydrogen concentration is maintained at a safe level, a redundant Hydrogen Recombiner system is provided in accordance with NRC Regulatory Guides 1.7 [5], 1.22 [6], 1.26 [7] and 1.29 [8], General Design Criteria 41, 42, and 43, [1] [2] [3], and Branch Technical Positions 6-2 [11] and 9.2 [10].~~

6.2.5.1 Design Bases

6.2.5.1.1 Generation, Accumulation, and Mixing of Combustible Gases

1. A combustible mixture can be formed when hydrogen gas concentration in the Containment atmosphere is greater than four volume percent (v/o). ~~Following a~~

~~LOCA, hydrogen gas is generated and builds up inside the Containment as described in Appendix 6.2.5A.~~

2. A volume of hydrogen is generated by radiolysis in the core and the sump and is released in the compartment where the LOCA occurred and in the Containment sump where the coolant is collected.

   All subcompartments are provided with vents at the top and drains at the bottom. The vents provide for the release, caused by buoyancy, of any hydrogen generated within or beneath the subcompartment. The drains prevent the accumulation of water within a subcompartment, thus preventing substantial generation of hydrogen by radiolysis within that subcompartment.

   Arrangement of the subcompartments with bottom and top openings creates a stack effect. In addition to the driving forces generated by diffusion rate, the natural ventilation going through the subcompartments provides mixing and avoids hydrogen stratification. Therefore, the flow caused by the stack effect yields a hydrogen concentration within a subcompartment that does not substantially differ from the bulk Containment conditions.

3. Although operation of the containment spray effectively prevents hydrogen stratification, neither the containment spray nor the recirculation fans are required to ensure adequate mixing. Use of containment spray during post LOCA conditions would enhance natural circulation by causing a temperature gradient in addition to the driving force of falling drops.

6.2.5.1.2 Electric Hydrogen Recombiners

The following ~~design bases~~ design descriptions apply to the electric hydrogen recombiners:

1. ~~The recombiners are designed to sustain all normal loads as well as accident loads including safe shutdown earthquake (SSE) and pressure-temperature transients from a design basis LOCA.~~ The recombiners are not required to mitigate design basis accidents.
2. The recombiners are designed for a lifetime of 40 years, consistent with that of the plant.
3. All materials used in the recombiners are selected to be compatible with the environmental conditions inside the Containment Building during normal operation and during accident conditions.
4. The recombiners are located so that there is adequate area around the units for maintenance.
5. The recombiners are protected from damage by missiles or jet impingement from broken pipes.

6. The recombiners are either located away from high velocity air streams such as could emanate from fan cooler exhaust ports or protected from direct impingement of such high velocity air streams by suitable barriers.

7. ~~Process capacity is such that the Containment hydrogen concentration does not exceed 4 v/o based on the release model indicated in Regulatory Guide 1.7.~~

8. ~~Two redundant, electric hydrogen recombiners are provided to meet the single failure criterion.~~

9. ~~Inspection and testing of the electric hydrogen recombiners are made periodically. For further details, see Technical Specifications.~~

10. Each Containment Building is provided with separate and independent permanently installed hydrogen recombiners.

11. The hydrogen recombiners are located in the Containment Building, which is inaccessible to plant personnel during an accident. Therefore, personnel protection from radiation in the vicinity of the operating units is not necessary.

12. The recombiners are mounted on a substantial foundation with no normal, ambient vibration.

6.2.5.1.3 Hydrogen Purge System

The following ~~design bases~~ design descriptions apply to the Hydrogen Purge System:

The Hydrogen Purge System functions as a supplementary system for the electric hydrogen recombiners. This system is designed to operate completely independent of the electric hydrogen recombiners and provides controlled purging of the containment atmosphere to aid in cleanup in accordance with ~~NRC Regulatory Guide 1.7, and~~ GDC 60.

As required by GDC 41, when the system operates, it is capable of maintaining the hydrogen concentration in the Containment below the lower flammability limit following an accident.

The manually actuated Hydrogen Purge System has a process capacity of 700 cfm. ~~cfm, which is sufficient to ensure that Containment hydrogen concentration will not exceed 4 v/o based on the NRC model as indicated in NRC Regulatory Guide 1.7. For hydrogen generation refer to Subsection 6.2.5.3.1.~~

The system is required to be capable of operating with a Containment pressure range of 0 to 5.8 psig and temperature range of 50 to 160°F.

Protection is provided to preclude damage by missiles. All materials are selected to be compatible with accident and normal operating environments.

6.2.5.1.4 Containment Hydrogen Monitoring System

The Containment Hydrogen Monitoring System monitors the hydrogen partial pressure in several well-ventilated areas of the Containment Building in order to obtain typical values for hydrogen gas concentration.

The plant has two hydrogen monitoring systems. Each monitoring system consists of four (4) sensor modules and one (1) microprocessor analyzer. Of the four (4) sensor modules in each system, two (2) are located in each Containment. The microprocessor analyzer is thus shared by Units 1 and 2. The system can be operational within ~~30~~ 90 minutes after an accident and is designed for continuous duty during normal plant operation. The hydrogen gas analyzers alarm at 3 v/o (wet) hydrogen.

The sensor modules and microprocessors are qualified to function under Seismic Category I requirements and post accident conditions as described in CPSES FSAR Appendix 3A, Table 5-1.

6.2.5.2 System Design

The primary means of reducing hydrogen concentration in the Containment following a LOCA are by the use of the electric hydrogen recombiners. As a supplementary system to the Hydrogen Recombiner System, a Hydrogen Purge System is available for use to aid in cleanup by providing controlled purging of the Containment atmosphere. A Containment Hydrogen Monitoring System is provided to sample the Containment atmosphere in various locations to determine the hydrogen concentration.

6.2.5.2.1 Electric Hydrogen Recombiners

~~The applicable codes, standards, and Regulatory Guides used in the design of the electric hydrogen recombiners are listed in Table 6.2.5-1.~~ Redundant recombiners as shown on Figure 6.2.5-1 are located inside the Containment Building. The recombiner units are located in the Containment in such a way that they process a flow of Containment air containing hydrogen at a concentration which is generally typical of the average concentration throughout the Containment.

~~To meet the requirements for redundancy and independence, two electric hydrogen recombiners are provided for each Containment Building.~~ Each recombiner is provided with a separate power panel and control panel, and is powered from a separate safeguards bus. There is no interdependency between this system and the other engineered safety features systems.

Containment atmosphere is circulated through the recombiner by natural circulation where hydrogen is removed by heating to a temperature sufficient to cause recombination with the Containment oxygen.

The recombiner consists of a thermally-insulated, vertical metal duct with electric resistance metal-sheathed heaters provided to heat a continuous flow of Containment air

(containing hydrogen) to a temperature which is sufficient to cause a reaction between hydrogen and oxygen. The recombiner is provided with an outer enclosure to keep out Containment spray water. The recombiner consists of an inlet preheater section, a heater-recombination section, and a discharge mixing chamber that lowers the exit temperature of the air.

The unit is manufactured of corrosion-resistant, high-temperature material except for the base which is carbon steel. The electric hydrogen recombiner uses commercial-type electric resistance heaters sheathed with Incoloy-800, which is an excellent corrosion-resistant material for this service. These recombiner heaters operate at significantly lower power densities than in commercial practice.

Air is drawn into the recombiner by natural convection and passes first through the preheater section. This section consists of a shroud placed around the central heater section to take advantage of heat conduction through the walls to preheat the incoming air. This process accomplishes the dual function of reducing heat losses from the recombiner and of preheating the air.

The warmed air passes through an orifice plate and then enters the electric heater section where it is heated to approximately 1150 to 1400°F, thus causing recombination to occur. Tests have verified that the recombination is not a catalytic surface effect associated with the heaters but occurs as a result of the increased temperature of the process gases. Since the phenomenon is not a catalytic effect, saturation of the unit by fission products does not occur. The heater section consists of five assemblies of electric heaters stacked vertically with each assembly containing individual heating elements. Table 6.2.5-2 gives the recombiner design parameters.

Operation of the recombiner is done manually from a control panel located in an accessible area outside the Containment.

The recombiner, power supply panel, and control panel are shown schematically on Figure 6.2.5-2. The power panel for the recombiner contains an isolation transformer plus an SCR controller to regulate power into the recombiner. This equipment is not exposed to the post- LOCA environment. To control the recombination process, the correct power input to bring the recombiner above the threshold temperature for recombination is set on the controller, and monitored by the watt meter. The correct power required for recombination depends upon Containment atmosphere conditions and is determined when recombiner operation is required. For equipment tests and periodic checkouts, a thermocouple readout instrument is also provided in the control panel for monitoring temperatures in the recombiner.

~~Reference [12] provides the design, and environmental and seismic qualification of the Westinghouse electric hydrogen recombiner, and a description of the testing of a full-scale prototype electric hydrogen recombiner. Acceptance for the proto type and production models described in Reference [12] is documented in References [15] and [16].~~

6.2.5.2.2 Hydrogen Purge System

The Hydrogen Purge System shown in Section 9.4 on Figure 9.4-6 is common to both units and is designed to be completely independent of the Hydrogen Recombiner System. ~~It is not considered credible that an accident could happen that would render both the Hydrogen Recombiner System and the supplementary Hydrogen Purge System simultaneously inoperable. It is also not considered credible that a LOCA could incapacitate Unit 1 and Unit 2 simultaneously. Therefore, no safety problems related to sharing between the two units are anticipated.~~ This system is not used during normal operation but is capable of operating intermittently or continuously after an accident. The Hydrogen Purge system consists of two 700 cfm blowers for supply, inlet and outlet ductwork, and piping, isolation valves, a flow control valve, two atmospheric cleanup systems and two exhaust fans. The blowers are capable of transporting 700 cfm of the fresh, filtered air to the Containment. Air is drawn from either Containment as required, passed through a filterplenum (particulate, iodine adsorbers, HEPA filters) and discharged through the plant discharge duct. A demister and heater are used to maintain the humidity entering the filters below 70 percent. Two trains are provided (one train is required to operate), each capable of controlling the design airflow of 700 cfm when the containment is less than 5.8 psig.

The Hydrogen Purge System is manually operated and is isolated from the Containment by normally closed valves. Mixing of the Containment atmosphere is by natural convection.

Any radioactivity discharged is measured by the plant vent stack monitoring system.

The expected efficiencies of the filters are in accordance with NRC Regulatory Guide 1.140.

6.2.5.2.3 Containment Hydrogen Monitoring System

The hydrogen concentration in each Containment is monitored by four (4) sensors located on four (4) different elevations of the containment. Two (2) sensors from each Containment are coupled to one of the two hydrogen analyzer microprocessors located in the control room. Each microprocessor is supplied from a safety-related uninterrupted power supply train. Thus, two independent analysis trains, each monitoring two points inside each Containment, are provided for measurement.

The analyzers continuously monitor the hydrogen content of the Containment atmosphere during normal plant operation and will be operational within 30 minutes following a LOCA. This monitoring system does not rely on the hydrogen recombiner installation or operation.

The analyzer system meets with the following requirements:

Sensitivity 0.1 percent hydrogen by volume

Accuracy	±2.0 percent of full scale
Range	0-10 percent hydrogen by volume
Calibration	Fully automatic sequencing for feeding known gaseous mixtures to the sensor modules and adjustment

The sensor modules are of the in-Containment measurement type using an electrochemical sensor for specific measurement of hydrogen partial pressure.

Each sensor module consists of the following major components mounted on an integral rack: hydrogen sensor, calibration mechanism, calibration gas bottles, solenoid valves (calibration gas isolation), RTD temperature transducer and an electronics interface terminal box. One absolute pressure transducer is provided with each pair of sensor modules. This transducer is mounted on one of the sensor modules.

The analyzer microprocessor modules accept, process and condition the sensor output signal. The microprocessor has a digital display for the following:

- Hydrogen volume percent (wet)
- Hydrogen volume percent (dry)
- Hydrogen partial pressure
- Temperature
- Pressure

The control room operators are able to select any display for instantaneous readout. The microprocessors also have two buffered 0- 10 volt dc output signals for remote analog display of hydrogen volume percent (wet) on the Main Control Board.

The alarms from the microprocessor modules are from solid state relays and indicate the following conditions: high hydrogen concentration, power failure and system error.

The Containment Hydrogen Monitoring System is designated as IEEE Class 1E and qualified per requirements of IEEE 323-1974.

6.2.5.3 Design Evaluation

6.2.5.3.1 Hydrogen Generation

Based on the revision to 10CFR50.44 effective October 16, 2003, the calculation of hydrogen generation following LOCA is no longer needed.

