HITACHI

GE Hitachi Nuclear Energy

James C. Kinsey
Vice President, ESBWR Licensing

PO Box 780 M/C A-55
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057

MFN 08-346

Docket No. 52-010

April 30, 2008

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-63

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAI transmitted via the Reference 1 letter. DCD Markups related to this response are provided in Enclosure 2.

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

If you have any questions or require additional information, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

D068

NRO

Reference:

1. MFN 07-054, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application*, January 19, 2007

Enclosures:

1. MFN 08-346 - Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-63
2. MFN 08-346 - Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-63 - DCD Markups

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	eDRF	0000-0077-1083R1

Enclosure 1

MFN 08-346

Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application

Emergency Core Cooling Systems

RAI Number 6.3-63

NRC RAI 6.3-63:

DCD, Tier 2, Revision 2, Page 6.2-3 states that: "During a [loss of coolant accident] LOCA, when the vacuum breaker opens and allows the flow of gas from the [wetwell] WW to the [drywell] DW to equalize the DW and WW pressure and subsequently does not completely close as detected by the proximity sensors, a control signal will close the upstream isolation valve to prevent extra bypass leakage due to the opening created by the vacuum breaker and therefore maintain the pressure suppression capability of the containment." How does the control system determine that there is extra leakage due to the vacuum breaker not closing? What is the leakage threshold? What is the time delay signal for the closing of the isolation valve? Given the allowed leakage and time delay of the isolation valve, what is the impact on the passive containment cooling system performance? How does this effect containment pressure and reactor pressure vessel level calculations?

GEH Response:

Bypass leakage is detected as described in response to RAI 6.2-148 (MFN 08-344, dated April 18, 2008). The control and instrumentation for the vacuum breaker isolation valve (VBIV) is described in a new DCD Tier 2, Subsection 7.3.6. The VBIV will close upon detection of bypass leakage based on a change in temperature within the vacuum breaker (VB)/VBIV assembly due to the hotter gases passing through a leaking VB. The heatup of the gases within the assembly is dependent upon the heatup rate of the drywell gases, which is dependent on the type of Design Basis Accident (DBA) postulated. The setpoint is determined such that there is sufficient margin to close the VBIV so that containment design pressure is not threatened and the pressure suppression function of the containment remains intact. With this sufficient margin to close the VBIV, containment pressure does not exceed design pressure for the analyzed DBAs.

DCD Impact:

DCD Tier 1, Table 2.2.15-1 and Table 2.15.1-1c, will be revised as shown in the attached markup.

DCD Tier 2, Subsection 6.2.1.1.5.5, Subsection 6.2.1.1.5.5.1, Subsection 6.2.1.1.5.5.2, Table 7.1-1, and Table 7.1-2 will be revised, a new Subsection 7.3.6 will be added, Section 7.5, Subsection 7.5.2.1, and Subsection 7.5.2.2 will be revised, and Subsection 7.5.6 will be deleted, as shown in the attached markup.

Enclosure 2

MFN 08-346

Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application

Emergency Core Cooling Systems

RAI Number 6.3-63

DCD Markups

Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box. The marked-up pages may contain unverified changes in addition to the verified changes resulting from this RAI response. Other changes shown in the markup(s) may not be fully developed and approved for inclusion in DCD Revision 5.

Table 2.2.15-1

ITAAC Applicability Matrix (1)

IEEE Std. 603 Criterion	NBS (2.1.2)	CRDS (2.2.2)	SLC System (2.2.4)	NMS (2.2.5)	RSS (2.2.6)	RPS (2.2.7)	LD&IS (2.2.12)	SSLC/ESF (2.2.13)	PRMS (2.3.1)	ICS (2.4.1)	GDCS (2.4.2)	CS (2.15.1)	CMS (2.15.7)	SPTM (2.15.7)	RBHVS (2.16.2.1)	CBHVS (2.16.2.2)	EFU (2.16.2.3)
5.1	-	-	-	X	-	X	X	X	-	X	X	X	-	-	X	X	X
5.2 and 7.3	-	-	-	-	-	X	X	X	-	-	-	X	-	-	-	-	-
5.3	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	-	(3)	(3)	(3)	(3)	(3)
5.4	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
5.5	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
5.6 and 6.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5.7 and 6.5	X	X	X	X	-	X	X	X	-X	X	X	X	X	X	X	X	X
5.8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5.9	-	-	-	X	X	X	X	X	-	-	-	-	-	-	-	-	-
5.10	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
5.11	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
5.12	-	-	-	X	-	X	X	X	-	X	X	-	-	-	X	X	X
5.13	-	-	-	X	-	X	X	X	-	X	X	-	-	-	-	-	-
5.14	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
5.15	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
6.1 and 7.1	-	-	-	-X	-	X	-X	X	-X	-	-	-	-	-	X	X	X
6.2 and 7.2	-	-	-	-X	-	X	-X	X	-X	-	-	X	-	-	X	X	X
6.4	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
6.6 and 7.4	-	-	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-
6.7, ~~and~~ 7.5, and 8.3	-	-	-	X	-	X	-	X	-	-	-	-	-	-	X	X	X
6.8	X	-	X	X	-	X	X	X	X	-	-	-	X	X	-	-	-
8.1	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X
8.2	-	X	-	-	-	-	X	-	-	X	X	-	-	-	X	X	X

(1) A dash means not applicable.

(2) Safety-related portions only.

(3) No ITAAC is required for this criterion. See the description of the 10 CFR 50, Appendix B, Quality Assurance Program that is applied to the design, fabrication, construction, and test of the safety-related structures, systems, and components provided as part of the preliminary safety evaluation report as required by 10 CFR 50.34(a)(7).

Table 2.15.1-1c

Electrical Equipment

Equipment Name (Description)	Equipment Identifier See Figure 2.15.1-1	Control Q-DCIS/ DPS	Seismic Category I	Safety-Related	Safety-Related Display	Active Function	Remotely Operated	Containment Isolation Valve Actuator
Vacuum Breaker	11(A)	-	Yes	Yes	Yes	Open/Close	No	No
Vacuum Breaker Isolation Valve	11a(A)	Note 1	Yes	Yes	Yes	Open/Close	Yes	No
Vacuum Breaker	11(B)	-	Yes	Yes	Yes	Open/Close	No	No
Vacuum Breaker Isolation Valve	11a(B)	Note 1	Yes	Yes	Yes	Open/Close	Yes	No
Vacuum Breaker	11(C)	-	Yes	Yes	Yes	Open/Close	No	No
Vacuum Breaker Isolation Valve	11a(C)	Note 1	Yes	Yes	Yes	Open/Close	Yes	No
Containment System Logic Controllers	-	Note 1	Yes	Yes	Yes	Open/Close Vacuum Breaker Isolation Valves on signals	Yes	No

Notes:

1. Safety-related control provided by control system independent of Q-DCIS and DPS

Local leakage rate measurement inaccuracies are typically less than or equal to 2% of the full scale flow range. This value is insignificant when compared to the margins between the local leakage rate acceptance criteria and the leakage equivalent to the bounding design basis accident allowable bypass area.~~The criteria specified for Mark II and III containments is a fraction of the analytical leakage capability. The fraction is judged small enough to cover degradation in performance between tests and uncertainties in test measurement. For ESBWR, an alternate acceptance criteria will be applied. The ability of the containment to tolerate degraded (increased) leakage up to ultimate strength has been determined to be more than a factor of 5 above the design capability (see Subsection 6.2.1.1.5.1). This adequately bounds potential degradation between test intervals. The uncertainty in the test measurement will be quantified and applied to the acceptance criteria. The acceptance criteria will be the leakage analytically required to keep the containment below design pressure, 2 cm2 (2.16E-03 ft2), (A/√K). The uncertainties associated with the specific test procedure and equipment applied will be determined by the licensee and added to the measured leakage prior to comparison against the acceptance criteria.[JGD118]~~

6.2.1.1.5.4.4 Surveillance Test

A visual inspection will be conducted to detect possible leak paths at each refueling outage. Each vacuum ~~relief valve~~ breaker and associated piping will be checked to determine that it is clear of foreign matter. Also, at this time each vacuum breaker will be tested for free disk movement.

