7.5 Information Systems Important to Safety

The information in this section of the reference ABWR DCD, including all subsections and tables, is incorporated by reference with the following departures and supplements.

STD DEP T1 2.3-1 (Table 7.5-2)

STD DEP T1 2.14-1 (Table 7.5-2, 7.5-6)

STD DEP 1.8-1 (Table 7.5-1)

STD DEP 7.5-1 (Tables 7.5-2, 7.5-3, 7.5-4)

STD DEP 11.5-1 (Table 7.5-2)

STD DEP Admin (Tables 7.5-2, 7.5-4)

STD DEP Vendor

7.5.1.1 Post Accident Monitoring System

STD DEP Admin

(1) Variable Types

Regulatory Guide 1.97 defines five "types" and three "categories" of plant variables for accident monitoring instrumentation. A discussion of these classifications is provided below. Each variable has been defined as to both type and ~~classification~~ category*. Plant variables are divided into types according to the purpose of the indication to the plant operator. Any one variable may belong to more than one type.*

(a) Type A

Type A variables are limited to those variables which are necessary (primary) to alert the control room operator of the need to perform preplanned manual actions for safety systems to perform their safety functions, such as, initiating ~~suppression pool cooling and~~ containment spray to permit the systems to perform safety functions for which no automatic system controls are provided. Variables that require actions specified by the Emergency Procedure Guidelines (EPGs) in response to specific operating limits have also been considered in performing the assessment documented in this chapter.

7.5.2 Systems Analysis

7.5.2.1 Post Accident Monitoring System

STD DEP T1 2.3-1

STD DEP T1 2.14-1

STD DEP 7.5-1

STD DEP Admin

STD DEP Vendor

(1) Type A Variables

(a) Type A Variable Evaluation and Analysis

Chapter 15 contains discussions of numerous events, not all of which are design basis accidents. Appendix 15A is a plant Nuclear Safety Operational Analysis (NSOA) which addresses these events in the following categories:

(i)	*Normal operations*	
(ii)	*Anticipated Operational Transients*	*(Table ~~5.7-4~~ 7.5-4)*
(iii)	*Abnormal Operational Transients*	*Table ~~5.7-5~~ 7.5-5)*
(iv)	*Design Basis Accidents*	*(Table ~~5.7-6~~ 7.5-6)*
(v)	*Special Events*	*(Table ~~5.7-7~~ 7.5-7)*

The offsite release rate (R_E) was also not included with the Type A Variable List because the emergency action (emergency depressurization) specified in the radioactivity release control guidelines would, in all events, have been previously initiated in response to other variables (e.g., RPV Water Level). This conclusion is reached because the source terms required to reach release rates associated with a general emergency (the point at which the emergency action is required by the EPG) can only occur following a release of a substantial proportion of the fuel noble gas inventory. Prevention of such a release is a primary goal of the RPV control guideline. Also, the other operator action (isolate lines discharging outside the primary and secondary containment) are intended to be taken at levels low enough as to not pose a significant risk for the general public. The primary lines which communicate with the RPV are automatically isolated ~~on high steamline radiation~~ which satisfies the intent of the EPG action for these lines. Other lines which pass outside of the primary and secondary containment but which do not communicate directly with the RPV also receive automatic isolation signals. Thus, response to the radioactivity release control guideline is considered to be a contingency action and is not required to be Type A.

(2) General Variable Assessments

(a) Drywell Pressure

Requirements for monitoring of drywell pressure are specified for both narrow range (from about -34.32 kPaG to + 34.32 kPaG) and wide range (from 0 to 110% of design pressure). The narrow range monitoring requirement is satisfied in the existing safety-related design by the four divisions of drywell pressure instruments which provide inputs to the initiation of the reactor protection (trip) system (RPS) and the emergency core cooling systems (ECCS). The requirement for unambiguous wide range drywell pressure monitoring are satisfied with two channels of drywell pressure instrumentation integrated with two channels of wetwell pressure instrumentation. Given the existence of (1) the normal pressure suppression vent path between the drywell and wetwell and (2) the wetwell to drywell vacuum breakers, the long-term pressure within the drywell and wetwell will be approximately the same. Therefore, if the two wide range drywell pressure indications disagreed, the operator could refer to the wetwell containment pressure indications to determine which of the two drywell pressure indications is correct. In order to provide full range pressure comparisons between the drywell wide range and wetwell pressure instruments, the drywell pressure instrument range is 689.4 kPa. This value exceeds the required value of 110% of design pressure. Drywell pressure is a Type A variable because it is used to initiate drywell spray to maintain the Reinforced Concrete Containment Vessel (RCCV) below temperature limits in LOCA.