~~Calculations of hydrogen generation following a LOCA show that although the hydrogen production rate decreases with time following an accident, the hydrogen accumulation can exceed the lower flammability level of 4 volume percent. Therefore, control measures are implemented to prevent hydrogen accumulation to this level.~~

~~The potential sources of hydrogen, method of analysis, and typical assumptions are described in Appendix 6.2.5A.~~

~~The following sources were used as input parameters for the hydrogen accumulation calculations:~~

~~1. Zirconium Weight~~

~~Weight of zirconium cladding: 46,500~~

~~2. Corrosion Rates As a Function of Time~~

~~a. For aluminum: hydrogen generated as a result of aluminum corrosion by spray is based on corrosion data obtained experimentally by ORNL (Reference 8, Section 6.2.5A). The long-term rate assumed for these calculations is 200 mils per year. The short-term corrosion rate is determined from the post-LOCA temperature transient given in Table 6.2.5A-1 and a curve of corrosion rate versus temperature given in Appendix 6.2.5A on Figure 6.2.5A-1.~~

~~b. For zinc (paint): hydrogen generated by corrosion of paint containing zinc is conservatively based on the corrosion of galvanized material.~~

~~c. For zinc (galvanized): The curve of corrosion rate versus temperature for zinc was derived experimentally by Westinghouse (Reference 9, Section 6.2.5A).~~

~~To account for any uncertainty in the two zinc (paint and galvanized) corrosion rates, a 9% contingency was included in the analysis.~~

~~3. Surface Area and Weight~~

~~For aluminum, zinc and zinc paint see Appendix 6.2.5A, Table 6.2.5A-3.~~

~~4. Hydrogen in the Primary Coolant at Start of an Accident~~

~~The total hydrogen within the primary system boundary, 1701 scf, is the sum of the hydrogen dissolved in the primary coolant water and that which is in the pressurizer gas space. This value is based on the 50 cm^3/kg (STP) in the primary coolant.~~

~~Assumptions for the pressurizer vapor space hydrogen are presented in Section 6.2.5A.1.~~

6.2.5.3.2 Hydrogen Mixing

As described in Subsection 6.2.5.1.1, all subcompartments are provided with vents to aid in hydrogen mixing and to avoid high concentration pockets of hydrogen. These vents

6.2.5.3.3 Electric Hydrogen Recombiners

~~Diagrams of the hydrogen production rate following the LOCA (refer to Figure 6.2.5A-5 in Appendix 6.2.5A) show that although hydrogen production rate decreases with time after the loss-of-coolant accident, total hydrogen accumulation can exceed the lower flammability limit of 4 v/o and positive measures are necessary to limit hydrogen accumulation to acceptable levels. The electric hydrogen recombiner provide the means to prevent unsafe levels of hydrogen concentration from being reached in the Containment following a LOCA.~~

~~For the purpose of showing that the electric hydrogen recombiner is capable of maintaining the safe hydrogen concentrations, an analysis was performed using the NRC Regulatory Guide 1.7 model. The result for the Containment volume is shown on Figure 6.2.5A-9. The NRC Regulatory Guide 1.7 model is based upon assuming a fission product activity release specified in Reference [13] and the values for postaccident hydrogen generation specified in this guide. Refer to Appendix 6.2.5A for further information.~~

Each electric recombiner is capable of continually processing a minimum of 100 scfm of Containment atmosphere. The hydrogen contained in the processed atmosphere is converted to steam which then exits to the Containment atmosphere, thus reducing the overall Containment hydrogen concentration. ~~The hydrogen concentration in the Containment calculated for the previously described models is based on a recombiner capability of processing 100 scfm of Containment atmosphere. This calculation shows that the maximum hydrogen concentration will be much less than the lower flammability limit of 4 v/o if the recombiner is started one day following the accident. Therefore, one of these units meets the design criterion of maintaining a safe hydrogen concentration with considerable margin, and the second unit provides a redundant system of equal capability on a redundant power supply.~~

~~The peak hydrogen concentration occurs when the amount of hydrogen being generated is equal to the amount of hydrogen being reprocessed. The production rate of hydrogen decreases with increasing time following the accident. Once this peak has been reached, the recombiner processes hydrogen at a faster rate than it is being produced. This results in an overall reduction of the hydrogen concentration inside the Containment and provides a continually increasing margin between the Containment hydrogen concentration and the lower flammability limit of 4 v/o.~~

~~The unit is designed to sustain all normal loads as well as accident loads such as seismic loads and temperature and pressure transients from a LOCA.~~

~~For further information on hydrogen production and accumulation, see Appendix 6.2.5A.~~

6.2.5.3.4 Hydrogen Purge System

The Hydrogen Purge System operates completely independent of the electric hydrogen recombiners~~, and is capable of maintaining a safe hydrogen concentration (below 4 v/o) in the Containment.~~ .

The system is capable of continually or intermittently processing a minimum of 700 cfm.

If a supply blower or exhaust fan fails, redundant fans will be able to supply or exhaust air by changing the valve and damper arrangement. Air supply and exhaust lines are arranged so as not to be rendered inoperative by accumulation of water in the line from Containment spray, condensation, or flooding.

All equipment is leaktight, and the filter housings are designed to facilitate replacement without undue exposure of personnel to radioactive sources.

The Hydrogen Purge exhaust air filtration units meet the requirements of NRC Regulatory Guide 1.140 as discussed in Appendix 1A(B).

The supply and exhaust lines are routed through different Containment penetrations. Each fan is connected to an emergency standby diesel generator bus. (Section 8.3)

The Containment isolation valves, the piping inside the Containment, and the piping between the isolation valves are ANS Safety Class 2. The exhaust equipment beyond the outboard Containment isolation valves is non-nuclear safety, seismic category II.

6.2.5.3.5 Containment Hydrogen Monitoring System

The Containment Hydrogen Monitoring System is capable of determining the hydrogen concentration at four elevations in the Containment. Four sensor modules and two microprocessors analyzers are provided to ensure that sufficient redundancy is available.

Deleted 6.2.5.4 Tests and Inspections

~~Test programs for preoperational testing and periodic test are implemented. The inservice inspection as part of surveillance tests is conducted periodically throughout the life of the plant to verify that the electric hydrogen recombiners are ready to perform their safety function.~~

~~1. Electric Hydrogen Recombiners~~

~~The electric hydrogen recombiners have undergone extensive testing in the Westinghouse development program. These tests encompassed the initial analytical studies, laboratory proof-of-principal tests, and full-scale prototype testing. The full-scale prototype tests included the effects of:~~

~~a. Varying hydrogen concentrations~~

~~b. Alkaline spray atmosphere~~

~~c. Steam~~

~~d. Convection currents~~

~~e. Seismic activity~~

~~A detailed discussion of these tests is given in Reference [12].~~

~~Postoperational tests and inspections are performed in accordance with Technical Specification requirements. Inspections are performed to ensure the capability of the recombiner to perform its function. Testing is performed to verify operation of the control system and to verify functional performance of the heaters to the required temperature level.~~

~~2. Hydrogen Purge System~~

~~Component qualification tests demonstrate the characteristics of materials incorporated into components (e.g., efficiency of charcoal filter).~~

~~Component acceptance tests demonstrate the capability of the components incorporated. Fans are tested by the manufacturers to determine that their characteristic curves are within design limits.~~

~~A post-installation test is performed to demonstrate system compliance with design requirements. During this test, fans are testing in accordance with the standards of the Air Moving and Conditioning Association (AMCA), and filters are tested in accordance with NRC Regulatory Guide 1.140 (See Appendix 1A(B)). All ductwork/piping of the Hydrogen Purge Air cleanup system are quantitatively leak tested from the outboard containment isolation valves.~~

~~After installation the Hydrogen Purge System can be tested. The system is normally idle. Periodic tests are performed on major components to demonstrate their ability to function.~~

~~3. Containment Hydrogen Monitoring System~~

~~The Containment Hydrogen Monitoring System is calibrated when installed and periodically recalibrated in accordance with manufacturer's instructions.~~

~~The sensors will be automatically recalibrated using known calibration gases containing two (2) and six (6) percent hydrogen in high purity nitrogen. The calibration cycle will be automatically initiated at regular intervals by the microprocessor system, although manual initiation is also possible.~~

~~The Containment Hydrogen Monitoring System will be field tested in accordance with Regulatory Guide 1.68, "Preoperational and Initial Startup Test Programs for Water Cooled Power Reactors."~~

6.2.5.5 Instrumentation Requirements

The electric hydrogen recombiners do not require any instrumentation inside the Containment for proper operation after a LOCA. The recombiners are started manually after a LOCA. The hydrogen monitoring system is used in determining Containment hydrogen concentration that indicate when the recombiners or the hydrogen purge system should be actuated. This measurement can be taken from any of four sensor locations within the Containment. Control measures can be initiated when the hydrogen concentration reaches 3 v/o (wet). A 3 v/o (wet) hydrogen concentration initiates an alarm in the Control Room thereby alerting the operator. Instrumentation is provided to both monitor the hydrogen concentration in the Containment and to monitor the Hydrogen Purge System operation. Two hydrogen indicators are provided, one mounted on the Main Control Board and the second one on the microprocessor analyzer.

The hydrogen purge supply blowers and exhaust fans are manually started from the Control Room. A humidity control heater located in the filter is interlocked with the fan to come on when the fan is started and to shut off when the fan is stopped. A thermistor is provided on the discharge side of the iodine adsorber to provide a high temperature signal to the Fire Protection Systems panel. Differential pressure switches and/or indicating switches are provided to monitor the differential pressure across the fans and exhaust filtration units. A low alarm is annunciated from the fan switch and a high alarm from the filter bank.

6.2.5.6 Materials

The materials of construction for the electric hydrogen recombiners are selected for their compatibility with the post-LOCA environment.

The major structural components are manufactured from 300-Series stainless steel. Incoloy-800 is used for the heater sheaths and Inconel-600 for other parts such as the heat duct, which operates at high temperature.

There are no radiolytic or pyrolytic decomposition products from these materials. Materials of construction for Containment Hydrogen Purge System components are listed in Table 6.2.5-6.

REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 41, Containment Atmosphere Cleanup.

2. 10 CFR Part 50, Appendix A, General Design Criterion 42, Inspection of Containment Atmosphere Cleanup Systems.

3. 10 CFR Part 50, Appendix A, General Design Criterion 43, Testing of Containment Atmosphere Cleanup Systems.

4. Deleted.

5. NRC Regulatory Guide 1.7, Revision 2, Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident, November 1978, U.S. Nuclear Regulatory Commission.

6. NRC Regulatory Guide 1.22, Periodic Testing of Protection System Actuation Functions, February 1972, U.S. Nuclear Regulatory Commission.

7. NRC Regulatory Guide 1.26, Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants, Rev. 3, February 1976, U.S. Nuclear Regulatory Commission.

8. NRC Regulatory Guide 1.29, Seismic Design Classification, Rev. 2, February 1976, U.S. Nuclear Regulatory Commission.

9. ANSI N18.2, Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, 1973.

10. Branch Technical Position APCSB 9-2, Residual Decay Energy for Light Water Reactors for Long-Term Cooling.

11. Branch Technical Position CSB 6-2, Control of Combustible Gas Concentrations In Containment Following a Loss of Coolant Accident, Nov. 24, 1975.

12. J. F. Wilson, Electric Hydrogen Recombiner for PWR Containments, WCAP-7709 (Proprietary) and WCAP-7820, Supplements 1, 2, 3, 4 and 5 (Nonproprietary).

13. TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites, March 23, 1962.

14. ANSI N101.1, Efficiency Testing of Air-Cleaning Systems Containing Devices for Removal of Particles, 1972.

15. Letter from D. B. Vassallo (NRC) to C. Eicheldinger (Westinghouse) dated May 1, 1975.

16. Letter from J. Stolz (NRC) to T. M. Anderson (Westinghouse) dated June 22, 1978.

This section has been deleted.

6.2.5A HYDROGEN PRODUCTION AND ACCUMULATION

~~Hydrogen accumulation in the Containment atmosphere following the design basis accident can be the result of production from several sources. The potential sources of~~

~~hydrogen are hydrogen dissolved in the reactor coolant, the zirconium-water reaction, corrosion of construction materials, and radiolytic decomposition of the emergency core cooling and sump solutions.~~

~~6.2.5A.1 Method of Analysis~~

~~The quantity of zirconium which reacts with the core cooling solution depends on the performance of the Emergency Core Cooling System (ECCS).~~

~~The criteria for evaluation of the ECCS requires that the zircaloy-water reaction be limited to no more than 1 percent by weight of the total quantity of zirconium in the core. ECCS calculations have shown the zircaloy-water reaction to be satisfactory. Regulatory Guide 1.7 [2] specifies that the amount of hydrogen assumed to be generated by the zircaloy-water reaction should include a margin of at least a factor of five over the calculated amount. Thus the calculated zircaloy-water reaction is conservatively assumed to be 5.0 percent.~~

~~The use of aluminum inside the Containment is limited, and is not used in safety-related components which are in contact with the recirculating core cooling fluid. Aluminum is much more reactive with the Containment spray alkaline borate solution than other plant materials such as galvanized steel, copper and copper-nickel alloys.~~

~~It should be noted that the zirconium-water reaction, and aluminum and zinc corrosion with Containment spray are chemical reactions and thus essentially independent of the radiation field inside the Containment following a loss of coolant accident. Radiolytic decomposition of water is dependent on the radiation field intensity. The radiation field inside the Containment is calculated for the maximum credible accident in which the fission product activities given in TID- 14844[1] are used.~~

~~The hydrogen generation calculation [10] was performed using the NRC model discussed in Regulatory Guide 1.7. Plant specific parameters, used in the hydrogen generation calculations, and the assumptions of Regulatory Guide 1.7 are summarized in Table 6.2.5A-2.~~

~~6.2.5A.2 Assumptions~~

~~The following discussion outlines the assumptions used in the calculations.~~

~~1. Zirconium-water reaction~~

~~The zirconium-water reaction is described by the chemical equation:~~

$$\cancel{Zr + 2H_2O \rightarrow ZrO_2 + 2H_2 + Heat}$$

~~The hydrogen generation due to this reaction will be completed during the first day following the loss of coolant accident. The analysis assumes a 5.0 percent~~

~~zirconium-water reaction. The hydrogen generated is assumed to be released immediately to the Containment atmosphere.~~

~~2. Hydrogen from the Reactor Coolant System~~

~~The quantity of hydrogen contained in the Reactor Coolant System during steady state operation is 1701 SCF. This includes hydrogen from the pressurizer gas space. The pressurizer gas space hydrogen is based on:~~

~~a. A reactor coolant hydrogen concentration of 50 cm^3/kg (STP) of coolant.~~

~~b. Normal pressurizer heaters turned on 50 percent of the time and all of the heat input goes to the boiling water.~~

~~c. Minimum bypass spray rate of 1.0 GPM.~~

~~d. Normal liquid level in the pressurizer (60%).~~

~~e. Pressurizer relief valves being closed.~~

~~The reactor coolant chemistry specifications specify a maximum coolant hydrogen concentration of 50 cm^3/kg (STP) of coolant. The hydrogen from the reactor coolant system is available for release to the Containment immediately following a LOCA.~~

~~3. Corrosion of Plant Materials~~

~~Oxidation of metals in aqueous solution results in the generation of hydrogen gas as one of the corrosion products. Extensive corrosion testing has been conducted to determine the behavior of the various metals used in the Containment in the emergency core cooling solution at design basis accident conditions. Metals tested include Zircaloy, Inconel, aluminum alloys, cupronickel alloys, carbon steel, galvanized carbon steel, and copper.~~