6.2.1.1.5.5 Vacuum ~~Relief~~ Breaker Valve and Isolation Valve Instrumentation and Tests

6.2.1.1.5.5.1 Position Indicators, Temperature Sensors, and Alarms

Redundant position indicators are placed on vacuum breakers with redundant indication and an alarm in the control room. The vacuum breaker position indicator system is designed to provide the plant operators with continuous surveillance of the vacuum breaker position. The vacuum ~~relief valve~~breaker position indicator system has adequate sensitivity to detect an ~~total valve~~ open~~ing~~ vacuum breaker~~, for all valves, that is less than the design bypass capability, discussed in Subsection 6.2.1.1.5.4~~.

Redundant temperature sensors are placed within the cavity created by the vacuum breaker and vacuum breaker isolation valve assembly, and in close proximity to the vacuum breaker outlets. The temperature sensor system is designed to provide detection of a leaking vacuum breaker during a LOCA.

6.2.1.1.5.5.2 Vacuum Breaker Valves and Isolation Valves Operability Tests

The vacuum ~~relief valves~~ breakers will be tested for free movement ~~during each refueling outage~~according to Technical Specification requirements. Vacuum breaker isolation valves will be tested as specified in Table 3.9-8.

6.2.1.1.6 Suppression Pool Dynamic Loads

During a postulated LOCA, DW-to-WW flow of gas and steam/water mixture produces hydrodynamic loading conditions on the suppression pool boundary. Also, SRV flow

Table 7.1-1

Regulatory Requirements Applicability Matrix

Applicable Criteria Guidelines: SRP NUREG-0800, Section 7.1	Reference Standard	System																											
		RPS (Q)	NMS (Q)	SPTM Function (Q)	ADS (Q)	GDCS (Q)	LD&IS (Q)	CRHS (Q)	SSLC /ESF (Q)	VB Isolation Function (Q)	SLC (Q)	RSS (Q & N)	RWCU /SDC (N)	ICS (Q)	PAM (Q & N)	CMS (Q &N)	PRMS (Q &N)	ARMS (N)	Interlock Systems (~~Q &~~ N)	NBS (Q)	RC&IS (N)	FWCS (N)	PAS (N)	SB&PC (N)	NMS (N)	CIS(N)	DPS(N) ATWS/SLC (Q)	Q-DCIS (Q)	N-DCIS (N)
		10 CFR																											
50.55a(a)(1)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	
50.55a(h)	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	
50.34(f)(2)(v)(I.D.3)		X	X	X	X	X	X	X	X	X	X			X	X	X	X		X	X								X	
50.34(f)(2)(xvii)(II.F.1)															X	X	X	X											
50.34(f)(2)(xviii)(II.F.2)															X														
50.34(f)(2)(xiv)(II.E.4.2)					X	X	X	X	X	X																			
50.34(f)(2)(xix)(II.F.3)															X	X	X	X											
50.34(f)(2)(xxiv)(II.K.3.23)															X														
50.44(c)(4)																X													
50.62											X										X	X					X#	X	
52.47(a)(1)(iv)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
52.47(a)(1)(vi)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
52.47(a)(1)(vii)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
52.47(a)(2)		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X							X	X	
52.47(b)(2)(i)		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X								X	
50.34(f)(2) xii [II.E.1.2]		N/A																											
50.34(f)(2) xx [II.G.1]		N/A																											
50.34(f)(2) xxii [II.K.2.9]		N/A																											
50.34(f)(2) xxiii [II.K.2.10]		X							X					X		~~N/A~~													
52.79(c)		N/A																											

Table 7.1-1

Regulatory Requirements Applicability Matrix

Applicable Criteria Guidelines: SRP NUREG-0800, Section 7.1	Reference Standard	System																											
		RPS (Q)	NMS (Q)	SPTM Function (Q)	ADS (Q)	GDCS (Q)	LD&IS (Q)	CRHS (Q)	SSLC /ESF (Q)	VB Isolation Function (Q)	SLC (Q)	RSS (Q & N)	RWCU /SDC (N)	ICS (Q)	PAM (Q & N)	CMS (Q &N)	PRMS (Q &N)	ARMS (N)	Interlock Systems (Q & N)	NBS (Q)	RC&IS (N)	FWCS (N)	PAS (N)	SB&PC (N)	NMS (N)	CIS(N)	DPS(N) ATWS/SLC (Q)	Q-DCIS (Q)	N-DCIS (N)
											General Design Criteria																		
1		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X							X	X	X
2	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X
4	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X
13	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
20	IEEE Std. 603	X	X	X	X	X	X	X	X	X																		X	
21	IEEE Std. 603 & IEEE Std. 338	X	X	X	X	X	X	X	X	X																		X	
22	IEEE Std. 603	X	X	X	X	X	X	X	X	X																		X	
23	IEEE Std. 603	X	X	X	X	X	X	X	X	X					X													X	
24	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
25	IEEE Std. 603	X	X	X															X									X	
29	IEEE Std. 603	X	X	X																	X							X	
											SRM to SECY 93-087																		
II.Q	BTP HICB-19	X	X	X	X	X	X	X	X	X										X							X	X	X
II.T															X	X	X											X	X
											Regulatory Guides (RG)																		
1.22		X	X	X	X	X	X	X	X	X	X			X													X	X	
1.47	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X			X		X	X		X									X	
1.53	IEEE Std. 379 IEEE Std. 603	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X									X	
1.62	IEEE Std. 603	X		X	X	X	X	X	X	X	X			X													X	X	

Table 7.1-1

Regulatory Requirements Applicability Matrix

Applicable Criteria Guidelines: SRP NUREG-0800, Section 7.1	Reference Standard	System																											
		RPS (Q)	NMS (Q)	SPTM Function (Q)	ADS (Q)	GDCS (Q)	LD&IS (Q)	CRHS (Q)	SSLC /ESF (Q)	VB Isolation Function (Q)	SLC (Q)	RSS (Q & N)	RWCU /SDC (N)	ICS (Q)	PAM (Q & N)	CMS (Q &N)	PRMS (Q &N)	ARMS (N)	Interlock Systems (Q & N)	NBS (Q)	RC&IS (N)	FWCS (N)	PAS (N)	SB&PC (N)	NMS (N)	CIS(N)	DPS(N) ATWS/SLC (Q)	Q-DCIS (Q)	N-DCIS (N)
1.75	IEEE Std. 384	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X							X	X	
1.89	IEEE Std. 323	X	X	X	X	X	X	X	X		X			X						X								X	
1.97	IEEE Std. 497		X	X											X		X											X	X
1.105	ANSI/ISA S67.04.01	X	X	X	X	X	X	X	X	X	X			X		X	X		X	X							X	X	
1.118	IEEE Std. 338	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X								X	X	
1.151	ANSI/ISA-S67.02										X								X	X		X					X	X	
1.152*	IEEE Std. 7-4.3.2	X	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	X
1.153	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X							X	X	
1.168*	IEEE Std. 1012 IEEE Std. 1028	X	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.169*	IEEE Std. 828	X	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.170*	IEEE Std. 829	X	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.171*	IEEE Std. 1008	X	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.172*	IEEE Std. 830	X	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.173*	IEEE Std. 1074	X	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.180	IEEE Std. 1050	X	X	X	X	X	X	X	X	X	X	X††	X††	X	X††	X††	X††	X††	X††	X	X††	X††	X††	X††	X††	X††	X††	X	X††
1.204	IEEE Std. 1050	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1.209	IEEE Std. 323	X	X	X	X	X	X	X	X		X			X						X								X	
Branch Technical Positions (BTP)																													
BTP HICB-1	IEEE Std. 603					X													X									X	
BTP HICB-3	IEEE Std. 603	N/A																											
BTP HICB-6	IEEE Std. 603	N/A																											