(d) BWR Core Temperature

Regulatory Guide 1.97 requires BWR core temperature (thermocouples) as a diverse indication of adequate core cooling. ~~*General Electric and the*~~The *BWR Owners' Group* ~~*have*~~has *taken exception to this requirement for diverse indication based upon studies regarding the relationship between reactor water level and adequate core cooling.* ~~*It is General Electric's view that no*~~No *instrumentation other than RPV water level indication is required to assure indication of adequate core cooling.*

(e) Drywell Sump Level

An exception is made to Regulatory Guide 1.97 as written for the design category for the equipment drain sump level. Rather than Category 1, ~~*General Electric considers*~~ *the Category 3 design requirements* ~~*to be*~~are *more appropriate for the following reason: Indication of drywell floor drain sump level provides monitoring of leakage to the drywell and will be an early indication of a very small reactor coolant system leak/break for those events for which the drywell cooling system remains operable. However, it is primarily a backup variable to other indications of reactor coolant system leaks/breaks such as drywell pressure or drywell radiation level. In addition, containment water level is provided as a Type D, Category 2 variable. A lower design* *classification for drywell sump level is therefore appropriate and triplicated instrument channels are not necessary.*

(h) Coolant Radiation

~~*The indicator of coolant radiation leakage will be provided by theProcess Radiation Monitoring System (PRMS) Main Steamline (MSL) radiation monitor subsystem. This subsystem consists of four physically and electrically separated and redundant divisions. Each division has a single channel consisting of a local radiation detection assembly, control room readout and trip actuators (Figure 7.6-5, sh 1). Each channel is located such that it can monitor each mainsteam line. These four divisions of PRMS radiation instrumentation satisfy the Regulatory Guide requirement for unambiguous indication.*~~

A continuous post-accident monitor for this parameter is not necessary and is not included in the design. This is consistent with BTP HICB-10, Table 1.

(i) Suppression Pool Water Temperature

The ABWR Suppression Pool Temperature Monitoring (SPTM) System design requirements satisfy the Regulatory Guide 1.97 requirements regarding redundancy. The SPTM System is composed of four separate and independent instrument divisions. Each division has associated with it multiple thermocouples which are spatially distributed around the suppression pool. With this configuration, the bulk average suppression pool temperature can be determined even in the event of the loss of an entire division of instrumentation, since thermocouple sensors of each division will be located in close proximity to facilitate direct comparison. Although the ABWR design initiates reactor scram and suppression pool cooling automatically on high pool temperature, suppression pool water temperature variable is considered a Type A variable since ~~*no credit is taken for automatic initiation in the safety analysis*~~ the operator uses it for manual RPV depressurization*.*

(k) Drywell/Wetwell Hydrogen/Oxygen Concentration

The Containment Atmospheric Monitoring System (CAMS) consists of two independent and redundant nonsafety-related *drywell/*~~*containment*~~wetwell *oxygen and hydrogen concentration monitoring channels. Emergency response actions regarding these variables are consistently directed toward minimizing the magnitude of these parameters (i.e., there are no safety actions which must be taken to increase the hydrogen/oxygen levels if they are low).* Minimizing drywell/wetwell oxygen and hydrogen concentrations is accomplished by manual operator actions using containment venting and purging or using containment spray. *Consequently, the two channel CAMS design provides adequate PAM indication, since, in the event that the two* *channels of information disagree, the operator can determine a correct and safe action based upon the higher of the two (in-range) indications.*

(q) Drywell Spray Flow and Wetwell Spray Flow

The ABWR design does not provide direct Drywell Spray Flow indication. Regulatory Guide 1.97 suggests this as a Type D Variable for the purpose of monitoring drywell spray operation. As allowed by BTP HICB-10, RHR flow, drywell temperature and drywell pressure indications are provided as acceptable alternatives. RHR provides water to the drywell spray headers. Following a postulated accident, presence of drywell spray flow results in drywell pressure and temperature reduction. The operator confirms drywell spray operation by observing that there is RHR flow present and that the drywell pressure and temperature is within expected limits. Operator use of these variables allows accurate and reliable measurement of the effectiveness of the drywell spray in a timely manner. In addition, the position of the spray throttling valves can be monitored and the sprays adequately controlled from the control room using these alternative variables.