~~Tests conducted at Oak Ridge National Laboratories (ORNL)[3 and 4] have also verified the compatibility of the various materials (exclusive of aluminum) with alkaline borate solution. As applied to the quantitative definition of hydrogen production rates, the results of the corrosion tests have shown that only aluminum and zinc will corrode at a rate that will significantly add to the hydrogen accumulation in the Containment atmosphere.~~

~~The corrosion of aluminum may be described by the overall reaction:~~

$$\cancel{2\,Al + 3H_2O \rightarrow Al_2O_3 + 3H_2}$$

~~Therefore, three moles of hydrogen are produced for every two moles of aluminum that is oxidized. (Approximately 20 standard cubic feet of hydrogen for each pound of aluminum corroded.)~~

~~The corrosion of zinc may be described by the overall reaction:~~

$$\cancel{ZN + 2H_2O \leftrightarrow ZN(OH)_2 + H_2}$$

~~Therefore one mole of hydrogen is produced for each mole of zinc oxidized. This corresponds to 5.5 SCF hydrogen produced for each pound of zinc corroded.~~

~~The time-temperature cycle (Table 6.2.5A-1) considered in the calculation of aluminum and zinc corrosion is based on a conservative step-wise representation of the postulated post accident Containment transient. The corrosion rates at the various steps were determined from the aluminum [8] and zinc [9] corrosion rate design curves shown in Figures 6.2.5A-1 and 6.2.5A-2. Aluminum corrosion data points include the effects of temperature, alloy, and spray solution conditions. Based on these corrosion rates and the maximum allowable aluminum and zinc inventory given in Table 6.2.5A-3, the contribution of aluminum and zinc corrosion to hydrogen accumulation in the Containment following the design basis accident has been calculated.~~

~~For conservative estimation, no credit was taken for protective shielding effects of insulation or enclosures from the spray, and complete and continuous immersion was assumed. Also, no credit was taken for protective finish coatings and all zinc present in the prime coating is assumed available for reaction.~~

~~Calculations based on Regulatory Guide 1.7 are performed by allowing an increased aluminum corrosion rate during the final step of the post accident Containment temperature transient (Table 6.2.5A-1) corresponding to 200 mils/year (15.7 mg/dm^2/hr). The aluminum corrosion rates earlier in the accident sequence are the higher rates determined from Figure 6.2.5A-1.~~

~~4. Radiolysis of Core and Sump Water~~

~~Water radiolysis is a complex process involving reactions of numerous intermediates. However, the overall radiolytic process may be described by the reaction:~~

$$\cancel{H_2O \longrightarrow H_2 + 1/2\ O_2}$$

~~Of interest here is the quantitative definition of the rates and extent of radiolytic hydrogen production following the design basis accident.~~

~~An extensive program has been conducted by Westinghouse to investigate the radiolytic decomposition of the core cooling solution following the design basis accident. In the course of this investigation, it became apparent that two separate~~

~~radiolytic environments exist in the Containment at design basis accident conditions. In one case, radiolysis of the core cooling solution occurs as a result of the decay energy of fission products in the fuel. In the other case, the decay of dissolved fission products, which have escaped from the core, results in the radiolysis of the sump solution. The results of these investigations are discussed in Reference [5].~~

~~6.2.5A.3 Core Solution Radiolysis~~

~~As the emergency core cooling solution flows through the core, it is subjected to gamma radiation by decay of fission products in the fuel. This energy deposition results in solution radiolysis and the production of molecular hydrogen and oxygen. The initial production rate of these species will depend on the rate of energy absorption and the specific radiolytic yields.~~

~~The energy absorption rate in solution can be assessed from knowledge of the fission products contained in the core, and a detailed analysis of the dissipation of the decay energy between core materials and the solution. The results of Westinghouse studies show essentially all of the beta energy will be absorbed within the fuel and cladding and that this represents approximately 50 percent of the total betagamma decay energy. This study shows further that of the gamma energy, a maximum of 7.4 percent will be absorbed by the solution in core. Thus, an overall absorption factor of 3.7 percent of the total core decay energy ($\beta + \gamma$) is used to compute solution radiation dose rates and the time integrated dose. Table 6.2.5A-5 presents the total decay energy ($\beta + \gamma$) of a reactor core, which considers full power operation with an extended fuel cycle prior to the accident. For the maximum credible accident case, the contained decay energy in the core accounts for the assumed TID-14844 release of 50 percent halogens and 1 percent other fission products. The noble gases are assumed by the TID-14844 model to escape to the Containment vapor space where little or no water radiolysis would result from decay of these nuclides.~~

~~The radiolysis yield of hydrogen in solution has been studied extensively by Westinghouse and ORNL. The results of static capsule tests conducted by Westinghouse indicate that hydrogen yields much lower than the maximum of 0.44 molecules per 100 ev would be the case incore. With little gas space to which the hydrogen formed in solution can escape, the rapid back reactions of molecular radiolytic products in solution to reform water is sufficient to result in very low net hydrogen yields.~~

~~However, it is recognized that there are differences between the static capsule tests and the dynamic condition in core, where the core cooling fluid is continuously flowing. Such flow is reasoned to disturb the steady state conditions which are observed in static capsule tests, and while the occurrence of back reactions would still be significant, the overall net yield of hydrogen would be somewhat higher in the flowing system.~~

~~The study of radiolysis in dynamic systems was initiated by Westinghouse, which formed the basis for experimental work performed at ORNL. Both studies clearly illustrate the~~

~~reduced yields in hydrogen from core radiolysis, i.e., reduced from the maximum yield of 0.44 molecules per 100 ev. These results have been published[5 and 6].~~

~~The calculations of hydrogen yield from core radiolysis are bounded by the very conservative value of 0.44 molecules per 100 ev. That this value is conservative and a maximum for this type of aqueous solution and gamma radiation is confirmed by many published works. The Westinghouse results from the dynamic studies show 0.44 to be a maximum at very high solution flow rates through the gamma radiation field. The referenced ORNL[6] work also confirms this value as a maximum at high flow rates. A. O. Allen[7] presents a very comprehensive review of work performed to confirm the primary hydrogen yield to be a maximum of 0.44 – 0.45 molecules per 100 ev.~~

~~Calculations based on Regulatory Guide 1.7 assume a hydrogen yield value of 0.5 molecules per 100 ev, 10 percent of the gamma energy produced from fission products in the fuel rods is absorbed by the solution in the region of the core, and the noble gases escape to the Containment vapor space.~~

~~6.2.5A.4 – Sump Solution Radiolysis~~

~~Another potential source of hydrogen assumed for the post accident period arises from water contained in the reactor Containment sump being subjected to radiolytic decomposition by fission products. In this consideration, an assessment must be made as to the decay energy deposited in the solution and the radiolytic hydrogen yield, much in the same manner as given above for core radiolysis.~~

~~The energy deposited in solution is computed using the following basis:~~

~~1. For the maximum credible accident, a TID-14844 release model[1] is assumed where 50 percent of the total core halogens and 1 percent of all other fission products, excluding noble gases, are released from the core to the sump solution.~~

~~2. The quantity of fission product release is based on reactor operation for an extended fuel cycle prior to the accident.~~

~~3. The total decay energy from the released fission products, both beta and gamma, is assumed to be fully absorbed in the solution.~~

~~Within the assessment of energy release by fission products in water, account is made of the decay of the fission products. To arrive at the time-integrated energy release, the energy release rates were integrated over time. The overall contributions from fission products at various times after a LOCA are shown in Table 6.2.5A-6.~~

~~The yield of hydrogen from sump solution radiolysis is most nearly represented by the static capsule tests performed by Westinghouse and ORNL with the alkaline sodium borate solution. The differences between these tests and the actual conditions for the sump solution, however, are important and render the capsule tests conservative in their predictions of radiolytic hydrogen yields.~~

~~In this assessment, the sump solution will have considerable depth, which inhibits the ready diffusion of hydrogen from solution, as compared to the case with shallow depth capsule tests. This retention of hydrogen in solution will have a significant effect in reducing the hydrogen yields to the Containment atmosphere. The build-up of hydrogen concentration in solution will enhance the back reaction to formation of water and lower the net hydrogen yield, in the same manner as a reduction in gas to liquid volume ratio will reduce the yield. This is illustrated by the data presented in Figure 6.2.5A-3 for capsule tests with various gas to liquid volume ratios. The data show a significant reduction in the apparent or net hydrogen yield from the published primary maximum yield of 0.44 molecules per 100 ev. Even at the very highest ratios, where capsule solution depths are very low, the yield is less than 0.30, with the highest scatter data point at 0.39 molecules per 100 ev.~~

~~Calculations based on Regulatory Guide 1.7 do not take credit for a reduced hydrogen yield in the case of sump radiolysis and a hydrogen yield value of 0.5 molecules per 100 ev has been used.~~

~~6.2.5A.5 Results~~

~~Figure 6.2.5A-5 shows hydrogen production rate as a function of time following a loss of coolant accident.~~

~~Figure 6.2.5A-7 shows quantity of hydrogen accumulated in the Containment as a function of time, with no recombiners operating.~~

~~Figure 6.2.5A-9 shows concentration of hydrogen as a function of time, for the maximum credible accident, with a 100 SCFM recombiner started after 24 hours following a LOCA, and with a recombiner started when the hydrogen concentration reaches 3.5 volume percent.~~

~~As discussed above, these figures were developed using as input parameters the sources of hydrogen generation that are discussed in Sections 6.2.5 and 6.2.5A.~~

~~As shown in Figure 6.2.5A-9, a single hydrogen recombiner has the capacity to maintain hydrogen concentration well below the lower flammability limit of 4 volume percent if put in operation after 24 hours following a LOCA or when the concentration reaches 3.5 volume percent.~~

~~6.2.5A.6 Conclusion~~

~~A single hydrogen recombiner, put in operation before the bulk Containment hydrogen concentration reaches 3.5 volume percent, will maintain the bulk hydrogen concentration well below the combustible limit of 4 volume percent.~~

TABLE 6.2.5-1

APPLICABLE CODES, STANDARDS, AND REGULATORY GUIDES USED IN THE DESIGN OF THE ELECTRIC HYDROGEN RECOMBINER

1. NRC Regulatory Guides

   ~~1.7 (March 10, 1971)~~

   ~~1.28 (Safety Guide 28, 6/7/72)~~

   1.29 (Rev. 2, 2/76)

   1.38 (Rev. 1, 10/76)

2. 10 CFR 50, Appendix A, GDC 2, ~~41, 42, 43~~

3. Industry Codes

   ASME IX (Welding and Brazing Requirements)

   National Electric Code

   National Electric Manufacutring Association

   National Fire Protection Association

4. Underwriters Laboratories, Inc.

5. Institute of Electrical and Electronics Engineers

   IEEE 308-1971

   IEEE 323-1974

   IEE 344-1975

TABLE 6.2.5-4

~~ZINC CORROSION RATE VERSUS TEMPERATURE~~

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~~Temperature (F)~~	~~Corrosion Rate ($mg/dm^2/hr$)~~	~~Mil/Month~~
~~150~~	~~0.036~~	~~0.002~~
~~200~~	~~0.046~~	~~0.003~~

~~NOTE:~~ ~~Data points are given in Appendix D of the Indian Point Unit 3 FSAR.~~

TABLE 6.2.5-5

FAILURE MODE AND EFFECTS ANALYSIS

Component of System		Malfunction	Comments and Consequences
~~1.~~	~~Electric Hydrogen Recombiner~~	~~Fails to start or perform its design function~~	~~Two redundant electrical hydrogen recombiners are provided Operation of one is required.~~
~~2.~~	Containment Spray System	Fails to operate and provide mixing of containment atmosphere	Two redundant containment spray trains are provided. Operation of one train is adequate for mixing of hydrogen in the post- LOCA containment atmosphere.
~~3.~~	Containment Hydrogen Monitoring System	Any failure in the system that can prevent post-LOCA monitoring of hydrogen in containment atmosphere	Two independent microprocessor analyzers, two sensor modules per analyzer and containment, and two alarm systems ensures that the monitoring system is functional during single failure.

TABLE 6.2.5A-1
THIS TABLE HAS BEEN DELETED
~~(Sheet 1 of 3)~~

~~GENNY POST-LOCA CONTAINMENT TEMPERATURES~~

~~Time Step No.~~	~~Time Interval (sec)~~		~~Time From Beginning of LOCA To End of Step~~	~~Temperature (°F)~~	~~pH Value~~	
					~~Min~~	~~Max~~
~~1~~	~~0—~~	~~1~~	~~1 sec~~	~~178~~	~~default~~	~~10.6~~
~~2~~	~~1—~~	~~2~~	~~2 sec~~	~~201~~	~~default~~	~~10.6~~
~~3~~	~~2—~~	~~4~~	~~4 sec~~	~~226~~	~~default~~	~~10.6~~
~~4~~	~~4—~~	~~6~~	~~6 sec~~	~~240~~	~~default~~	~~10.6~~
~~5~~	~~6—~~	~~10~~	~~10 sec~~	~~258~~	~~default~~	~~10.6~~
~~6~~	~~10—~~	~~15~~	~~15 sec~~	~~270~~	~~default~~	~~10.6~~
~~7~~	~~15—~~	~~300~~	~~5 min~~	~~280~~	~~default~~	~~10.6~~
~~8~~	~~300—~~	~~400~~	~~6.7 min~~	~~280~~	~~default~~	~~10.6~~
~~9~~	~~400—~~	~~500~~	~~8.3 min~~	~~277~~	~~default~~	~~10.6~~
~~10~~	~~500—~~	~~650~~	~~10.8 min~~	~~275~~	~~default~~	~~10.6~~
~~11~~	~~650—~~	~~750~~	~~12.5 min~~	~~273~~	~~default~~	~~10.0~~
~~12~~	~~750—~~	~~900~~	~~15.0 min~~	~~271~~	~~default~~	~~10.0~~
~~13~~	~~900—~~	~~1000~~	~~16.7 min~~	~~269~~	~~10.6~~	~~12.1~~
~~14~~	~~1000—~~	~~1200~~	~~20 min~~	~~267~~	~~10.6~~	~~12.1~~
~~15~~	~~1200—~~	~~1800~~	~~30 min~~	~~265~~	~~10.6~~	~~12.1~~
~~16~~	~~1800—~~	~~2000~~	~~33.3 min~~	~~262~~	~~10.6~~	~~12.25~~
~~17~~	~~2000—~~	~~2400~~	~~40 min~~	~~260~~	~~10.6~~	~~12.25~~
~~18~~	~~2400—~~	~~2700~~	~~45 min~~	~~257~~	~~11.0~~	~~12.4~~
~~19~~	~~2700—~~	~~3000~~	~~50 min~~	~~256~~	~~11.0~~	~~12.5~~
~~20~~	~~3000—~~	~~3480~~	~~58 min~~	~~255~~	~~11.0~~	~~12.5~~
~~21~~	~~3480—~~	~~4200~~	~~70 min~~	~~253~~	~~11.0~~	~~default~~
~~22~~	~~4200—~~	~~5000~~	~~83.3 min~~	~~252~~	~~11.65~~	~~default~~
~~23~~	~~5000—~~	~~5500~~	~~91.7 min~~	~~250~~	~~11.65~~	~~default~~
~~24~~	~~5500—~~	~~6000~~	~~100 min~~	~~247~~	~~11.65~~	~~default~~
~~25~~	~~6000—~~	~~6500~~	~~1.8 hrs~~	~~245~~	~~default~~	~~default~~
~~26~~	~~6500—~~	~~7000~~	~~1.9 hrs~~	~~243~~	~~default~~	~~default~~
~~27~~	~~7000—~~	~~8000~~	~~2.2 hrs~~	~~240~~	~~default~~	~~default~~