Table 7.1-1

Regulatory Requirements Applicability Matrix

		System																											
Applicable Criteria Guidelines: SRP NUREG-0800, Section 7.1	Reference Standard	RPS (Q)	NMS (Q)	SPTM Function (Q)	ADS (Q)	GDCS (Q)	LD&IS (Q)	CRHS (Q)	SSLC /ESF (Q)	VB Isolation Function (Q)	SLC (Q)	RSS (Q & N)	RWCU /SDC (N)	ICS (Q)	PAM (Q & N)	CMS (Q &N)	PRMS (Q &N)	ARMS (N)	Interlock Systems (~~Q & N~~) [†]	NBS (Q)	RC&IS (N)	FWCS (N)	PAS (N)	SB&PC (N)	NMS (N)	CIS(N)	DPS(N) ATWS/SLC (Q)	Q-DCIS (Q)	N-DCIS (N)
BTP HICB-8	Refer to RG 1.22	X	X	X	X	X	X	X	X		X			X													X	X	
BTP HICB-9	Refer to RG 1.153	X																										X	
BTP HICB-10	Refer to RG 1.97		X	X											X		X											X	X
BTP HICB-11	Refer to RG1.75 RG 1.153	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X							X	X	X
BTP HICB-12	Refer to RG 1.105	X	X	X	X	X	X	X	X	X	X			X		X	X		X	X							X	X	X
BTP HICB-13	Refer to RG 1.153										N/A																		
BTP HICB-14*	Refer to RG 1.152	X	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X
BTP HICB-16		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
BTP HICB-17*	Refer to RG 1.22, 1.47, 1.53, 1.118, 1.152 & 1.153	X	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X
BTP HICB-18*	Refer to RG 1.152	X	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X
BTP HICB-19*	NUREG/CR-6303	X	X	X	X	X	X	X	X	X										X		X					X	X	X
BTP HICB-21*	NUREG/CR-6083	X	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X

Notes:
Q=~~Q-DCIS~~Safety-related, N=Nonsafety-related~~-DCIS~~
X = The code or regulation is applicable to the specified system.
N/A = The code or regulation is not applicable to the ESBWR design.
(1) = Parts or all of this code or regulation are voluntarily invoked for the specified system..
*These criteria are addressed with the digital computer-related functions of the Q-DCIS
[†]Interlocks are embedded within system logic
[††]N-DCIS hardware uses industrial methods for EMI/EMF compliance
[#]Initiates the 10 CFR 50.62 ARI, SLC and FW runback and trip functions as described in Section 7.8.

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumentation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumentation and Control Systems
IEEE Std. 603 Section	**Functions [1]**	**Q-DCIS, N-DCIS**	**RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)**	**SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF**	**Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)**	**Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)**	**HP/LP SI (~~Q~~N)**	**NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)**	**ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)**
4	Safety System Designation	7.1.2.1 7.1.3.1.1 7.1.6.6.1.1 Table 15.0-2 Table 15.1-2 Table 15.1-3 NEDO-33251	7.1.6.6.1.1 Table 15.0-2 Table 15.1-2 Table 15.1-3 NEDO-33251	7.1.6.6.1.1 Table 15.0-2 Table 15.1-2 Table 15.1-3 NEDO-33251	7.1.6.6.1.1 Table 15.0-2 Table 15.1-2 Table 15.1-3 NEDO-33251	7.1.6.6.1.1 Table 15.0-2 Table 15.1-2 Table 15.1-3 NEDO-33251	~~7.1.6.6.1.1~~	7.1.6.6.1.1 Table 15.0-2 Table 15.1-2 Table 15.1-3 NEDO-33251	7.1.6.6.1.1 Table 15.0-2 Table 15.1-2 Table 15.1-3 NEDO-33251
4.1 4.2 4.3 4.4 4.5	DBE, safety-related functions, permissive conditions for operating bypasses, monitored variables, analytical limits, minimum criteria for manual actions	7.1.6.6.1 7.1.2.1 7.1.3.1.1	7.2.1.1 (RPS) 7.2.1.2.4.1 7.2.1.2.4.2 Table 15.0-2 NEDO-33251	7.3.1.2.1 (GDCS) 7.4.4.1 (ICS) 7.4.4.5 7.4.1.1 (SLC) 7.3.6.1 (VBIF)	7.4.1.1 (SLC) 7.4.1.2 7.4.2.2.2 (RSS) 7.4.3.1.2 (RWCU/SDC) 7.4.4.1 (ICS) 7.4.4.5	7.5.2.1 (CMS)	~~7.6.1.3~~	7.7.1.1.1 (NBS)	
4.6	Spatially dependent variables, identification, number and location	7.1.6.6.1.1	-	-	-	-	-	-	-
4.7	Range of transient and steady-state conditions	-	-	-	-	-	-	-	-

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
4.8	Adverse environmental conditions	7.1.2.1 7.1.3.1.1	-	7.4.4.3 (ICS) 7.4.1.1 (SLC) 7.4.1.3	7.4.1.1 (SLC) 7.4.1.3 7.4.4.3 (ICS)	-	~~7.6.1.2.11~~	7.7.1.1.1 (NBS) 7.7.1.3	-
4.10	DBE critical times / conditions	7.1.2.1 7.1.3.1.1	-	-	7.4.1.1 (SLC) 7.4.4.3 (ICS)	-	~~7.6.1.2.1~~	7.7.1.1.1 (NBS)	-
4.12	Special design basis	-	-	7.3.1.1.4 (ADS) 7.4.4.2 (ICS)	7.4.4.2 (ICS)	-	~~7.6.1.2.10~~	-	-

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumentation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumentation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
5.1	Single failure criterion	7.1.3.3 7.1.6.6.1.2	7.1.6.6.1.2 7.2.1.1 (RPS) 7.2.1.2.4 7.2.1.3.4 7.2.2.2.4.3 (NMS) 7.2.2.2.4.6 7.2.2.2.6.4	7.1.6.6.1.2 7.3.1.1.2 (ADS) 7.3.1.1.3 7.3.1.1.3.4 7.3.1.2.1 (GDCS) 7.3.1.2.2 7.3.1.2.3 7.3.1.2.3.4 7.3.3.1 (LD&IS) 7.3.3.2 7.3.4.2 (CRHS) 7.3.5.2.2 (SSLC/ESF) 7.3.5.3.4 7.4.4.3 (ICS) 7.3.6.1 (VBIF)	7.1.6.6.1.2 7.4.1.3 (SLC) 7.4.2.2.1 (RSS) 7.4.2.3.1 7.4.2.3.3 7.4.4.3 (ICS)	7.1.6.6.1.2	~~7.1.6.6.1.2-7.6.1.2.4~~	7.1.6.6.1.2 7.7.1.3 (NBS)	7.1.6.6.1.2