Table 7.5-1 Design and Qualifiction Criteria for Instrumentation

Category 1	Category 2	Category 3
4. Channel Availability		
The instrumentation channel is available prior to an accident except as ~~provided in Paragraph 4.11, "Exception," as defined in IEEE-279, 1971, "Criteria for Protection~~ **noted in the Exception to Paragraph 6.7, "Maintenance Bypass," in IEEE-603, "Standard Criteria for Safety** Systems for Nuclear Power Generating Stations," or as specified in the technical specifications.	The out-of-service interval is based on normal technical specification requirements on out-of-service for the system it serves where applicable or where specified by other requirements.	No specific provision

Table 7.5-2 ABWR PAM Variable List

Variable	Range Required	Type	Cate-gory	Discussion Section
Drywell Pressure	~~0.034 MPaG to 0.021 MPaG~~ **-0.034 MPaG to +0.034 MPaG** (narrow range) ~~0–100~~ **0–110**% design pressure (wide range)	**A,**B,C,D	1	Subsection 7.5.2.1(2)(a)
Containment Area Radiation	10^{-2} ~~Gy~~ **Sv**/h to 10^{5} ~~Gy~~ **Sv**/h	C,E	1	Subsection 7.5.2.1(2)(f)
~~Coolant Radiation~~	~~1/2 Tech Spec limit to 100 times Tech Spec limit~~	~~C~~	~~1~~	~~Subsection 7.5.2.1(2)(h)~~
Drywell/Wetwell Hydrogen Concentration	0–30 Volume%	C	~~1~~ **3**	Subsection 7.5.2.1(2)(k)
Drywell/Wetwell Oxygen Concentration	0–10 Volume%	C	~~1~~ **2**	Subsection 7.5.2.1(2)(k)
Service Area Radiation Exposure Rate	10^{-3} ~~Gy~~ **Sv**/h to 10^{2} ~~Gy~~ **Sv**/h	E	3	
Plant and Environs Radiation/Radioactivity (Portable Instruments)	10^{-5} ~~Gy~~ **Sv**/h to10^{2} ~~Gy~~ **Sv**/h photons 10^{-5} ~~Gy~~ **Sv**/h to 10^{2} ~~Gy~~ **Sv**/h, beta and low energy photons	E	3	Portable Instruments *
Meteorological Data (Wind Speed, Wind Direction, and Atmospheric Stability)	0–360° 0–**22** ~~9.8~~ m/s **-5°C to 10°C**	E	3	*
On Site Analysis Capability (Primary Coolant, Sump and Space Containment Air Grab Sampling)	Refer to Regulatory Guide 1.97	E	3	*
~~Secondary Containment Area Temperature~~		~~E~~	~~2~~	
Secondary Containment Area Radiation	10^{-3} ~~Gy~~ **Sv**/h to 10^{2} ~~Gy~~ **Sv**/h	E	2	
Suppression Chamber Spray (Wetwell) Flow	**0-110% Design Flow**	**D**	**2**	**Subsection 7.3.1.1.4**