CPSES/FSAR

TABLE 6.2.5A-1

~~(SHEET 2)~~

~~GENNY POST LOCA CONTAINMENT TEMPERATURES~~

~~Time Step No.~~	~~Time Interval (sec)~~		~~Time From Beginning of LOCA To End of Step~~	~~Temperature (°F)~~	~~pH Value~~ ~~Min~~	~~Max~~
~~28~~	~~8000 –~~	~~8500~~	~~2.4 hrs~~	~~237~~	~~default~~	~~default~~
~~29~~	~~8500 –~~	~~9200~~	~~2.6 hrs~~	~~235~~	~~default~~	~~default~~
~~30~~	~~9200 –~~	~~10000~~	~~2.8 hrs~~	~~233~~	~~default~~	~~default~~
~~31~~	~~10000 –~~	~~11000~~	~~3.1 hrs~~	~~230~~	~~default~~	~~default~~
~~32~~	~~11000 –~~	~~12000~~	~~3.3 hrs~~	~~227~~	~~default~~	~~default~~
~~33~~	~~12000 –~~	~~13500~~	~~3.8 hrs~~	~~225~~	~~default~~	~~default~~
~~34~~	~~13500 –~~	~~15000~~	~~4.2 hrs~~	~~222~~	~~default~~	~~default~~
~~35~~	~~15000 –~~	~~17000~~	~~4.7 hrs~~	~~220~~	~~default~~	~~default~~
~~36~~	~~17000 –~~	~~18000~~	~~5.0 hrs~~	~~217~~	~~default~~	~~default~~
~~37~~	~~18000 –~~	~~19000~~	~~5.3 hrs~~	~~215~~	~~default~~	~~default~~
~~38~~	~~19000 –~~	~~20000~~	~~5.6 hrs~~	~~213~~	~~default~~	~~default~~
~~39~~	~~20000 –~~	~~22000~~	~~6.1 hrs~~	~~210~~	~~default~~	~~default~~
~~40~~	~~22000 –~~	~~24000~~	~~6.7 hrs~~	~~207~~	~~default~~	~~default~~
~~41~~	~~24000 –~~	~~27000~~	~~7.5 hrs~~	~~205~~	~~default~~	~~default~~
~~42~~	~~27000 –~~	~~30000~~	~~8.3 hrs~~	~~203~~	~~default~~	~~default~~
~~43~~	~~30000 –~~	~~330000~~	~~9.2 hrs~~	~~200~~	~~default~~	~~default~~
~~44~~	~~33000 –~~	~~36000~~	~~10 hrs~~	~~197~~	~~default~~	~~default~~
~~45~~	~~36000 –~~	~~38000~~	~~10.6 hrs~~	~~195~~	~~default~~	~~default~~
~~46~~	~~38000 –~~	~~40000~~	~~11.1 hrs~~	~~193~~	~~default~~	~~default~~
~~47~~	~~40000 –~~	~~44000~~	~~12.2 hrs~~	~~190~~	~~default~~	~~default~~
~~48~~	~~44000 –~~	~~47000~~	~~13.1 hrs~~	~~188~~	~~default~~	~~default~~
~~49~~	~~47000 –~~	~~50000~~	~~13.9 hrs~~	~~185~~	~~default~~	~~default~~
~~50~~	~~50000 –~~	~~55000~~	~~15.3 hrs~~	~~183~~	~~default~~	~~default~~
~~51~~	~~55000 –~~	~~60000~~	~~16.7 hrs~~	~~180~~	~~default~~	~~default~~
~~52~~	~~60000 –~~	~~65000~~	~~18.1 hrs~~	~~177~~	~~default~~	~~default~~
~~53~~	~~65000 –~~	~~75000~~	~~20.8 hrs~~	~~175~~	~~default~~	~~default~~
~~54~~	~~75000 –~~	~~80000~~	~~22.2 hrs~~	~~172~~	~~default~~	~~default~~
~~55~~	~~80000 –~~	~~85000~~	~~23.6 hrs~~	~~170~~	~~default~~	~~default~~
~~56~~	~~85000 –~~	~~95000~~	~~26.4 hrs~~	~~168~~	~~default~~	~~default~~

CPSES/FSAR

TABLE 6.2.5A-1

~~(SHEET 3)~~

~~GENNY POST LOCA CONTAINMENT TEMPERATURES~~

~~Time Step No.~~	~~Time Interval (sec)~~		~~Time From Beginning of LOCA To End of Step~~	~~Temperature (°F)~~	~~pH Value~~	
					~~Min~~	~~Max~~
~~57~~	~~95000 –~~	~~100000~~	~~27.8 hrs~~	~~165~~	~~default~~	~~default~~
~~58~~	~~100000 –~~	~~150000~~	~~41.7 hrs~~	~~163~~	~~default~~	~~default~~
~~59~~	~~150000 –~~	~~220000~~	~~2.5 days~~	~~160~~	~~default~~	~~default~~
~~60*~~	~~220000 –~~	~~1000000~~	~~11.6 days~~	~~153~~	~~default~~	~~default~~

~~*~~ ~~Constant aluminum corrosion rate of 200 mils/year is considered for temperatures equal to or less than 153 deg F.~~

TABLE 6.2.5A-2
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~~(Sheet 1 of 2)~~

~~PARAMETERS USED TO DETERMINE HYDROGEN GENERATION~~

~~Thermal Power Rating~~	~~3565 MWt~~
~~Containment Free Volume~~	~~2.9×10^6 ft^3~~
~~Containment Temperature at Accident~~	~~120° F~~
~~Weight Zirconium Cladding~~	~~46,500 lb~~
~~Hydrogen Generated Zirconium-Water Reaction Based on 5.0 percent value~~	~~18,370 SCF~~
~~Initial Hydrogen Inventory Including~~	
~~Hydrogen in Primary Coolant~~	~~9470 SCF~~
~~Hydrogen Recombiner Capacity~~	~~100 SCFM~~

~~HYDROGEN PRODUCTION CALCULATION ASSUMPTIONS OF REGULATORY GUIDE 1.7~~

~~CORE COOLING SOLUTION RADIOLYSIS~~

~~Sources~~

- ~~Percent of total halogens retained in the core~~	~~50~~
- ~~Percent of total noble gases retained in the core~~	~~0~~
- ~~Percent of other fission products retained in the core~~	~~99~~

~~Energy Distribution~~

- ~~Percent of total decay energy—gamma~~	~~50~~
- ~~Percent of total decay energy—beta~~	~~50~~

~~TABLE 6.2.5A-2~~

~~(Sheet 2)~~

~~Energy Absorption by Core Cooling Solution~~	
- ~~Percent of gamma energy absorbed by solution~~	~~10~~
- ~~Percent of beta energy absorbed by solution~~	~~0~~
~~Hydrogen Production~~	
- ~~Molecules H_2 produced per 100 ev energy absorbed by solution~~	~~0.50~~
~~SUMP SOLUTION RADIOLYSIS~~	
- ~~Percent of total halogens released to sump solution~~	~~50~~
- ~~Percent of noble gases released to sump solution~~	~~0~~
- ~~Percent of other fission products released to sump solution~~	~~1~~
~~Energy Absorption by Sump Solution~~	
- ~~Percent of total energy (beta and gamma) which is absorbed by the sump solution~~	~~100~~
~~Hydrogen Production~~	
- ~~Molecules of hydrogen produced per 100 ev of energy absorbed by the sump solution~~	~~0.5~~
~~Long Term Aluminum Corrosion Rate~~	
- ~~Mills per year~~	~~200~~
- ~~Milligrams per square decimeter per hour~~	~~16~~

TABLE 6.2.5A-3

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~~INVENTORY OF ALUMINUM AND ZINC IN CONTAINMENT~~

~~Item~~	~~Material~~	~~Source~~	~~Weight (lbs)~~	~~Area (sq. ft)~~
~~Flux Mapping Drive System~~	~~A1~~	~~—~~	~~205~~	~~88~~
~~Nuclear Instrumentation System~~	~~A1~~	~~—~~	~~280~~	~~95~~
~~Rod Position Indicators~~	~~A1~~	~~—~~	~~177~~	~~93~~
~~Miscellaneous Valves~~	~~A1~~	~~—~~	~~230~~	~~86~~
~~Control Rod Drive Mechanism~~	~~A1~~	~~—~~	~~193~~	~~42~~
~~Contingency~~	~~A1~~	~~—~~	~~250~~	~~85~~
~~Refueling Machine~~	~~A1~~	~~—~~	~~28~~	~~5~~
~~Miscellaneous Mechanical Equip~~	~~A1~~	~~Parts~~	~~240~~	~~38~~
~~Miscellaneous Electrical Equip~~	~~A1~~	~~Parts~~	~~7~~	~~14~~
~~I&C Valves and Accessories~~	~~A1~~	~~Parts~~	~~55~~	~~20~~
~~Miscellaneous Electrical Equipment (Ref. TNE-NU-CA-9000-145 R/0)~~	~~A1~~	~~—~~	~~9~~	~~4~~
~~Miscellaneous Electrical Equipment (Ref. TNE-NU-CA-9000-156 R/I)~~	~~A1~~	~~—~~	~~4~~	~~4~~
~~Other (Ref. TE-SE-90-581)~~	~~A1~~	~~—~~	~~Infinite~~	~~1750~~
~~Other (Ref. TU Transmittal #S-411)~~	~~A1~~	~~—~~	~~Infinite~~	~~4000~~
~~**Total Aluminum**~~			~~**1678**~~	~~**6324**~~
~~Miscellaneous Mechanical Equip~~	~~Zinc~~	~~Paint~~	~~5135~~	~~117693~~
~~Miscellaneous Mechanical Equip~~	~~Zinc~~	~~Galvan.~~	~~98~~	~~1254~~
~~Miscellaneous Mechanical Equip~~	~~Zinc~~	~~Parts~~	~~13~~	~~1~~
~~HVAC Equipment and Ducts~~	~~Zinc~~	~~Paint~~	~~539~~	~~12272~~
~~HVAC Equipment and Ducts~~	~~Zinc~~	~~Galvan.~~	~~5113~~	~~107477~~
~~Miscellaneous Electrical Equip~~	~~Zinc~~	~~Galvan.~~	~~4126~~	~~56010~~
~~Electrical Cable Trays~~	~~Zinc~~	~~Galvan.~~	~~2300~~	~~26000~~
~~I&C Valves and Accessories~~	~~Zinc~~	~~Paint~~	~~98~~	~~2250~~
~~I&C Valves and Accessories~~	~~Zinc~~	~~Galvan.~~	~~870~~	~~8000~~
~~I&C Valves and Accessories~~	~~Zinc~~	~~Parts~~	~~86~~	~~1242~~
~~Structural Liner~~	~~Zinc~~	~~Paint~~	~~4830~~	~~111330~~
~~Structural Miscellaneous Steel~~	~~Zinc~~	~~Paint~~	~~2875~~	~~66284~~
~~Structural Miscellaneous Steel~~	~~Zinc~~	~~Galvan.~~	~~2980~~	~~23838~~
~~Other (Ref. TE-SE-90-581)~~	~~Zinc~~	~~Galvan.~~	~~388~~	~~2700~~
~~Other (Ref. TU Transmittal #S-411)~~	~~Zinc~~	~~Galvan.~~	~~575~~	~~4000~~
~~Contingency~~	~~Zinc~~	~~—~~	~~1387~~	~~9649~~
~~**Total Zinc**~~			~~**31413**~~	~~**550000**~~

TABLE 6.2.5A-5

~~FISSION PRODUCT DECAY ENERGY IN THE CORE~~

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	~~Core Fission Product Energy*~~	
~~Time After LOCA Days~~	~~Energy Release Rate Watts/MWt~~	~~Integrated Energy Release Watt-Days/MWt~~
~~1~~	~~4.57E+03~~	~~6.36E+03~~
~~5~~	~~3.07E+03~~	~~2.08E+04~~
~~10~~	~~2.44E+03~~	~~3.44E+04~~
~~15~~	~~2.08E+03~~	~~4.56E+04~~
~~20~~	~~1.84E+03~~	~~5.54E+04~~
~~25~~	~~1.67E+03~~	~~6.41E+04~~
~~30~~	~~1.54E+03~~	~~7.22E+04~~
~~40~~	~~1.35E+03~~	~~8.65E+04~~
~~50~~	~~1.20E+03~~	~~9.92E+04~~
~~60~~	~~1.08E+03~~	~~1.11E+05~~
~~70~~	~~9.90E+02~~	~~1.21E+05~~
~~80~~	~~9.14E+02~~	~~1.30E+05~~
~~90~~	~~8.54E+02~~	~~1.39E+05~~
~~100~~	~~8.09E+02~~	~~1.48E+05~~

~~* - Considers 50 percent of core halogens, no noble gases and 99 percent of other fission products in the core.~~

~~- n.nnE+yy denotes n.nn x 10^{yy}~~

TABLE 6.2.5A-6

~~FISSION PRODUCT DECAY ENERGY IN SUMP SOLUTION~~

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	~~Sump Fission Product Energy*~~	
~~Time After LOCA Days~~	~~Energy Release Rate Watts/MWt~~	~~Integrated Energy Release Watt-Days/MWt~~
~~1~~	~~2.32E+02~~	~~4.87E+02~~
~~5~~	~~7.59E+01~~	~~9.32E+02~~
~~10~~	~~4.69E+01~~	~~1.23E+03~~
~~15~~	~~3.35E+01~~	~~1.43E+03~~
~~20~~	~~2.66E+01~~	~~1.58E+03~~
~~25~~	~~2.26E+01~~	~~1.70E+03~~
~~30~~	~~2.00E+01~~	~~1.81E+03~~
~~40~~	~~1.62E+01~~	~~1.98E+03~~
~~50~~	~~1.35E+01~~	~~2.13E+03~~
~~60~~	~~1.14E+01~~	~~2.26E+03~~
~~70~~	~~9.81E+00~~	~~2.36E+03~~
~~80~~	~~8.79E+00~~	~~2.45E+03~~
~~90~~	~~8.29E+00~~	~~2.54E+03~~
~~100~~	~~8.31E+00~~	~~2.62E+03~~

~~*~~ - ~~Considers release of 50 percent of core halogens, no noble gases and 1 percent of other fission products to the sump solution.~~

- ~~n.nnE+yy denotes n.nn x 10^{yy}~~

This definition includes comparator accuracy, channel accuracy, each input, and rack environmental effects. This is the tolerance expressed in process terms (or percent of span) within which the complete channel must perform its intended trip function. This includes all instrument errors but no process effects such as streaming. The term "actuation accuracy" may be used where the word "trip" might cause confusion (for example, when starting pumps and other equipment).