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTM~~S~~ [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
5.2	Completion of protective action	7.1.6.6.1.3	7.1.6.6.1.3 7.2.1.1 (RPS) 7.2.1.3.4	7.1.6.6.1.3 7.3.1.1.2 (ADS) 7.3.1.2.2 (GDCS) 7.3.3.1 (LD&IS) 7.3.3.3 7.3.5.2.2 (SSLC/ESF)	7.1.6.6.1.3 7.4.1.2.2 (SLC)	7.1.6.6.1.3	-	7.1.6.6.1.3	7.1.6.6.1.3
5.3	Quality	7.1.6.6.1.4	7.1.6.6.1.4	7.1.6.6.1.4	7.1.6.6.1.4	7.1.6.6.1.4	~~7.1.6.6.1.4~~	7.1.6.6.1.4	7.1.6.6.1.4
5.4	Equipment qualification	7.1.6.6.1.5	7.1.6.6.1.5 7.2.1.3.5 (RPS)	7.1.6.6.1.5 7.4.4.2 (ICS)	7.1.6.6.1.5 7.4.1.3 (SLC) 7.4.4.2 (ICS)	7.1.6.6.1.5	~~7.1.6.6.1.5~~ ~~7.6.1.2.11~~	7.1.6.6.1.5	7.1.6.6.1.5 7.8.3 (CMF defenses within SSD)
5.5	System Integrity	7.1.6.6.1.6	7.1.6.6.1.6	7.1.6.6.1.6 7.3.4.2 (CRHS)	7.1.6.6.1.6	7.1.6.6.1.6	~~7.1.6.6.1.6~~	7.1.6.6.1.6	7.1.6.6.1.6

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	**Functions [1]**	**Q-DCIS, N-DCIS**	**RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)**	**SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF**	**Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)**	**Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)**	**HP/LP SI (~~Q~~N)**	**NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)**	**ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)**
5.6	Independence	7.1.6.6.1.7 7.1.3.3	7.1.6.6.1.7 7.2.1.1 (RPS) 7.2.1.2.4.1 7.2.1.3.1 7.2.1.3.4 7.2.2.2.4.3 (NMS) 7.2.2.2.5.3 7.2.2.2.6.4 7.2.2.3.1 7.2.3.3.1 (SPTM)	7.1.6.6.1.7 7.3.1.2.3.1 (GDCS) 7.3.3.1 (LD&IS) 7.3.3.2 7.3.3.3.1 7.3.4.2 (CRHS) 7.3.5.2.2 (SSLC/ESF) 7.3.6.3.1 (VBIF)	7.1.6.6.1.7 7.4.1.3 (SLC) 7.4.2.2.1 (RSS) 7.4.2.3.1 7.4.2.3.3 7.4.4.3.1 (ICS)	7.1.6.6.1.7 7.5.2.2 (CMS) 7.5.2.3.1 7.5.3.3.1 (PRMS)	~~7.1.6.6.1.7~~ ~~7.6.1.2.9~~	7.1.6.6.1.7 7.7.2.2.7.4 (RC&IS) 7.7.3.1.2 (FWCS) 7.7.4.2 (PAS) 7.7.5.1.2 (SB&PC)	7.1.6.6.1.7 7.8.3 7.8.3.1
5.7	Capability for test and calibration	7.1.6.6.1.8 7.1~~.2.6~~.3.3 7.1.3.4 7.1.3.5 7.1.6.4	7.1.6.6.1.8 ~~7.2.2.4 (NMS)~~ 7.2.1.3.4 (RPS) 7.2.1.4.1	7.1.6.6.1.8 7.3.1.1.4 (ADS) 7.3.1.2.4 (GDCS) 7.3.3.1 (LD&IS) 7.3.3.4.2 7.3.5.4 (SSLC/ESF) 7.4.4.4 (ICS) 7.4.4.5 7.4.1.3 (SLC) 7.4.1.4 7.3.6.4 (VBIF)	7.1.6.6.1.8 7.4.1.3 (SLC) 7.4.1.4 7.4.3.4 (RWCU/SDC) 7.4.4.4 (ICS) 7.4.4.5	7.1.6.6.1.8 7.5.3.4 (PRMS)	~~7.1.6.6.1.8~~ ~~7.6.1.2.10~~	7.1.6.6.1.8 7.7.1.4 (NBS)	7.1.6.6.1.8

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
5.8	Information displays	7.1.2.6 7.1.3.5 7.1.6.6.1.9	7.1.6.6.1.9 7.2.1.2.4.2 (RPS) 7.2.1.3.1 7.2.1.3.4 7.2.2.3.1 (NMS) 7.2.2.5.1	7.1.6.6.1.9 7.3.1.1.2 (ADS) 7.3.1.1.5 7.3.1.2.1 (GDCS) 7.3.1.2.2 7.3.1.2.3.1 7.3.1.2.5 7.3.3.3.1 (LD&IS) 7.3.4.2 (CRHS) 7.3.5.3.1 (SSLC/ESF) 7.4.4.5 (ICS) 7.4.1.3 (SLC) 7.4.1.5 7.3.6.1 (VBIF)	7.1.6.6.1.9 7.4.1.3 (SLC) 7.4.1.5 7.4.2.2.1 (RSS) 7.4.4.5 (ICS)	7.1.6.6.1.9 7.5.2.1 (CMS)	~~7.1.6.6.1.9~~ ~~7.6.1.5~~	7.1.6.6.1.9 7.7.1.5 (NBS)	7.1.6.6.1.9
5.9	Control of Access	7.1.6.6.1.10	7.1.6.6.1.10 7.2.1.1 (RPS)	7.1.6.6.1.10 7.3.3.1 (LD&IS)	7.1.6.6.1.10 7.4.2.2.1 (RSS)	7.1.6.6.1.10	~~7.1.6.6.1.10~~	7.1.6.6.1.10	7.1.6.6.1.10

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTM~~S~~ [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRH~~S~~, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
5.10.	Repair	7.1.3.5 7.1.6.6.1.11	7.1.6.6.1.11 7.2.1.2.4.4 (RPS) 7.2.2.2.4.6 (NMS) 7.2.2.2.6.6	7.1.6.6.1.11	7.1.6.6.1.11	7.1.6.6.1.11	~~7.1.6.6.1.11~~	7.1.6.6.1.11	7.1.6.6.1.11
5.11	Identification	~~7.1.3.3~~ ~~7.1.6.6.1.7~~ 7.1.6.6.1.12	7.1.6.6.1.12	7.1.6.6.1.12	7.1.6.6.1.12	7.1.6.6.1.12	~~7.1.6.6.1.12~~	7.1.6.6.1.12	7.1.6.6.1.12
5.12	Auxiliary features	7.1.6.6.1.13	7.1.6.6.1.13 7.2.1.1 (RPS)	7.1.6.6.1.13	7.1.6.6.1.13 7.4.1.2.1 (SLC)	7.1.6.6.1.13	~~7.1.6.6.1.13~~ ~~7.6.1.2.2~~	7.1.6.6.1.13	7.1.6.6.1.13
5.13	Multi-unit stations	~~7.1.2.6~~ ~~7.1.3.5~~ ~~7.1.6.4~~ 7.1.6.6.1.14	7.1.6.6.1.14	7.1.6.6.1.14	7.1.6.6.1.14	7.1.6.6.1.14	~~7.1.6.6.1.14~~	7.1.6.6.1.14	7.1.6.6.1.14
5.14	Human factors considerations	7.1.6.6.1.15	7.1.6.6.1.15	7.1.6.6.1.15	7.1.6.6.1.15	7.1.6.6.1.15	~~7.1.6.6.1.15~~	7.1.6.6.1.15	7.1.6.6.1.15
5.15	Reliability	7.1.6.6.1.16	7.1.6.6.1.16	7.1.6.6.1.16	7.1.6.6.1.16	7.1.6.6.1.16	~~7.1.6.6.1.16~~	7.1.6.6.1.16	7.1.6.6.1.16