* *Out of ABWR Standard Plant Scope*

Table 7.5-3 ABWR Type A Variables

Suppression Pool Water Temperature
~~Wetwell~~**Drywell** Pressure

Table 7.5-4 Anticipated Operational Transients

Event Description	NSOA Event Figure No.	Tier 2 Section No.	Manual Action Variables*
Manual or Inadvertent SCRAM	~~15A.6-7~~ **15A-12**	15A.6.3.3 Event 7	P_{RPV}, L_{RPV}
Loss of Plant Instrument Service Air Systems	~~15A.6-8~~ **15A-13**	15A.6.3.3 Event 8	T_{SP},P_{RPV}, L_{RPV}
Recirculation Flow Control Failure—One RIP Runout	~~15A.6-9~~ **15A-14**	15.4.5	P_{RPV}, L_{RPV}
Recirculation Flow Control Failure—One RIP Runback	~~15A.6-10~~ **15A-15**	15.3.2	P_{RPV}, L_{RPV}
Three RIPs Trip	~~15A.6-11~~ **15A-16**	15.3.1	P_{RPV}, L_{RPV}
All MSIV Closure	~~15A.6-12~~ **15A-17**	15.2.4	T_{SP},P_{RPV}, L_{RPV}
One MSIV Closure	~~15A.6-13~~ **15A-18**	15.2.4	T_{SP},P_{RPV}, L_{RPV}
Loss of All Feedwater Flow	~~15A.6-14~~ **15A-19**	15.2.7	P_{RPV}, L_{RPV}
Loss of a Feedwater Heater	~~15A.6-15~~ **15A-20**	15.1.1	ϕ,P_{RPV}, L_{RPV}
Feedwater Controller Failure—Runout of One Feedwater Pump	~~15A.6-16~~ **15A-21**	15.1.2	P_{RPV}, L_{RPV}
Pressure Regulator Failure—Opening of One Bypass Valve	~~15A.6-17~~ **15A-22**	15.1.3	P_{RPV}, L_{RPV}
Pressure Regulator Failure—Opening of One Control Valve	~~15A.6-18~~ **15A-23**	15.2.1	P_{RPV}, L_{RPV}
Main Turbine Trip with Bypass System Operational	~~15A.6-19~~ **15A-24**	15.2.3	T_{SP}, P_{RPV}, L_{RPV}
Loss of Main Condenser Vacuum	~~15A.6-20~~ **15A-25**	15.2.5	P_{RPV}, L_{RPV}
Generator Load Rejection with Bypass System Operational	~~15A.6-21~~ **15A-26**	15.2.2	T_{SP},P_{RPV},L_{RPV}
Loss of Unit Auxiliary Transformer	~~15A.6-22~~ **15A-27**	15.2.6	T_{SP},P_{RPV}, L_{RPV}

* See Table 7.5-9 for Definition of symbols

Table 7.5-5 Abnormal Operational Transients

Event Description	NSOA Event Figure No.	Tier 2 Section No.	Manual Action Variables*
Inadvertent Startup of HPCF Pump	~~15A.6-23~~ **15A-28**	15.5.1	ϕ
Main Turbine Trip with One Bypass Valve Failure	~~15A.6-26~~ **15A-31**	15.2.3	P_{RPV}, L_{RPV}
Generator Load Rejection with One Bypass Valve Failure	~~15A.6-27~~ **15A.32**	15.2.2	P_{RPV}, L_{RPV}
Abnormal Startup of the Idle Reactor Internal Pump	**15A-45**	**15.4.4**	P_{RPV}, L_{RPV}
Recirculation Flow Control Failure – All RIPs Runout	**15A-46**	**15.4.5**	ϕ, L_{RPV}
Recirculation Flow Control Failure – All RIPs Runback	**15A-47**	**15.3.2**	L_{RPV}
Feedwater Controller Failure Maximum Demand	**15A-51**	**15.1.2**	P_{RPV}, L_{RPV}
Pressure Regulator Failure – Opening of All Bypass and Control Valves	**15A-52**	**15.1.3**	P_{RPV}, L_{RPV}
Main Turbine Trip with Bypass Failure	**15A-55**	**15.2.3**	T_{SP}, P_{RPV}, L_{RPV}
Generator Load Rejection with Bypass Failure	**15A-56**	**15.2.2**	T_{SP}, P_{RPV}, L_{RPV}

* See Table 7.5-9 for Definition of symbols

Table 7.5-6 Design Basis Accidents

Event Description	NSOA Event Figure No.	Tier 2 Section No.	Manual Action Variables*
Loss-of-Coolant Accident Resulting from Spectrum of Postulated Piping Breaks within the RCPB Inside Containment	*15A.6-32*	*15.6.5*	~~H_{2C}, O_{2C},~~ L_{RPV}, L_{SP}, P_{RPV}, P_{DW}, Ø