16. Control Accuracy

This definition includes channel accuracy, accuracy of readout devices (isolator and controller), and rack environmental effects. Where an isolator separates control and protection signals, the isolator accuracy is added to the channel accuracy to determine control accuracy, but credit is taken for tuning beyond this point; i.e., the accuracy of these modules (excluding controllers) is included in the original channel accuracy. It is simply defined as the accuracy of the control signal in percent of the span of that signal. This will then include gain changes where the control span is different from the span of the measured variable. Where controllers are involved, the control span is the input span of the controller. No error is included for the time in which the system is in a nonsteady state condition.

7.1.1 IDENTIFICATION OF SAFETY-RELATED SYSTEMS

7.1.1.1 Safety-Related Systems

The Nuclear Steam Supply System (NSSS) and the balance of plant (BOP) instrumentation discussed in Chapter 7 that is required to function to achieve the system responses assumed in the safety evaluations, and those needed to shutdown the plant safely are given in this section.

Refer to Figure 7.1-3 for location layout drawings of Class 1E instrumentation. These figures pertain to location layout drawing requirements as discussed in Sections 7.2, 7.3 and 7.5.

7.1.1.1.1 Reactor Trip System

The Reactor Trip System (RTS) is a functionally defined system described in Section 7.2. The RTS responsibility falls primarily under the NSSS supplier, with the exceptions of underfrequency, and undervoltage, and turbine trip signal which are under BOP scope (See Figure 7.2-1). The equipment which provides the trip functions is identified and discussed in Section 7.2. Design bases for the RTS are given in Section 7.1.2.1. Figure 7.1-1 is a block diagram of this system.

7.1.1.1.2 Engineered Safety Features Actuation System

The Engineered Safety Features Actuation System (ESFAS) is a functionally defined system described in Section 7.3. The equipment which provides the actuation functions

is identified and discussed in Section 7.3. Design bases for the ESFAS are given in Section 7.1.2.1.

The ESF and ESF Support Systems requiring actuation are as follows:

ESF Systems:

1. Emergency Core Cooling System (Section 6.3)

   a. Safety Injection System

   b. Residual Heat Removal System (partial)

   c. Chemical and Volume Control System (partial)

   Designed by NSSS vendor.

2. Containment Spray System (Section 6.2.2)

   a. Containment Spray Chemical Additive Subsystem (Section 6.5.2)

   Designed under the Architect-Engineer's (A-E) specifications.

3. Containment Isolation System (Section 6.2.4)

   Containment isolation valves for the following systems are furnished by the NSSS vendor.

   a. Chemical and Volume Control System.

   b. Residual Heat Removal System.

   c. Safety Injection System.

   d. Waste Processing System.

   The remaining Containment isolation valves are built to the specifications of the A-E.

4. ~~Combustible Gas Control System (Section 6.2.5)~~
   Deleted.
   ~~Electric Hydrogen Recombiners~~

   ~~Basically similar to the William B. McGuire Nuclear Station. Hydrogen recombiners furnished by the NSSS vendor.~~

5. Control Room Air Conditioning System (Sections 6.4 and 9.4).

   Designed and built to the specifications of the A-E.

Delete column

TABLE 7.1-2.6

(Sheet 1 of 5)

SAFETY RELATED INSTRUMENTATION & CONTROL SYSTEMS/CODES, STANDARDS & GUIDES/APPLICABILITY MATRIX FOR OTHER INSTRUMENTATION SYSTEMS REQUIRED FOR SAFETY (1,7)

	I & C POWER SUPPLY(3)	RHR ISOLATION VALVES	REFUELING INTERLOCKS(8)	ACCUMULATOR MO. VALVES	SWITCHOVER INJECTION TO RECIRCULATION	PROCESS & EFF RADIATION MONITORS	RCPB LEAK DETECTION	INTERLOCKS RCS PRESSURE CONTROL	~~HYDROGEN MONITORING~~	FIRE PROTECTION(6)
GDC 1		X	-	X	X	X	X	-	X	-
GDC 2		X	-	X	X	X	X	X	X	-
GDC 3		X	-	X	X	X	X	X	X	-
GDC 4		X	-	X	X	X	X	X	X	-
GDC 5		X	-	X	X	X	X	X	X	-
GDC 10		X	-	-	-	-	-	-	-	-
GDC 12		-	-	-	-	-	-	-	-	-
GDC 13		X	-	X	X	X	X	X	X	-
GDC 15		X	-	-	-	-	-	X	-	-
GDC 19		X	-	X	X	X	X	X	X	-
GDC 20		-	-	-	-	-	-	-	-	-
GDC 21		-	-	-	-	-	-	-	-	-
GDC 22		-	-	-	-	-	-	-	-	-
GDC 23		-	-	-	-	-	-	-	-	-
GDC 24		X	-	X	X	X	X	X	-	-
GDC 25	-	-	-	-	-	-	-	-	-	-
GDC 26		-	-	-	-	-	-	-	-	-
GDC 27		-	-	-	-	-	-	-	-	-

CPSES/FSAR
TABLE 7.1-2.6

(Sheet 2)

SAFETY RELATED INSTRUMENTATION & CONTROL SYSTEMS/CODES, STANDARDS & GUIDES/APPLICABILITY MATRIX FOR OTHER INSTRUMENTATION SYSTEMS REQUIRED FOR SAFETY (1,7)

	I & C POWER SUPPLY[3]	RHR ISOLATION VALVES	REFUELING INTERLOCKS(8)	ACCUMULATOR MO. VALVES	SWITCHOVER INJECTION TO RECIRCULATION	PROCESS & EFF RADIATION MONITORS	RCPB LEAK DETECTION	INTERLOCKS RCS PRESSURE CONTROL	~~HYDROGEN MONITORING~~	FIRE PROTECTION[6]
GDC 28		-	-	-	-	-	-	-	-	-
GDC 29		-	-	-	-	-	-	-	-	-
GDC 30		-	-	-	-	-	X	X	-	-
GDC 33		-	-	-	-	-	-	-	-	-
GDC 34		X	-	-	-	-	-	-	-	-
GDC 35		X	-	X	X	-	-	-	-	-
GDC 37	-	-	-	X	X	-	-	-	-	-
GDC 38	-	-	-	-	X	-	-	-	-	-
GDC 40	-	-	-	-	X	-	-	-	-	-
GDC 41		-	-	-	-	-	-	-	X	-
GDC 43		-	-	-	-	-	-	-	X	-
GDC 44		-	-	-	-	-	-	-	-	-
GDC 46		-	-	-	-	-	-	-	-	-
GDC 50		-	-	-	-	-	-	-	-	-
GDC 54		-	-	-	-	-	-	-	-	-
GDC 55		X	-	-	-	-	-	-	-	-
GDC 56		-	-	-	-	-	-	-	-	-
GDC 57		-	-	-	-	-	-	-	-	-
GDC 63		-	-	-	-	X	-	-	-	-
GDC 64		-	-	-	-	X	-	-	-	-

CPSES/FSAR
TABLE 7.1-2.6

(Sheet 3)

SAFETY RELATED INSTRUMENTATION & CONTROL SYSTEMS/CODES, STANDARDS & GUIDES/APPLICABILITY MATRIX FOR OTHER INSTRUMENTATION SYSTEMS REQUIRED FOR SAFETY (1,7)

	I & C POWER SUPPLY[3]	RHR ISOLATION VALVES	REFUELING INTERLOCKS(8)	ACCUMULATOR MO. VALVES	SWITCHOVER INJECTION TO RECIRCULATION	PROCESS & EFF RADIATION MONITORS	RCPB LEAK DETECTION	INTERLOCKS RCS PRESSURE CONTROL	~~HYDROGEN MONITORING~~	FIRE PROTECTION[6]
RG 1.6		-	-	-	-	-	-	-	-	-
RG 1.7		-	-	-	-	-	-	-	X	-
RG 1.11		-	-	-	-	-	-	-	-	-
RG 1.12[2]										
RG 1.22		-	-	-	X	-	-	-	X	-
RG 1.29		X	-	X	X	X	X	-	X	-
RG 1.30		X	-	X	X	X	X	-	X	-
RG 1.32		-	-	-	-	-	-	-	-	-
RG 1.45		-	-	-	-	X	X	-	-	-
RG 1.47		-	-	-	X	-	-	-	-	-
RG 1.53		X	-	X	-	X	-	-	X	-
RG 1.62		-	-	-	-	-	-	-	-	-
RG 1.63[3]										
RG 1.67[4]										
RG 1.68[5]										
RG 1.70		X	-	X	X	X	X	X	X	-
RG 1.73		-	-	X	-	-	-	-	-	-
RG 1.75		X	-	X	X	-	-	-	X	-
RG 1.78		-	-	-	-	-	-	-	-	-

CPSES/FSAR
TABLE 7.1-2.6

(Sheet 4)

SAFETY RELATED INSTRUMENTATION & CONTROL SYSTEMS/CODES, STANDARDS & GUIDES/APPLICABILITY MATRIX FOR OTHER INSTRUMENTATION SYSTEMS REQUIRED FOR SAFETY (1,7)

	I & C POWER SUPPLY[3]	RHR ISOLATION VALVES	REFUELING INTERLOCKS(8)	ACCUMULATOR MO. VALVES	SWITCHOVER INJECTION TO RECIRCULATION	PROCESS & EFF RADIATION MONITORS	RCPB LEAK DETECTION	INTERLOCKS RCS PRESSURE CONTROL	~~HYDROGEN MONITORING~~	FIRE PROTECTION[6]
RG 1.80[5]						78				
RG 1.89		X	-	X	X	X	-	-	X	-
RG 1.95		-	-	-	-	-	-	-	-	-
RG 1.97		-	-	X	X	X	-	-	X	-
RG 1.100		X	-	X	X	X	-	-	X	-
RG 1.105		X	-	X	X	X	-	-	X	-
RG 1.118		-	-	-	-	-	-	-	-	-
RG 1.120[6]						78				
IEEE STD 279		-	-	-	-	-	-	-	-	-
IEEE STD 308		-	-	-	-	-	-	-	-	-
IEEE STD 317[3]										
IEEE STD 323		X	-	X	X	X	-	-	X	-
IEEE STD 336		X	-	X	X	X	X	-	X	-
IEEE STD 338		-	-	-	X	-	-	-	X	-
IEEE STD 344		X	-	X	X	X	-	-	X	-
IEEE STD 379		X	-	X	X	X	-	-	X	-
IEEE STD 384		X	-	X	X	X	-	-	X	-

NOTES:

TABLE 7.1-2.6

(Sheet 5)

SAFETY RELATED INSTRUMENTATION & CONTROL SYSTEMS/CODES, STANDARDS & GUIDES/APPLICABILITY MATRIX FOR OTHER INSTRUMENTATION SYSTEMS REQUIRED FOR SAFETY (1,7)

1. The scope of applicability is instrumentation & control.
2. Refer to FSAR Section 3.7.B.4 and Appendix 1A (B).
3. Refer to FSAR Section 8.3.1.2.1 and Appendix 1A (B).
4. Refer to FSAR Section 3.9 B.3.3. and Appendix 1A (B).
5. Refer to FSAR Section 14.2 and Appendix 1A (B).
6. Refer to FSAR Section 9.5.1 and Appendix 1A (B).
7. X Signifies compliance as discussed or qualified in the FSAR Sections referenced in Table 7.1-1. - Not applicable.
8. Refer to FSAR Sections 7.6.3 and 9.1.4.

2. Maximum system pressure = 2750 pounds per square inch absolute (psia).

3. Fuel rod maximum linear power for determination of protection setpoints = 18.0 kilowatts per foot (kw/ft)

The accident analyses described in Chapter 15 demonstrate that the functional requirements as specified for the RTS are adequate to meet the above considerations, even assuming, for conservatism, adverse combinations of instrument errors. A discussion of the safety limits associated with the reactor core and Reactor Coolant System, plus the limiting safety system setpoints, are presented in the Technical Specifications.

7.2.1.2.5 Abnormal Events

The malfunctions, accidents or other unusual events which could physically damage RTS components or could cause environmental changes and the protection criteria followed are:

1. Earthquakes (see Sections 3.7N and 3.7B).

2. Fire (see Section 9.5.1).

3. ~~Explosion, hydrogen build-up inside Containment (see Section 6.2).~~ Deleted.