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTM~~S~~ [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
6.1	Automatic Control	7.1.6.6.1.17	7.1.6.6.1.17	7.1.6.6.1.17 7.3.1.1.2 (ADS) 7.3.3.1 (LD&IS)	7.1.6.6.1.17	7.1.6.6.1.17	~~7.6.1.2.4~~	7.1.6.6.1.17	7.1.6.6.1.17
6.2	Manual control	7.1.6.6.1.18	7.1.6.6.1.18 7.2.1.1 (RPS) 7.2.1.3.4	7.1.6.6.1.18 7.3.1.1.2 (ADS) 7.3.1.2.1 (GDCS) 7.3.1.2.2 7.3.3.3~~2~~ (LD&IS) 7.3.4.2 (CRHS) 7.3.5.3.1 (SSLC/ESF) 7.4.4.5 (ICS) 7.3.6.1 (VBIF)	7.1.6.6.1.18 7.4.4.5 (ICS)	7.1.6.6.1.18	~~7.6.1.2.4~~	7.1.6.6.1.18	7.1.6.6.1.18
6.3	Interaction between the sense and command features and other systems	7.1.3.3 7.1.6.6.1.19	7.1.6.6.1.19 7.2.1.3.1 (RPS) 7.2.2.3.1 (NMS)	7.1.6.6.1.19	7.1.6.6.1.19 7.4.2.2.1 (RSS) 7.4.2.3.1 7.4.2.3.3 7.4.4.3.1 (ICS)	7.1.6.6.1.19	~~7.1.6.6.1.19~~ ~~7.6.1.2.4~~	7.1.6.6.1.19	7.1.6.6.1.19

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
6.4	Derivation of system inputs	7.1.6.6.1.20	7.1.6.6.1.20	7.1.6.6.1.20	7.1.6.6.1.20	7.1.6.6.1.20	~~7.1.6.6.1.20~~	7.1.6.6.1.20	7.1.6.6.1.20
6.5	Capability for testing and calibration	7.1.3.3 7.1.3.5 7.1.6.6.1.21	7.1.6.6.1.21 7.2.1.3.4 (RPS) 7.2.1.4.1	7.1.6.6.1.21 7.3.1.1.4 (ADS) 7.3.1.2.4 (GDCS) 7.3.3.4.2 (LD&IS) 7.3.5.4 (SSLC/ESF) 7.4.4.4 (ICS) 7.4.4.5 7.4.1.3 (SLC) 7.3.6.4 (VBIF)	7.1.6.6.1.21 7.4.1.3 (SLC) 7.4.3.4 (RWCU/SDC) 7.4.4.4 (ICS) 7.4.4.5	7.1.6.6.1.21 7.5.2.4 (CMS) 7.5.3.4 (PRMS)	~~7.1.6.6.1.21~~ ~~7.6.1.2.10~~ ~~7.6.1.4~~	7.1.6.6.1.21	7.1.6.6.1.21
6.6	Operating bypasses	7.1.6.6.1.22	7.1.6.6.1.22 7.2.1.5.2.1 (RPS)	7.1.6.6.1.22	7.1.6.6.1.22	7.1.6.6.1.22	-	7.1.6.6.1.22	7.1.6.6.1.22
6.7	Maintenance bypass	7.1.6.6.1.23	7.1.6.6.1.23 7.2.1.2.4 (RPS) 7.2.1.5.2.2	7.1.6.6.1.23	7.4.1.3 (SLC)	-	-	-	-

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumen-tation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumen-tation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
6.8	Setpoints	7.1.6.6.1.24	7.1.6.6.1.24 7.2.2.1.1.1 (NMS) 7.2.2.2.4.5 7.2.2.2.4.6	7.1.6.6.1.24 7.3.3.1 (LD&IS)	7.1.6.6.1.24	7.1.6.6.1.24	~~7.1.6.6.1.24~~	7.1.6.6.1.24	7.1.6.6.1.24
7.1	Automatic Control	7.1.6.6.1.17	7.1.6.6.1.17	7.1.6.6.1.17 7.3.1.1.2 (ADS)	7.1.6.6.1.17	7.1.6.6.1.17	~~7.6.1.2.4~~	7.1.6.6.1.17	7.1.6.6.1.17
7.2	Manual control	7.1.6.6.1.18	7.1.6.6.1.18	7.1.6.6.1.18 7.3.1.1.2 (ADS) 7.3.1.2.1 (GDCS) 7.3.1.2.2 7.3.3.2 (LD&IS) 7.3.3.3 (LD&IS) 7.3.4.2 (CRHS) 7.3.5.3.1 (SSLC/ESF) 7.4.4.5 (ICS) 7.3.6.1 (VBIF)	7.1.6.6.1.18 7.4.4.5 (ICS)	7.1.6.6.1.18	-	7.1.6.6.1.18	7.1.6.6.1.18

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumentation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumentation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTMS [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)
7.3	Completion of protective action	~~7.1.6.6.1.19~~	-	7.3.1.2.1 (GDCS) 7.3.6.1 (VBIF)	-	-	-	-	-
7.4	Operating bypass	7.1.6.6.1.22	7.1.6.6.1.22 7.2.1.5.2.1 (RPS)	7.1.6.6.1.22	7.1.6.6.1.22	7.1.6.6.1.22	-	7.1.6.6.1.22	7.1.6.6.1.22
7.5	Maintenance bypass	7.1.6.6.1.23	7.1.6.6.1.23 7.2.1.2.4 (RPS) 7.2.1.5.2.2	7.1.6.6.1.23	-	-	-	-	-
8.1	Electrical power sources	7.1.3.3 7.1.6.6.1.25	7.1.6.6.1.25	7.1.6.6.1.25 7.4.4.3 (ICS) 7.4.1.2.1 (SLC)	7.1.6.6.1.25 7.4.1.2.1 (SLC) 7.4.4.3 (ICS)	7.1.6.6.1.25	~~7.1.6.6.1.25~~ ~~7.6.1.2.2~~	7.1.6.6.1.25	7.1.6.6.1.25
8.2	Non-electrical power sources	7.1.6.6.1.26	-	-	7.4.1.2.1 (SLC)	-	~~7.6.1.2.8~~	-	-
8.3	Maintenance Bypass	7.1.6.6.1.27	-	-	-	-	-	-	-

Table 7.1-2

Section Roadmap of Evaluation of IEEE Std. 603 Specific Criteria Compliance

Subject		Instrumentation & Control Systems	Reactor Trip Systems	Engineered Safety Features	Safe Shutdown Systems	Information Systems	Interlock Systems	Control Systems	Diverse Instrumentation and Control Systems
IEEE Std. 603 Section	Functions [1]	Q-DCIS, N-DCIS	RPS, NMS [2], SPTM~~S~~ [3], MSIV (for LD&IS)	SSLC/ESF ECCS [4] (that is, ADS, GDCS, ICS, SLC), PCCS [5], LD&IS (except MSIV) CRHS, VBIF	Q and N SS (that is, SLC, RSS, RWCU / SDC (N), ICS)	Q and N IS (that is, Q IC Displays, PAM (QN), CMS (QN), PRMS (N), ARMS (N), PMS (QN), WTDVBM)	HP/LP SI (~~Q~~N)	NBS (QN), RC&IS (QN), FWCS (N), PAS (N), SB&PC (N), NMS [(2)] (N) CIS (N)	ATWS (N), DIC* (N), DMCD* (N), CMF* defenses within SSD* (N), SD* against CMF (N)

1. All systems are safety-related (Q) unless shown as nonsafety-related (N)
2. NMS has Q and N parts. The Q parts are SRNM, LPRM, APRM, and OPRM. The N parts are AFIP and MRBM.
3. SPTM~~S~~ is part of the RTS, ref. 7.2.3.
4. The SSLC/ESF ECCS resides within the NBS, ref. 7.3.1.1.2.
5. Passive system which does not require any control system interface to perform its safety-related function

* CMF: Common Mode Failure
DIC: Diverse Instrumentation and Control
DMCD: Diverse Manual Controls and Displays
SSD: Safety-Related System Design
SD: System Defense
IS: Information Systems
SS: Safe Shutdown
VBIF Vacuum Breaker Isolation Function

Logic and controls for SSLC/ESF are located on each divisional SSLC/ESF cabinet in the equipment rooms in the CB, with ~~key~~ controls and system operating status available on the operator interface section in the MCR. The SSLC/ESF controls are used infrequently. Such controls ~~typically do not require~~are available for operator action during plant operation or during accident or transient conditions, and ~~mainly are~~may be used for test and maintenance purposes. ~~However, c~~Conditions such as equipment failure, maintenance, or testing, ~~may~~ normally require the operator ~~manually to bypass a division of sensors or a division of trip logic. Under the bypass status, SSLC/ESF continues to run in automatic mode using the unaffected logic in the remaining divisions.~~ to gain access to an SSLC/ESF cabinet. If required the affected division's sensors are bypassed such that they do not provide trip inputs to other divisions, and the division can be disconnected from its actuators so that its logic remains functional. After maintenance or other access the affected division's diagnostics, self-testing, and actuator/sensor monitoring confirm correct operation.~~manually to bypass a division of sensors or a division of trip logic. [TCF614]Under the bypass status, SSLC/ESF continues to run in automatic mode using the unaffected logic in the remaining divisions~~[RVS615][G616]~~.~~

The minimum required SSLC/ESF displays provided in the MCR (per division) are ~~provided in the MCR (per division)~~:

- Division-of-sensors in bypass,~~;~~
- SSLC/ESF controller inoperative (DTM or VLU), and
- Communication Interface Module (CIM) inoperative.

7.3.6 Containment System Wetwell-to-Drywell Vacuum Breaker Isolation Function[RVS617]

Upon detection of excessive vacuum breaker leakage the vacuum breaker isolation function prevents the loss of long-term containment integrity.

7.3.6.1 System Design Bases

The wetwell-to-drywell vacuum breaker isolation function has the following safety-related requirements (IEEE Std. 603, Sections 4.1, 4.2, 4.5, 5.1, 5.6, 5.8, 6.2, 7.2, and 7.3) and 10 CFR 50.2 Design Bases.

- Automatically isolates an excessively leaking vacuum breaker using a vacuum breaker isolation valve.
- The vacuum breaker and vacuum breaker isolation valve are qualified for a harsh environment inside the drywell.
- Manual opening and closing of a vacuum breaker isolation valve is provided for in the design.
- No single control logic and instrumentation failure opens/closes more than one vacuum breaker isolation valve.
- Vacuum breaker and vacuum breaker isolation valve positions are displayed in the MCR.

- The safety-related function is met with one vacuum breaker/vacuum breaker isolation valve path isolated together with any active identifiable single failure.
- Divisional instruments performing vacuum breaker isolation valve logic are powered by the associated safety-related divisional power supplies.
- Containment system vacuum breaker isolation function logic controllers are independent (IEEE Std. 603, Section 5.6).

7.3.6.2 System Description

The wetwell-to-drywell vacuum breaker isolation function comprises three sets of vacuum breakers, vacuum breaker isolation valves, and independent logic controllers. A more detailed description is given in Subsection 6.2.1.1.2.

- Automatic Operation
  - Closure of the vacuum breaker isolation valve is performed automatically, without need for operator action, once excessive bypass leakage through a vacuum breaker is detected.
  - Automatic actuation logic is performed by a control system with components similar to those used in the ATWS/SLC control system. These components are independent of the Q-DCIS and other N-DCIS systems.
  - Each vacuum breaker/vacuum breaker isolation valve pair has dedicated sensors and logic. Each vacuum breaker isolation valve operates independently of the other vacuum breaker isolation valves according to input received from its sensors. Logic is processed for each individual isolation valve; failure of the logic for one isolation valve does not affect the logic for any other isolation valve.
- Manual Operation
  - Manual controls are available to the operator in the MCR to:
    - Open each vacuum breaker isolation valve
    - Close each vacuum breaker isolation valve
  - Manual controls are independent for each vacuum breaker isolation valve and are hard-wired to be independent of the vacuum breaker isolation valve automatic control logic.
- Actuation Logic
  - The primary closure demand for the vacuum breaker isolation valve is based upon a temperature differential between the drywell and wetwell and upon the bypass status of the associated division of logic. A separate LOCA temperature value also is provided to the logic.

- A secondary closure demand signal is based upon a temperature differential between the drywell and wetwell and upon vacuum breaker position. A separate LOCA temperature value also is provided to the logic.

- Manual control over each vacuum breaker isolation valve is available to the operator.

- Logic for each vacuum breaker isolation valve is controlled by 16 thermocouples (four groups of four) and four proximity switches. Each of the four thermocouples in each group is assigned to a separate division. Each of the four groups provides temperature values for separate drywell and wetwell locations.

- Proximity switches on each vacuum breaker body give positive indication of fully open or fully closed positions.

- The thermocouples are located in the:

  - Wetwell (on or adjacent to the vacuum breaker debris screen);

  - Wetwell cavity (in the pipe cavity between the vacuum breaker and the vacuum breaker isolation valve);

  - Drywell (1) (on or near the outlet of the vacuum breaker isolation valve); and

  - Drywell (2) (inside the drywell separate from the vacuum breaker/vacuum breaker isolation valve assembly).

- Each VB isolation function ATWS/SLC division can be placed into manual bypass status that is automatically indicated in the MCR.

7.3.6.3 Safety Evaluation

Section 6.2 evaluates the vacuum breaker isolation function and shows that for the entire range of nuclear process system pipe break sizes, the opening of a single vacuum breaker ensures containment structure functional integrity.

7.3.6.3.1 Code of Federal Regulations

10 CFR 50.55a(a)(1), Quality Standards for Systems Important to Safety:

- Conformance: The vacuum breaker isolation function complies with these standards.

10 CFR 50.55a(h), Protection and Safety Systems, compliance with IEEE Std. 603:

- Conformance: Safety-related systems are in conformance with RG 1.153 and IEEE Std. 603 as discussed in Subsection 7.1.6.4. Separation and isolation is preserved both mechanically and electrically in accordance with IEEE Std. 603, Section 5.6 and RG 1.75. The vacuum breaker isolation function is divisionalized and designed with redundancy so failure of any instrument will not prevent the system operation. Electrical separation is maintained between the redundant divisions.

10 CFR 50.34(f)(2)(v)(I.D.3), Bypass and Inoperable Status Indication:

- Conformance: The vacuum breaker isolation function complies by providing automatic indication of bypassed and inoperable status (IEEE Std. 603, Section 5.8).

10 CFR 50.34(f)(2)(xiv)(II.E.4.2), Containment Isolation Systems:

- Conformance: The vacuum breaker isolation function complies with this requirement.

10 CFR 52.47(a)(1)(iv), Resolution of Unresolved and Generic Safety Issues:

- Conformance: Resolution of unresolved and generic safety issues is discussed in Section 1.11.

10 CFR 52.47(a)(1)(vi), ITAAC in Design Certification Applications:

- Conformance: ITAAC are provided for the I&C systems and equipment in Tier 1.

10 CFR 52.47(a)(1)(vii), Interface Requirements:

- Conformance: There are no interface requirements for this section.

10 CFR 52.47(a)(2), Level of Detail:

- Conformance: The level of detail provided for the vacuum breaker and vacuum breaker isolation function within the DCD complies with this requirement.