4. Missiles (see Section 3.5).

5. Flood (see Section 3.4).

6. Wind and tornadoes (see Section 3.3).

7. Loss of coolant accidents (see Section 6.2)

8. Steam line breaks (see Section 6.2)

9. Loss of ventilation (see Section 9.4)

The RTS fulfills the requirements of IEEE Standard 279-1971 to provide automatic protection and to provide initiating signals to mitigate the consequences of faulted conditions.

7.2.1.2.6 Minimum Performance Requirements

1. RTS response times

RTS response time is defined in Section 7.1. The maximum allowable time delays tabulated in Table 7.2-3 represent functional design values as opposed to acceptance criteria for response time testing. The Technical Specification response time requirements ensure that reactor protection system functional

7.3.1.2.4 Limits, Margins and Levels

Prudent operational limits, available margins and setpoints before onset of unsafe conditions requiring protective action are discussed in Chapter 15 and Technical Specifications.

7.3.1.2.5 Abnormal Events

The malfunctions, accidents, or other unusual events which could physically damage Protection System components or could cause environmental changes are as follows:

1. Earthquakes (see Sections 3.7N and 3.7B).

2. Fire (see Section 9.5.1).

3. ~~Explosion, hydrogen build-up inside Containment (see Section 6.2).~~ Deleted.

4. Missiles (see Section 3.5).

5. Flood (see Section 3.4).

6. Wind and tornadoes (see Section 3.3)

7. Loss of Coolant Accidents (see Section 6.2)

8. Steam line breaks (see Section 6.2)

9. Loss of ventilation (see Section 9.4)

7.3.1.2.6 Minimum Performance Requirements

Minimum performance requirements are as follows:

1. System response times

   The ESFAS response time is defined as the interval required for the engineered safety features sequence to be initiated subsequent to the point in time that the appropriate variable(s) exceed setpoints. The response time includes sensor/process (analog) and logic (digital) delay plus, the time delay associated with tripping open the reactor trip breakers and control and latching mechanisms, although the engineered safety features actuation signal occurs before or simultaneously with engineered safety features sequence initiation (see Figure 7.2- 1, Sheet 8). Therefore, the response times to initiating engineered safety features presented herein are conservative. The values listed herein are maximum allowable times consistent with the safety analyses and are systematically verified during plant preoperational startup tests. These maximum delay times thus include all compensation and therefore require that any such network be aligned and operating during verification.

7.3.2.2 Compliance With Standards and Design Criteria

Discussion of GDC are provided in various sections of Chapter 7 where a particular GDC is applicable. Applicable GDC include Criteria 13, 20, 21, 22, 23, 24, 25, 35, 37, 40, 43, and 46. ~~In addition, the Westinghouse supplied hydrogen recombiner meets GDC 41.~~ Compliance with certain IEEE Standards is presented in Sections 7.1.2.7, 7.1.2.9, 7.1.2.10, and 7.1.2.11. Compliance with Regulatory Guide 1.22 is discussed in Section 7.1.2.5. The discussion given below shows that the ESFAS complies with IEEE Standard 279-1971, Reference [4]. For the list of references to the discussions of conformance to applicable criteria, see Table 7.1-1.

7.3.2.2.1 Single Failure Criteria

The discussion presented in Section 7.2.2.2.3 is applicable to the ESFAS, with the following exception.

In the engineered safety features, a loss of instrument power will call for actuation of engineered safety features equipment controlled by the specific bistable that lost power (containment spray and RWST Low-Low excepted). The actuated equipment must have power to comply. The power supply for the protection systems is discussed in Section 7.6 and in Chapter 8. For containment spray, the final bistables are energized to trip to avoid spurious actuation. In addition, manual containment spray requires a simultaneous actuation of two manual controls. This is considered acceptable because spray actuation on hi-3 containment pressure signal provides automatic initiation of the system via protection channels meeting the criteria in Reference [3]. Moreover, two sets (two switches per set) of containment spray manual initiation switches are provided to meet the requirements of IEEE Standard 279-1971. Also, it is possible for all engineered safety features equipment (valves, pumps, etc.) to be individually manually actuated from the control board. Hence, a third mode of containment spray initiation is available. The design meets the requirements of Criteria 21 and 23 of the 1971 GDC.

7.3.2.2.2 Equipment Qualification

Equipment qualifications are discussed in Sections 3.10(B), 3.10(N), 3.11(B) and 3.11(N).

7.3.2.2.3 Channel Independence

The discussion presented in Section 7.2.2.2.3 is applicable. The engineered safety features slave relay outputs from the solid state logic protection cabinets are redundant, and the actuations associated with each train are energized up to and including the final actuators by the separate alternating current (AC) power supplies which power the logic trains.

7.3.2.2.4 Control and Protection System Interaction

The discussions presented in Section 7.2.2.2.3 are applicable.

TABLE 7.5-3

(Sheet 2)

SUMMARY OF TYPE B VARIABLES

Function Monitored	Variable	Variable Function	Type/ Category
	RCS Pressure (WR)	Backup (P)	B2
Heat Sink	Steam Generator Level (NR)	Key	B1
	Steam Generator Level (WR)	Key	B1
	Auxiliary Feedwater Flow to each S/G	Key	B1
	Main Steamline Pressure (S/G Pressure)	Key	B1
Containment Integrity	Containment Pressure (IR)	Key	B1
	Containment Water Level	Key	B1
	Containment Hydrogen Concentration	~~Key~~ Backup	~~B1~~ B3

Backup (P) - Preferred backup

IR - Intermediate Range

TABLE 7.5-4

SUMMARY OF TYPE C VARIABLES

Function Monitored	Variable	Variable Function	Type/ Category
Fuel Cladding	Core Exit Temperature	Key	C1
	Reactor Vessel Water Level (RVLIS)	Backup (P)	C2
	Accident Sampling	Backup	C3
	Radiation Level in Primary Coolant	Backup	C3
RCS Pressure Boundary	RCS Pressure (WR)	Key	C1
	Containment Pressure (IR)	Backup (P)	C2
	Containment Water Level	Backup (P)	C2
	Containment Radiation Level (HR)	Backup (P)	C2
	S/G Blowdown Radiation Level	Backup (P)	C2
	Condenser Off-gas Radiation	Backup (P)	C2
Containment Boundary	Containment Pressure (WR)	Key	C1
	Containment Hydrogen Concentration	~~Key~~	~~C1~~ Backup C3
	Plant Vent Effluent radioactivity and flow	Backup (P)	C2
	RCS Pressure (WR)	Backup (P)	C2
	Containment Isolation Valve Status*	Backup (P)	C2
	Containment Pressure (IR)	Backup (P)	C2
	Area Radiation Level Adjacent Containment	Backup (P)	C3

* Excludes local manual, check, relief and safety valves.

IR - Intermediate Range
WR - Wide Range
HR - High Range

CPSES/FSAR

TABLE 7.5-7A

(Sheet 3)

Instrument Summary Data for Variables in Table 2 of Reg. Guide 1.97, Rev 2

Variable	Type/ Category CPSES (RG 1.97)	Quantity Tag Numbers	Redundance and Sensor Location (11)	Instrument Range (1)	QA and Qualification (19)	Power Supply	Location of Display CR Displays	TSC/EOF Location (25)
	E3 PRIMARY COOLANT AND SUMP (E3 PRIMARY COOLANT AND SUMP)	GROSS ACTIVITY		10uCi/ml to 10 Ci/ml				
		GAMMA SPECTRUM		ISOTOPIC ANALYSIS				
		BORON CONTENT		500 TO 6000 ppm				
		CHLORIDE CONTENT		25 ppb TO 5 ppm				
		DISSOLVED HYDROGEN		0.5 TO 2000 cc/kg (STP)				
		OR TOTAL GAS						
		DISSOLVED OXYGEN		0.1 TO 20 ppm				
		pH		0 TO 14				
	E3 CONTAINMENT AIR (E3 CONTAINMENT AIR)	HYDROGEN CONTENT		0.1 TO 10%				
		OXYGEN CONTENT		0.1 TO 30%				
		GAMMA SPECTRUM		ISOTOPIC ANALYSIS				
CONTAINMENT RAD LEVEL (HR)	B2, C2, E1 (E1, C3)	2 PER UNIT RE-6290A&B	YES FIGURE 7.1-3	$1\text{-}10^7$R/hr.	EQ, SQ, QA	1E	ERFCS, RAD MONITOR CONSOLE	YES
CONDENSER OFF-GAS RADIATION	B2, C2 (C3)	1 PER UNIT RE-2959	N/A FIGURE 7.1-3	10^5 TO 10^{-1} uCi/cc	NONE (NOTE 2)	NON 1E	ERFCS, RAD MONITOR CONSOLE	YES
CONTAINMENT HYDROGEN CONCENTRATION	~~B1, C1~~ B3, C3 (C1)	4 PER UNIT AE-5506A THRU D	YES FIGURE 7.1-3	0-10%	EQ, SQ, QA	1E	ERFCS, INDICATION (1 PER TRAIN)	YES
CONTAINMENT PRESSURE (WR)	C1, D2 (C1)	2 PER UNIT PT-938 PT-939	YES FIGURE 7.1-3	0-150 psig	EQ, SQ, QA	1E	ERFCS, INDICATION	YES
PLANT VENT EFFLUENT RADIOACTIVITY AND FLOW	C2, E2 (C1, E2)	1 PER VENT STACK X-RE-5570 A & B	N/A FIGURE 7.1-3	10^{-6} - 10^5 uCi/cc 0-140,000 cfm	NONE (NOTE 3)	NON 1E	ERFCS, RAD MONITOR CONSOLE	YES
AREA RAD. LEVELS ADJACENT	C3 (C2)	11 PER UNIT RE-6259 A&B RE-6291 A&B	N/A FIGURE 7.1-3	10^{-1} - 10^4 R/hr	NONE	NON 1E	ERFCS, RAD. MONITOR CONSOLE	YES

TABLE 7.5-7D

(Sheet 7)

Specific Deviations from the Guidance in Reg. Guide 1.97, Rev. 2

Variable	Item	R.G. 1.97 Rev. 2	CPSES	Table 7.5-7E Reference (Justification)
PASS Room Area Radiation	Range Category	10^{-1}R/hr to 10^{4}R/hr Category 2	10^{-1}mR/hr to 10^{4}mR/hr Category 3	(1) (6)
Plant Vent Stack Area Radiation	Range Category	10^{-1}R/hr to 10^{4}R/hr Category 2	10^{-1}mR/hr to 10^{4}mR/hr Category 3	(1) (6)
Hot Lab Area Radiation	Range Category	10^{-1}R/hr to 10^{4}R/hr Category 2	10^{-1}mR/hr to 10^{4}mR/hr Category 3	(1) (6)
RHR Pump Room Area Radiation	Category	Category 2	Category 3	(6)
High Level Radioactive Liquid Tank Level	Instrument Range	Top to Bottom	0-100%	(1)
Plant and Environs Radioactivity	Instrument Range	Multichannel gamma-ray spectrometer	Hot Lab NOSF	(23)
CCW Header Temperature	Range	32°F-200°F	30°F-150°F	(2)
Hydrogen Monitors	Category	Category 1	Category 3	(24)

TABLE 7.5-7E

REFERENCE FOR TABLE 7.5-7D

(Sheet 4 of 4)

display in the control room. Local, such as indication gauge level and pump suction pressure indications are available to resolve ambiguities. Sufficient time is available to resolve ambiguities before the operator must act on CST Water Level Information.

(22) Containment Pressure Wide Range has qualified redundant channels but additional information is not available to resolve ambiguities over the full range of the instruments. The additional information provided by the Containment Pressure Narrow Range is sufficient.

(23) CPSES field monitoring teams are dispatched, as needed, to collect samples. These samples are transported to the Nuclear Operations Support Facility or the plant Hot Lab for analysis. At either location gamma spectroscophy equipment is used to analyze the samples. Instrumentation provided for this capability meets the intent of Regulatory Guide 1.97, Revision 2.

(24) The Hydrogen Monitors are capable of diagnosing beyond design-basis accidents. The Hydrogen Monitors were changed from Category 1 to Category 3 based on the revision to 10CFR50.44 on October 16, 2003.