10 CFR 52.47(b)(2)(i), Innovative Means of Accomplishing Safety Functions:

- Conformance: The I&C design does not use innovative means for accomplishing safety-related functions.

7.3.6.3.2 General Design Criteria

GDC 1, 2, 4, 13, 19, 20, 21, 22, 23, and 24:

- Conformance: The vacuum breaker isolation function complies with these GDCs.

7.3.6.3.3 Staff Requirements Memorandum

SECY-93-087, Item II.Q, Defense Against Common-Mode Failures in Digital Instrumentation and Control Systems:

- Conformance: The vacuum breaker isolation function complies with these criteria by providing diverse I&C , as described in Section 7.8.

7.3.6.3.4 Regulatory Guides

RG 1.22 - Periodic Testing of Protection System Function:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.22. System logic and components are tested periodically during refueling outages.

RG 1.47 - Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.47. Automatic indication is provided in the MCR to inform the operator that the system is inoperable or a division is bypassed.

RG 1.53 - Application of the Single-Failure Criterion to Nuclear Power Protection Systems:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.53, IEEE Std. 603, Section 5.1, and IEEE Std. 379.

RG 1.62 - Manual Initiation of Protective Actions:

- Conformance: The vacuum breaker isolation function design complies with RG 1.62. Each division has a manual actuation switch in the MCR. Initiation of the system requires actuation of two switches to ensure that manual initiation is a premeditated act.

RG 1.75 - Physical Independence of Electric Systems:

- The vacuum breaker isolation function design conforms to RG 1.75 as described in Subsections 8.3.1.3 and 8.3.1.4.

RG 1.105 - Instrument Setpoints for Safety-Related Systems:

- Conformance: The setpoints established to control the vacuum breaker isolation valve conform to RG 1.105. Reference 7.3-2 provides a detailed description of the GEH methodology.

RG 1.118 - Periodic Testing of Electric Power and Protection Systems:

- Conformance: The vacuum breaker isolation function design complies with the guidance of RG 1.118.

RG 1.152 - Criteria for Digital computers in Safety Systems of Nuclear Power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.152.

RG 1.153 - Criteria for Power, I&C Portions of Safety Systems:

- Conformance: The vacuum breaker isolation function design complies with RG 1.153.

RG 1.168 - Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.168.

RG 1.169 - Configuration Management Plans for Digital Computer Software Used in Safety Systems of Nuclear power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.169.

RG 1.170 - Software Test Documentation for Digital Computer Software Used in Safety Systems of Nuclear Power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.170.

RG 1.171 - Software Unit Testing for Digital Computer Software Used in Safety Systems of Nuclear Power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.171.

RG 1.172 - Software Requirements Specifications for Digital Computer Software Used in Safety Systems of Nuclear Power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.172.

RG 1.173 – Developing Software Life Cycle Processes for Digital Computer Software used in Safety Systems of Nuclear Power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.173.

RG 1.180 - Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in safety-related I&C Systems:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.180.

RG 1.204 - Guidelines for Lightning Protection of Nuclear Power Plants:

- Conformance: The vacuum breaker isolation function design conforms to RG 1.204.

7.3.6.3.5 Branch Technical Positions

In accordance with the SRP for Section 7.3 and Table 7.1-1, the following BTPs are addressed for the vacuum breaker isolation function:

BTP-HICB-11 - Guidance on Application and Qualification of Isolation Devices:

- Conformance: Logic controllers for the vacuum breaker isolation function use fiber optic cables for interconnections between safety-related divisions for data exchange and for interconnections between safety-related and nonsafety-related devices.

BTP HICB-12 - Guidance on Establishing and Maintaining Instrument Setpoints:

- Conformance: The setpoints established to control the vacuum breaker isolation valve conform to this guide. Reference 7.3-2 provides a detailed description of the GEH methodology.

BTP HICB-13 - Guidance on Cross-Calibration of Protection System Resistance Temperature Detectors:

- Conformance: This BTP does not apply to the vacuum breaker isolation function because it does not use these instruments.

BTP HICB-14 – Guidance on Software Reviews for Digital Computer-Based Instrumentation and Control Systems:

- Conformance: The vacuum breaker isolation function design conforms to BTP HICB-14.

BTP HICB-16 - Guidance on the Level of Detail Required for Design Certification Applications Under 10 CFR 52:

- Conformance: The level of detail in the vacuum breaker isolation function description conforms to BTP HICB-16

BTP HICB-17 - Guidance on Self-Test and Surveillance Test Provisions:

- Conformance: The vacuum breaker isolation function design conforms to BTP HICB-17.

BTP HICB-18 - Guidance on Use of Programmable Logic Controllers in Digital Computer-Based Instrumentation and control Systems:

- Conformance: The vacuum breaker isolation function design conforms to BTP HICB-18.

BTP HICB-19 - Guidance on Evaluation of Defense-in-Depth and Diversity in digital Computer-based Instrumentation and Control Systems:

- Conformance: The vacuum breaker isolation function design conforms to BTP HICB-19.

BTP HICB-21 – Guidance on Digital Computer Real-Time Performance:

- Conformance: The vacuum breaker isolation function design conforms to BTP HICB-21.

7.3.6.3.6 Three Mile Island Action Plan Requirements

In accordance with the SRP for 7.3 and with Table 7.1-1, 10 CFR 50.34(f)(2)(v)[I.D.3] and 10 CFR 50.34(f)(2)(xiv)[II.E.4.2] apply to the vacuum breaker isolation function. The vacuum breaker isolation function complies with the requirements as indicated above. TMI action plan requirements are addressed in Appendix 1A.

7.3.6.4 Testing and Inspection Requirements

The vacuum breaker isolation function TLUs are self-tested continually at preset intervals and can be tested during plant operation (IEEE Std. 603, Sections 5.7 and 6.5). Vacuum breaker isolation function equipment inside containment is tested during refueling outages. Refer to Subsection 6.2.1.1.5 for a discussion of mechanical tests performed on the vacuum breaker isolation functions.

7.3.6.5 Instrumentation and Control Requirements

The performance and effectiveness of the vacuum breaker isolation function in a postulated accident is verified by observing the following MCR indications (IEEE Std. 603, Section 5.8) (additional discussion on the vacuum breaker isolation function instrumentation is contained in Subsection 7.3.6.1 and in Subsection 6.2.1.1.5):

- Status indication of vacuum breaker position;
- Status indication of vacuum breaker isolation valve position;
- Drywell and wetwell pressure indication;
- Drywell and wetwell temperature indications;
- vacuum breaker isolation valve bypass status; and
- Status indication of bypass leakage.

The vacuum breaker isolation function instrumentation that is essential for system operation is designed to operate in a drywell environment resulting from a LOCA. Safety-related instruments, located outside the drywell, are qualified for the environment in which they must perform their safety-related function.

~~7.3.6~~ 7.3.7 COL Information

None

~~7.3.7~~ 7.3.8 References

7.3-1 Triconex Topical Report 7286-545-1-a, "Qualification Summary Report", March 08, 2002.

7.3-2 GE-Hitachi Nuclear Energy, "GEH ABWR/ESBWR Setpoint Methodology," NEDO-33304, Class I (Non-proprietary); and "GEH ABWR/ESBWR Setpoint Methodology," NEDE-33304P, Class III (Proprietary), Revision 0, October 2007. ~~GE Nuclear Energy, "General Electric Instrument Setpoint Methodology," NEDC-31336P-A, Class III (Proprietary), September 1996.~~[RVS618]

7.3-3 GE Energy Nuclear, "ESBWR I&C Software Management Plan," NEDO-33226, Class I (Non-proprietary), and "ESBWR I&C Software Management Plan," NEDE-33226P, Class III (Proprietary), Revision 2, July 2007.