TABLE 8.1-1

(Sheet 1 of 2)

SAFETY LOADS AND FUNCTION

Safety Load	Function	Power
Safety injection pumps	Provide emergency core cooling	AC
Charging pumps	Provide emergency core cooling	AC
Residual heat removal (RHR) pumps	Provide emergency core cooling and reactor heat removal during refueling operations	AC
Containment spray pumps	Provide cooling spray in containment following a loss-of-coolant accident (LOCA)	AC
Service water pumps	Provide cooling water for Component Cooling Water System (CCWS) heat exchangers, and emergency diesel generators	AC
Component cooling water pumps	Provide cooling water to safety-related equipment	AC
Auxiliary feedwater pumps	Provide adequate water to steam generators in the event of a unit trip coupled with a loss of offsite power	AC
Spent-fuel pool cooling and cleanup pumps	Cool spent fuel pool water	AC
~~Hydrogen recombiner~~	~~Reduce hydrogen concentration in Containment following a LOCA~~	~~AC~~
Control Room emergency	Maintain safe environmental conditions for operating personnel air cooling units and limit ambient air temperature in safety-related compartments heating, ventilating, and air conditioning.	AC

TABLE 8.1-1

(Sheet 2)

SAFETY LOADS AND FUNCTION

Safety Load	Function	Power
Heating, ventilating,and air-conditioning (HVAC) water chiller	Provide cooling fluid for emergency air cooling units	AC
~~Containment Hydrogen Purge System~~	~~Control post LOCA hydrogen concentrations.~~	~~AC~~
Motor-operated valves small motors, fans and heaters, associated with Safety-related equipment	Insure coordinated operation of safety-related systems	AC
Reactor Protection System and Engineered Safety Features (ESF) Actuation System	Provide safe plant shutdown	AC and DC
Plant instrumentation	Provide safe reactor operation	AC
Instrument buses	Provide power to instrumentation and control equipment	AC
Shutdown control and instrumentation	Provide control to shutdown plant from outside of Control Room.	AC and DC
Instrument bus inverters	Provide power to instrument buses	DC

TABLE 8.3-11

(Sheet 7)

NON-CLASS 1E EQUIPMENT CONNECTED TO SAFETY RELATED POWER CIRCUITS

EQUIPMENT ID NO.	DESCRIPTION	POWER SOURCE ID NO.		NOTE
XEB2-2/6M/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CPX-EPMCEB-02	6M	(1)
XEB1-1/2M/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CPX-EPMCEB-07	2M	(1)
XEB2-1/5M/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CPX-EPMCEB-08	5M	(1)
XEB3-2/2F/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CPX-EPMCEB-03	2F	(1)
XEB4-2/2F/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CPX-EPMCEB-04	2F	(1)
1EB3-3/3M/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CP1-EPMCEB-07	3M	(1)
1EB3-4/8J/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CP1-EPMCEB-09	8J	(1)
1EB4-3/3M/TR	MCC AND MOTOR SPACE HEATER SUPPLY	CP1-EPMCEB-08	3M	(1)
CPX-ELTRET-06	XFMR FOR LTG DIST PNL ECB2 & EAB10	CPX-EPMCEB-02	6C	(5),(6)
CPX-ELTRET-10	XFMR FOR LTG DIST PNL EABD4, EAB6 & EAB8	CPX-EPMCEB-02	4BL	(5),(6)
CP1-ELTRET-05	XFMR FOR LTG DIST PNL ECB5 & ECB3	CP1-EPMCEB-07	5BL	(5),(6)
CP2-ELTRET-05	XFMR FOR LTG DIST PNL 2ECB3	CPX-EPMCEB-07	5BR	(5),(6)
CPX-ELTRET-05	XFMR FOR LTG DIST PNL EAB9 & ECB1	CPX-EPMCEB-07	1BL	(5),(6)
CP2-ELTRET-06	XFMR FOR LTG DIST PNL 2ECB4	CPX-EPMCEB-08	2BL	(5),(6)
CP1-ELTRET-06	XFMR FOR LTG DIST PNL ECB4 & ECB6	CPX-EPMCEB-08	2BR	(5),(6)
CPX-ELTRET-07	XFMR FOR LTG DIST PNL EAB1, EAB3, EAB11 & EABD1	CPX-EPMCEB-03	4BL	(5),(6)
CPX-ELTRET-08	XFMR FOR LTG DIST PNL EAB2, EAB4, EAB12 & EABD2	CPX-EPMCEB-04	6A	(5),(6)
CP1-MEDGEE-01H	GENERATOR SPACE HEATER	CP1-EPMCEB-09	2BL	(8)
CP1-MEDGEE-02H	GENERATOR SPACE HEATER	CP1-EPMCEB-10	2BL	(8)
CPX-VAFNCB-01	HYDROGEN PURGE SYSTEM (HPS) EXHAUST FAN 01	CPX-EPMCEB-01	6J	(1)
CPX-VAFNCB-02	HYDROGEN PURGE SYSTEM (HPS) EXHAUST FAN 02	CPX-EPMCEB-02	6J	(1)
CPX-VAFUPK-19	HPS FILTRATION UNIT HEATERS 19	CPX-EPMCEB-01	2BR	(1)
CPX-VAFUPK-20	HPS FILTRATION UNIT HEATERS 20	CPX-EPMCEB-02	2BR	(1)
CPX-VAFULV-19	FIRE PROTECTION PANEL 19	CPX-ECDPEC-03	9	(5)
CPX-VAFULV-20	FIRE PROTECTION PANEL 20	CPX-ECDPEC-04	9	(5)
X-HV-5526	HPS MOTORIZED VALVE	CPX-EPMCEB-03	2C	(5B
TBX-GHCPEL-01	Hydrogen Recombiner	1EB3-2 (11)		
TBX-GHCPEL-02	Hydrogen recombiner	1EB4-2 (11)		

TABLE 8.3-11

(Sheet 8)

NON-CLASS 1E EQUIPMENT CONNECTED TO SAFETY RELATED POWER CIRCUITS

EQUIPMENT ID NO.	DESCRIPTION	POWER SOURCE ID NO.		NOTE
X-HV-5579	HPS MOTORIZED VALVE	CPX-EPMCEB-03	6F	(5)
X-HV-5529	HPS MOTORIZED VALVE	CPX-EPMCEB-04	2C	(5)
X-HV-5580	HPS MOTORIZED VALVE	CPX-EPMCEB-04	6D	(5)

NOTES:

(1) In accordance with Regulatory Guide 1.75, January 1975, Position C.1, Automatically Tripped on SIAS (accident signal). Reconnection requires operator action(s) after resetting SIAS.

(2) Breaker trips on SIAS, requires operator action to reset, and connecting cable is black and routed separately. In addition, these loads are also tripped on LOOP.

(3) This portion of the non-Class 1E MCC is tripped on SIAS or Blackout (Loss of Offsite Power) signal, and cable is in dedicated raceway.

(4) Same as No. 1, except MCC's are tripped from either Unit 1 or 2 independent power supply, thus MCC's, associated and non-Class 1E loads are isolated by SIAS signal. During normal operation MCC's are powered by Unit 2, and Unit 1 power is locked out.

(5) Non-Class 1E loads fed from Class 1E supplies are protected by two separate Class 1E breakers, or Class 1E breaker and Class 1E fuse or two separate Class 1E fuses connected in series. These breakers/fuses are coordinated with their supply breakers, and breakers will be tested and calibrated periodically to ensure coordination.

(6) The Class 1E transformers and lighting distribution panels feed non-Class 1E loads.

(7) Breaker trips on SIAS (accident signal), reconnection requires operator action to reset, and connecting cable is associated. In addition, this load is also tripped on LOOP.

(8) Breaker trips on SIAS, requires operator action to reset, and connecting cable is black and routed separately. These loads are also tripped by diesel generator breaker auxiliary contacts when the breaker closes to power the Class 1E bus. Therefore the loads will not be on the bus during a safety injection or loss of offsite power.

(9) Equipment listed, is for Unit 1; Unit 2 is similar, except for equipment identification numbers.

(10) Transfer switch is isolated from Class 1E bus by administratively controlled normally open circuit breakers. There are no automatic connections to the 1E bus. It is only connected to either bus during modes 5 and 6, and only if the plant experiences a loss of offsite power coincident with failure of the Class 1E Emergency Diesel Generators

11. Hydrogen Recombiners were originally Engineered Safety Features and fully qualified. However, based on a change to 10 CFR 50.44 They no longer have a Nuclear Safety Function. The power supply to the recombiners is locked out during modes where the bus is required operable by Technical Specifications. A recombiner may be powered and used in the long term post accident if required.

TABLE II.B.2-4

(Sheet 3)

VITAL AREA ACCESS

	Vital Access Area	Description of Task[1]	Time After LOCA (hrs) When Access is Required	UNIT 1 Route No.	UNIT 1 Operator Dose[7] (rem)	UNIT 2 Route No.	UNIT 2 Operator Dose[7] (rem)
10.	Rooms No. 84 and 85[5] Diesel generator control station	To inspect the fuel oil storage tank level, fill the oil storage tanks when needed	1.0	10 Fig. II.B.2-36	0.86	10 Fig. II.B.2-62 Fig. II.B.2-63 Fig. II.B.2-64	0.84
11.	Rooms No. 84 and 85[5] Diesel generator control station	To inspect the DG lube oil makeup duplex filter and strainers	1.0	11 Fig. II.B.2-36	0.86	11 Fig. II.B.2-62 Fig. II.B.2-63 Fig. II.B.2-64	0.84
12.	Equipment Yard Diesel generator fuel oil tank filling area	To fill main diesel generator oil storage tanks from a delivery tanker truck	Three days after LOCA[8]	12 Fig. II.B.2-37	2.2[9]	12 Fig. II.B.2-65	2.2[9]
13.	Task deleted						
14.	Rooms No. 82, 95, 96, 103, 113, 133, 134 and 241	To deenergize lights, in the case of loss of the non ESF ventilation after a LOCA to prevent temperature excursions	0.5	14 Fig. II.B.2-39	0.61	14 Fig. II.B.2-68 through Fig. II.B.2-73	0.64
15.	~~Room No.104 or 82 Mechanical equipment area, hydrogen recombiners control panels~~	~~To turn the hydrogen recombiners on and adjust power until the required temperature is reached.~~	~~24.0~~	~~15~~ ~~Fig. II.B.2-40~~	~~0.04~~	~~15A~~ ~~Fig. II.B.2-74~~ ~~15B~~ ~~Fig. II.B.2-75~~ ~~Fig. II.B.2-76~~ ~~Fig. II.B.2-77~~	~~0.11~~ ~~0.04~~
16.	Room No.79 Safeguards Drain Panel (TAG No. CPI-E1PRLV-24)	Diagnose passive failures in the ESF Systems.	24.0	16 Fig. II.B.2-41	0.11	16 Fig. II.B.2-78	0.07
17.	Rooms No.150 and 150A, Mechanical	To manually open control room intake dampers.	Within 48	17	0.3[6] Fig. II.B.2-42	17 Fig. II.B.2-79	0.30[6]

TABLE II.B.2-5

(Sheet 2)

DOSE RATES AND TIME SPENT BETWEEN CONSECUTIVE POINTS OF UNIT 1 OPERATOR ROUTE[1]

	A		B		C		D		E		F		G	
Operator Task and Route No.	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
7. Switch over the reactor makeup water pump Route #7	13	77	33	34	14	4.1	13	305	37	4.1	15	5.0	23	28
8. Isolation of NNS portion of the reactor makeup water system Route #8	13	77	33	34	14	4.1	13	305	37	4.1	15	5.0	23	28
9. Maintaining the fuel pool water level Route #9	13	18	33	18	14	3.3	13	170	37	3.3	15	5.0	23	17
10. Inspection of the diesel generator fuel tanks level Route #10	13	27	33	27	14	3.7	13	253	37	3.7	15	5.0	6	5.0
11. Inspection of the diesel generator lube oil makeup duplex filters and strainers Route #11	13	27	33	27	14	3.7	13	253	37	3.7	15	5.0	6.0	5.0
12. Filling the main diesel generator fuel storage tank Route #12	54	0.3	60	0.6	90	0.5	30	125	- Task 3 hrs[2]	125				
13. Task deleted														
14. Deenergizing the lights Route #14	46	77	14	4.1	67 Task 60 sec.	3,300	14	4.1	13	305	37	4.1	29	5.0
15. ~~Powering up the hydrogen Recombiners Route #15~~	~~13~~	~~1.0~~	~~33~~	~~1.0~~	~~14~~	~~2.5~~	~~13~~	~~17.0~~	~~37~~	~~2.5~~	~~15~~	~~5.0~~	~~6.4~~	~~5.0~~
16. Safeguards Drain Panel Access Route #16	13	1.0	33	1.0	11	1.0	24	108	7	2,000	-	2,000 Task 3 min.	-	-
17. Manually open Control Room HVAC Intake Damper Route #17	30	1.0	3	24.8	20	1.66	10	24.8	15 Task 30 min.	565	-	-	-	-
19. Manually realign valves to maintain spent fuel pool cooling	12.5	77	33	34	14.3	4.1	13.3	305	36.7	4.1	16.7	5	47	5
20. Manually isolate steam supply to the AFWPT	12.5	18	33	18	14.3	3.3	13.3	170	36.7	3.3	29.3	5	64.3	24.7

TABLE II.B.2-5

(Sheet 4)

DOSE RATES AND TIME SPENT BETWEEN CONSECUTIVE POINTS OF UNIT 1 OPERATOR ROUTE[1]

		H		I		J		K		L		M	
Operator Task and Route No.		t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
12.	Filling the main diesel (contd)												
13.	Task deleted												
14.	Deenergizing the lights (contd)	97 Task 90 sec.	24.7	15	5.0	64	5.0	31	4,400	13 Task 30 sec.	6,500	8	4,400
~~15.~~	~~Powering up (contd)~~	~~38~~	~~520~~	~~19~~	~~5.2~~	~~22~~	~~25.4~~	~~8~~	~~90~~	~~15~~	~~790~~	~~10~~	~~1,600~~
16.	Safeguards Drain Panel Access (contd)												
17.	Manually open control room HVAC Intake Damper (contd)												
19.	Manually realign valves to maintain spent fuel pool cooling	39.6	3510	126 Task 10 min.	5580	39.6	3510	47	5	31.3	5	23.3	28
20.	Manually isolate steam supply to the AFWPT	14.7	89.5	12	42	9.3	250	13	96000	- Task 124 sec.			

		N		O		P		Q		R		S		T	
Operator Task and Route No.		t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
1.	Post accident (contd)														
2.	Sampling of plant (contd)														
3.	Filling the CCW (contd)														
4.	Filling the safety (contd)														
5.	Safety chilled water (contd)														
6.	Adjusting the AFW (contd)	8	29,000	6	1,240	4	13,300	9	13,000	3 Task 15 min.	1,900				

TABLE II.B.2-5

(Sheet 5)

DOSE RATES AND TIME SPENT BETWEEN CONSECUTIVE POINTS OF UNIT 1 OPERATOR ROUTE[1]

		N		O		P		Q		R		S		T	
Operator Task and Route No.		t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
7.	Switch over (contd)														
8.	Isolation of NNS (contd)														
9.	Maintaining the fuel (contd)														
10.	Inspection of diesel (contd)	12	38,000	11	6,200	16 Task 5 min.	5.0	19	6,200	18	9,800	16 Task 5 min.	5.0		
11.	Inspection of diesel (cont)	12	38,000	11	6,200	16 Task 10 min.	5.0	19	6,200	18	9,800	16 Task 10 min.	5.0		
12.	Filling the main diesel (contd)														
13.	Task deleted														
14.	Deenergizing the lights (contd)	22 Task 30 sec.	350	24.3	686	7.3	1,100	15	8,500	10 Task 30 sec.	17,700	12	10,800	27 Task 15 sec.	410
15.	~~Powering up (contd)~~	~~12~~	~~1,000~~	~~17~~	~~29~~	~~10~~	~~29~~	~~9~~	~~96~~	~~- Task 60 min.~~	~~3~~				
16.	Safeguards Drain Panel Access (contd)														
17.	Manually open Control Room HVAC Intake Damper (contd)														
19.	Manually realign valves to maintain spent fuel pool cooling	30.3	4.1	27.8	380	25	2.5	13.3	25	77.3 Task 32 min.	25	96.6 Task 28 min.	398	42 Task 5 min.	25
20.	Manually isolate steam supply to the AFWPT														

TABLE II.B.2-6

(Sheet 2)

DOSE RATES AND TIME SPENT BETWEEN CONSECUTIVE POINTS OF UNIT 2 OPERATOR ROUTE[1]

		A		B		C		D		E		F		G	
Route	Operator Task	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
6.	Adjusting the AFW flow rate	12.5	77	33	34	5	5	14.7	5	5	2600	9.3	740	9.3	125
7.	Switchover the reactor makeup water pumps in case of low pressure alarm	12.5	77	33	34	5	5	14.7	5	23.3	28	14	66	30.3	1040
8.	Isolation of NNS portion of the reactor makeup water system	12.5	77	33	34	5	5	14.7	5	23.3	28	14	66	30.3	1040
9.	Maintaining the fuel pool water level	12.5	6	33	6	5	5	14.7	5	23.3	8	17.3	17	30.3	195
10.	Inspection of the diesel generator fuel tank level	12.5	27	33	27	5	5	14.7	5	64.3	5	38.3	3600	9.8	280
11.	Inspection of the diesel generator lube oil makeup duplex filters & strainers	12.5	27	33	27	5	5	14.7	5	64.3	5	38.3	3600	9.8	280
12.	Filling the main diesel generator fuel storage tank	97	0.3	60	0.6	90 Task 3 hrs.[2]	0.5	37.5	125	-	125				
13.	Task Deleted														
14.	De-energizing lights	12.5	77	33	34	14.3 Task 1 min.	4.1	13.3	305	36.7	4.1	66.6	3300	36.7	4.1
15A.	~~Powering up the hydrogen recombiners~~	~~12.5~~	~~1~~	~~33~~	~~1~~	~~14.3~~	~~2.5~~	~~13.3 Task 60 min.~~	~~17~~	~~36.7~~	~~2.5~~	~~33.3~~	~~110~~	-	~~110~~
15B.	~~Powering up the hydrogen recombiners~~	~~12.5~~	~~1~~	~~33~~	~~1~~	~~5~~	~~2.5~~	~~14.7~~	~~5~~	~~64.3~~	~~5~~	~~38.3~~	~~520~~	~~19~~	~~5.2~~

CPSES/FSAR

TABLE II.B.2-6

(Sheet 5)

DOSE RATES AND TIME SPENT BETWEEN CONSECUTIVE POINTS OF UNIT 2 OPERATOR ROUTE[1]

		H		I		J		K		L		M		N	
Route	Operator Task	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
14.	De-energizing lights	13.3	305	14.3	4.1	29.3	5	96.6 Task 1.5 min.	24.7	14.7	5	64.3	5	30.7	4400
15A.	~~Powering up the hydrogen recombiners~~														
15B.	~~Powering up the hydrogen recombiners~~	~~22~~	~~25.4~~	~~8~~	~~95~~	~~14.7~~	~~790~~	~~10~~	~~1600~~	~~12~~	~~1000~~	~~7.3~~	~~29~~	~~10~~	~~29~~
16.	Safeguards drain panel access	- Task 3 min.	1200												
17.	Manually open Control Room HVAC intake damper	12	561	- Task 30 min.	561										
19.	Manually realign valves to maintain spent fuel pool cooling	39.6	3510	21.7	5	31.3	5	23.3	28	14	66	30.3	1040	27.8	380
20.	Manually isolate steam supply to the AFWPT	9.3	250	13	97000	- Task 124 sec									

		O		P		Q		R		S		T		U	
Route	Operator Task	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
1.	Post-accident Sampling														
1A.	Initial valve lineup	10	21700	20	27000	20	27000								
1B.	Sample retrieval														
1C.	Hot lab preparation														

CPSES/FSAR

TABLE II.B.2-6

(Sheet 7)

DOSE RATES AND TIME SPENT BETWEEN CONSECUTIVE POINTS OF UNIT 2 OPERATOR ROUTE[1]

		O		P		Q		R		S		T		U	
Route	Operator Task	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
12.	Filling the main diesel generator fuel storage tank														
13.	Task Deleted														
14.	De-energizing lights	12.6 Task 0.5 min.	6500	7.7	4400 Task 0.5 min.	22	350	24.3	686	7.5	1100	14.7	8500	10	17700
15A.	~~Powering up the hydrogen recombiners~~														
15B.	~~Powering up the hydrogen recombiners~~	~~9.3~~	~~96~~	~~- Task 60 min.~~	3										
16.	Safeguards drain panel access														
17.	Manually open Control Room HVAC intake damper														
19.	Manually realign valves to maintain spent fuel pool cooling	25	2.5	13.3	25 Task 32 min	77.3	25	96.6 Task 28 min	1150	42 Task 5 min	25	13.3	25	25	2.5
20.	Manually isolate steam supply to the AFWPT														

		V		W		X		Y		Z		AA		BB	
Route	Operator Task	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr	t	dr
1.	Post-accident Sampling														

(4) Pressurizer heater motive and control power interfaces with the emergency buses shall be accomplished through devices that have been qualified in accordance with safety-grade requirements.

- NUREG 0737

CPSES Response

Power is supplied to four pressurizer heater groups from offsite power, when available, and from the onsite emergency diesel generators through ESF buses. Redundancy is provided by supplying two groups of pressurizer heaters from each redundant ESF train, Control power for manual on/off control of each of these four heater groups is supplied from the 125 volt DC ESF bus in the same train as the main power supply.

Procedures are established to control Reactor Coolant System pressure and temperature. Per Westinghouse analysis, pressurizer heaters are not required during natural circulation cooldown to Hot Shutdown or Cold Shutdown.

No loads need to be shed from the emergency power source to provide sufficient capacity for the connection of the pressurizer heaters.

The electrical interface between each of the four pressurizer heater groups and its associated F bus of concern is through a circuit breaker which trips on an "S" signal and is qualified in accordance with safety-grade requirements. The manual controls for these breakers are qualified in accordance with safety-grade requirements.

II.E.4 CONTAINMENT DESIGN

OBJECTIVE:

"Improve the reliability and capability of nuclear power plant containment structures to reduce the radiological consequences and risks to the public from design basis events and degraded—core and core—melt accidents."

- NUREG 0660, Pg. II.E.4-1

II.E.4.1 Dedicated Penetration

Action Plan Requirements:

Plants using external recombiners or purge systems for postaccident combustible gas control of the containment atmosphere should provide containment penetration systems for external recombiner or purge systems that are dedicated to that service only, that meet the redundancy and single—failure requirements of General Design Criteria 54 and 56 of Appendix A to 10 CFR 50, and that are sized to satisfy the flow requirements of the recombiner or purge system.

The procedures for the use of combustible gas control systems following an accident that results in a degraded core and release of radioactivity to the containment must be reviewed and revised, if necessary.

- NUREG 0737

CPSES Response

See Sections 6.2.4 and 6.2.5 for containment penetration isolation and for combustible gas control.

~~CPSES has redundant safety-grade hydrogen recombiners located inside each containment for post-accident hydrogen control. These recombiners are controlled from outside the containment.~~

II.E.4.2 Isolation Dependability

Action Plan Requirements:

"Provide containment isolation on diverse signals in conformance with Section 6.2.4 of the Standard Review Plan, review isolation provisions for non-essential systems and revise as necessary, and modify containment isolation designs as necessary to eliminate the potential for inadvertent reopening upon reset of the isolation signal."

- NUREG 0578, Pg. 8

"(1) Containment isolation system designs shall comply with the recommendations of Standard Review Plan Section 6.2.4, (i.e., that there be diversity in the parameters sensed for the initiation of containment isolation).

"(2) All plant personnel shall give careful consideration to the definition of essential and nonessential systems, identify each system determined to be nonessential, describe the basis for selection of each essential system, modify their containment isolation designs accordingly, and report the results of the reevaluation to the NRC.

"(3) All nonessential systems shall be automatically isolated by the containment isolation signal.

"(4) The design of control systems for automatic containment isolation valves shall be such that resetting the isolation signal will not result in the automatic reopening of containment isolation valves. Reopening of containment isolation valves shall require deliberate operator action.

"(5) The containment setpoint pressure that initiates containment isolation for nonessential penetrations must be reduced to the minimum compatible with normal operating conditions.

"(6) Containment purge valves that do not satisfy the operability criteria set forth in Branch Technical Position CSB 6-4 or the Staff Interim Position of October 23,

Included for Information only

II.F INSTRUMENTATION AND CONTROLS

OBJECTIVE:

"Provide instrumentation to monitor plant variables and systems during and following an accident. Indications of plant variables and status of systems important to safety are required by the plant operator (licensee) during accident situations to (1) provide information needed to permit the operator to take preplanned manual actions to accomplish safe plant shutdown; (2) determine whether the reactor trip, engineered safety features systems, and manually initiated systems are performing their intended functions (i.e., reactivity control, core cooling, maintaining reactor coolant system integrity, and maintaining containment integrity); (3) provide information to the operator that will enable him to determine the potential for a breach of the barriers to radioactivity release (i.e., fuel cladding, reactor coolant pressure boundary, and containment) and if a barrier has been breached; (4) furnish data for deciding on the need to take unplanned action if an automatic or manually initiated safety system is not functioning properly or the plant is not responding properly to the safety systems in operation; (5) allow for early indication of the need to initiate action necessary to protect the public and for an estimate of the magnitude of the impending threat; and (6) improve requirements and guidance for classifying nuclear power plant instrumentation, control, and electrical equipment important to safety."

-NUREG 0660, pg. II.F-1

II.F.1 ADDITIONAL ACCIDENT MONITORING INSTRUMENTATION.

Action Plan Requirements:

"Item II.F.1 of NUREG-0660 contains the following subparts:

(1) Noble gas effluent radiological monitor:

(2) Provisions for continuous sampling of plant effluents for postaccident releases of radioactive iodines and particulates and onsite laboratory capabilities (this requirement was inadvertently omitted from NUREG-0660; see Attachment 2 that follows, for position);

(3) Containment high-range radiation monitor;

(4) Containment pressure monitor;

(5) Containment water level monitor; and

(6) Containment hudrogen concentration monitor.

"NUREG-0578 provided the basic requirements associated with items (1) through (3) above. Letters issued to all operating nuclear power plants dated Septemcber 13, 1979

and October 30, 1979 provided clarification of staff requirements associated with items (1) through (6) above. Attachments 1 through 6 present the NRC position on these matters."

-NUREG-0737

CPSES Response

The use of the additional accident monitoring instrumentation as listed will be integrated into the operating procedures and training programs prior to fuel load:

(1) Noble Gas Monitor

The CPSES design will include wide range noble gas monitors for the plant vent stack which will detect and measure concentrations of noble gas fission products in plant gaseous effluents during and following an accident.

An adjacent-to-line monitor will be provided for each main steam line to monitor the concentration in steam that may be released to the environment by the safety or relief valves.

For description of these monitors, see Section 11.5.

(2) Iodine/Particulate Sampling

The wide range noble gas monitor discussed above provides the capability to sample the plant vent stacks as required.

For description, see Section 11.5.

(3) Containment High Range Radiation Monitor

The redundant Category 1 monitors will be located in each Containment Building at Elevation 905'-9". Exact location is provided in Figure II.F-1. To ensure valid data, these monitors will be located at least 90E apart and will not be located adjacent to process piping.

Monitor special calibration and environmental qualification will be performed as specified in Table II.F.1-3 of NUREG-0737.

For further discussion, see Section 12.3.

(4) Containment Pressure

The CPSES design will include redundant wide range pressure indication (0 - 150 psig) on the Main Control Board meeting Regulatory Guide 1.97 Rev. 2 requirements. In addition this parameter will be provided as input to the SPDS high level display.

The present CPSES design includes four channels of intermediate range pressure indication (-5 to + 60 psig) on the Main Control Board meeting Regulatory Guide 1.97 Rev. 2 requirements. In addition this parameter will be provided as input to the SPDS high level display.

(5) Containment Water Level

CPSES design will include redundant wide range containment level indication (elevation 808' to 817' - 6) on the Main Control Board meeting Regulatory Guide 1.97 Rev. 2 requirements. In addition this parameter will be provided as input to the SPDS high level display. These transmitters measure volume in excess of 600,000 gallons. CPSES design will also include normal sump level indications (0 - 3 feet) on the Main Control Board. The containment wide range level indication covers the entire range of expected water level in the Containment for post accident conditions. Therefore, containment narrow range level indication is not considered as required for accident monitoring.

(6) Containment Hydrogen

Based on a revision to 10CFR 50.44, the design basis LOCA hydrogen release has been eliminated and the requirements for hydrogen monitoring has been changed. See Section 7.5 for current requirements."

~~The CPSES design will include H_2 concentration indication (0 - 10%) on the Main Control Board meeting Regulatory Guide 1.97 Rev. 2 requirements. In addition this parameter will be provided as input to the SPDS high level display.~~

II.F.2 IDENTIFICATION OF AND RECOVERY FROM CONDITIONS LEADING TO INADEQUATE CORE COOLING

Action Plan Requirements:

"Licensees shall provide a description of any additional instrumentation or controls (primary or backup) proposed for the plant to supplement existing instrumentation (including primary coolant saturation monitors) in order to provide an unambiguous, easy-to-interpret indication of inadequate core cooling (ICC). A description of the functional design requirements for the system shall also be included. A description of the procedures to be used with the proposed equipment, the analysis used in developing these procedures, and a schedule for installing the equipment shall be provided."

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CPSES Response

The CPSES design will include redundant instrumentation to monitor the approach to, existence of and recovery from inadequate core cooling. The monitored parameters will be the reactor coolant system (RCS) saturation margin, the collapsed water level above the reactor core and the RCS temperature at the core exit.

An indication of a declining margin to saturation in the RCS will provide the earliest warning that conditions are developing which could lead to ICC. If the event is allowed