7.3-4 GE Energy Nuclear, "ESBWR I&C Software Quality Assurance Plan," NEDO-33245, Class I (Non-proprietary), and "ESBWR I&C Software Quality Assurance Plan," NEDE-33245P, Class III (Proprietary), Revision 2, July 2007.

7.5 SAFETY-RELATED AND NONSAFETY-RELATED INFORMATION SYSTEMS

This section discusses instrumentation associated with ~~the following~~:

- Post Accident Monitoring (PAM),
- Containment Monitoring System (CMS),
- Process Radiation Monitoring System (PRMS),
- Area Radiation Monitoring System (ARMS), and
- Pool Monitoring Subsystems.

The safety-related portions of the PAM Instrumentation, CMS, PRMS, and Pool Monitoring Subsystems ~~and Wetwell to Drywell Vacuum Breakers~~ are part of a group of systems collectively called the Safety-Related Distributed Control and Information System (Q-DCIS). A functional block diagram of the Q-DCIS is included as part of Figure 7.1-1 and a functional network diagram appears as Figure 7.1-2 (not all systems are shown on these figures.)

These diagrams generally indicate the relationships of a safety-related system with its safety-related peers and with nonsafety-related plant data systems called the Nonsafety-Related Distributed Control and Information System (N-DCIS). Section 7.1 contains a description of these relationships.

The nonsafety-related portions of the PAM Instrumentation, CMS, PRMS, and the ARMS are part of the N-DCIS.

7.5.1 Post Accident Monitoring Instrumentation

7.5.1.1 System Design Bases

The PAM instrumentation ~~has the following~~ safety-related design base~~is~~ are to:

- Provide instrumentation to monitor variables and systems over their anticipated ranges for accident conditions as appropriate to ensure adequate safety.
- Provide the appropriate Main Control Room (MCR) instrumentation and displays to provide the information from which actions can be taken to maintain a safe plant condition under accident conditions, including Loss-of-Coolant Accidents (LOCAs).
- Provide equipment (including the necessary instrumentation) at appropriate locations outside the MCR with the capability for prompt hot shutdown of the reactor, and
- Provide the means for monitoring the reactor containment atmosphere~~,~~ spaces containing components that recirculate LOCA fluids, effluent discharge paths, and the plant environs for radioactivity that may be released as a result of accidents.

~~The drywell and wetwell volumes are provided with two additional safety-related differential pressure transmitters, connected between these two volumes. These channels are used for vacuum breaker valve monitoring.~~

MCR alarms and indication are provided for suppression pool temperature monitoring as discussed in ~~(see~~ Subsection 7.2.3~~)~~.

7.5.2.2 System Description

The CMS is a divisionalized and segregated (safety/nonsafety-related) monitoring system (IEEE Std. 603, Subsection 5.6.3), and is configured as shown in Figure 7.5-1. The specific system features are as follows.~~:~~

- Radiation monitoring and gas H_2/O_2 sampling are provided for the drywell and for the airspace above the suppression pool.
- Each radiation monitoring channel uses one gamma-sensitive ion chamber and one digital log radiation monitor. Four channels are provided, two for the drywell and two for the suppression pool (wetwell) airspace.
- During normal plant operation, both the radiation monitoring and gas sampling subsystems are operating. For post-accident monitoring, the gas sampling subsystem is automatically activated by the LOCA signal to alternate its sampling between the drywell and the wetwell. The area of sampling can be selected manually or sequentially controlled.
- Heat tracing is provided on the gas sampling lines for control of moisture and condensation.
- Two isolation valves are provided on each sample and return line that penetrates the containment. Each line has one ~~manual~~ inner valve and one ~~remote-control~~ outer valve.
- Each gas sampling analyzer has dual redundant pumps. One is used during normal operation; the other is used for added capacity or backup.
- Separate oxygen and hydrogen gas sources are provided in each CMS sampling rack with known compositions for monitor calibration.
- CMS piping connections are provided. Piping connections are required in order to connect the sampling instrumentation
- The drywell pressure instrumentation consists of transmitters located throughout the containment.
- Four drywell pressure transmitters are provided for safety-related signals for use by the Reactor Protection System (RPS) for reactor scram. These drywell pressure signals also are transmitted to the Leak Detection and Isolation System (LD&IS), where they are used to initiate isolation of containment valves, transfer pump suction, and initiate suppression pool cooling. In addition, these pressure signals and alarms are hardwired to the MCR to

provide diverse information for operator use. The containment isolation function is discussed in Subsection 6.2.4.

- Two wide-range safety-related pressure transmitters are used for providing safety-related drywell pressure information meeting the requirements of post-accident monitoring.
- Four nonsafety-related drywell pressure transmitters are used by the DPS for diverse scram protection monitoring and by the Containment Inerting System (CIS) for controlling the position of the nitrogen makeup pressure control valve.

~~The drywell and wetwell volumes also are provided with two additional safety-related differential pressure transmitters, connected between these two volumes. These channels also are used for vacuum breaker valve monitoring.~~

- The suppression pool water level is monitored during all plant operating conditions and post-accident conditions. Suppression pool water level monitoring consists of ten channels of water level detection sensors distributed into four safety-related narrow-range and four nonsafety-related wide-range instruments. The narrow range suppression pool water level signals are used to detect the uncovering of the first set of suppression pool temperature sensors below the pool surface. When the suppression pool water level drops below the elevation of a particular set of temperature sensors, those sensor signals are not used in computing the average pool temperature.
- Two of the wide range water level signals are used for displaying suppression pool water level on the Remote Shutdown System (RSS) Panels.
- Suppression pool temperatures are monitored (see Subsection 7.2.3).

7.5.2.3 Safety Evaluation

The CMS design, including the sensors and the instrumentation channels, is engineered into both safety-related and nonsafety-related subsystems. Safety-related systems are environmentally and seismically qualified for continuous monitoring during reactor operation, as well as abnormal and accident plant conditions. The system design conforms ~~with~~to the System Design Bases.

Table 7.1-1 identifies the CMS and the associated regulatory requirements, guidelines, and codes and standards applied, in accordance with NUREG 0800. This subsection addresses conformance ~~with~~ to regulatory requirements, guidelines, and industry standards.

7.5.2.3.1 Code of Federal Regulations

10 CFR 50.55a(a)(1), Quality Standards for Systems Important to Safety:

- Conformance: The CMS complies with this requirement.

10 CFR 50.55a(h), Protection and Safety Systems compliance with IEEE Std. 603:

- Conformance: Separation and isolation is preserved both mechanically and electrically in accordance with IEEE Std. 603, Section 5.6 and RG 1.75. The CMS safety-related

for tripping the FAPCS pump operating in the spent fuel pool cooling mode. The high level setpoint is established to avoid overflow of skimmer surge tank water. The low water level setpoint is established to prevent inadvertent draining of the tank water below the minimum safe level.

The level instruments for the spent fuel pool are classified as safety-related components because they provide necessary information to the operator for performing the safety-related function of refilling the spent fuel pool following an accident.

7.5.5.1 System Design Bases

See Subsection 9.1.3.1.

7.5.5.2 System Description

See subsection 9.1.3.2.

7.5.5.3 Safety Evaluation

See Subsection 9.1.3.3.

7.5.5.4 Testing and Inspection Requirements

See Subsection 9.1.3.4.

7.5.5.5 Instrumentation and Control Requirements

See Subsection 9.1.3.5.

7.5.6 Deleted~~Wetwell-to-Drywell Vacuum Breaker Monitoring~~

~~The wetwell-to-drywell vacuum breakers are provided with four safety-related proximity sensors in four safety-related instrument divisions that monitor their closed position. See Subsection 6.2.1 for further discussion.~~

7.5.7 COL Information

None

References