

18F Emergency Operation Information and Controls

18F.1 Introduction

This appendix contains the results of an analysis of information and control needs of the main control room operators. The analysis is based upon the operation strategies given in the ABWR Emergency Procedure Guidelines (EPGs) as presented in Appendix 18A and the significant operator actions determined by the Probabilistic Risk Assessment (PRA) described in Section 19D.7. The minimum inventory of controls, displays and alarms from this analysis are presented in Tables 18F-1 through 18F-3. The information and controls identified from this analysis do not necessarily include those from other design requirements (such as those from Section 18.4.2.11, SPDS). Supporting information is provided in Appendix 18H.

Information and control needs for each operative instruction or action were developed through task analyses conducted in the following manner:

- Each specific step in the EPGs (referred to as the EPG step) or specific operator action referenced in the PRA (herein referred to as the PRA operator action) was individually identified.
- A summary description of the step or PRA operator action was developed for each EPG step and PRA operator action.
- Information needs required for the operator to perform the specific EPG step or PRA operator action were then identified.
- Next, the control functions that the operators perform to execute the actions specified in the EPG step or PRA operator action were identified.
- The plant process parameters or other displays needed for execution of the individual EPG step or PRA operator action, were then identified.
- Similarly, the controls needed for the execution of each step, were identified.
- Alarms to perform step and alarms to provide feedback information to the operator were identified.
- Operator aids, such as supplementary procedures or other information needed to execute the step, were identified.
- Displays needed to provide confirmatory feedback to the operators that the specified control functions have been initiated or accomplished, were identified.
- Position of control devices that provide feedback to the operators to confirm that proper controls are manipulated to the correct positions, were identified.

- Annunciators which provide feedback to the operators to confirm that proper control actions are initiated or accomplished were identified.
- Operator aids, which provide feedback to the operators to confirm that proper control actions are initiated or accomplished, were identified.

The following operator actions are considered to be important operator actions in the ABWR PRA (refer to Section 19D.7):

- (1) Use of condensate injection following scram with reactor depressurized
- (2) Recovery of feedwater following a scram
- (3) Control of reactor water level in an ATWS
- (4) Open RCIC pump manual discharge valve
- (5) Restoration of main condenser normal heat removal
- (6) Activate CUW
- (7) Initiate SLC delivery of boron
- (8) Not used
- (9) Not used

These actions are already specified in the EPGs and are included in the analyses.

Based upon the results of those operator task analyses, the listings of controls, displays and alarms that will be provided in the implemented ABWR design to support execution of the EOPs and PRA significant operator actions (as presented in Tables 18F-1, 18F-2, and 18F-3), were generated.

**Table 18F-1
Inventory of Controls Based Upon the ABWR EPGs and PRA**

| No. | Fixed Position Controls |
|-----|---|
| 1 | Manual Scram Initiation SW(A) |
| 2 | Manual Scram Initiation SW(B) |
| 3 | Reactor Mode SW |
| 4 | Div. I Main steamline Manual Isolation SW |
| 5 | Div. II Main steamline Manual Isolation SW |
| 6 | Div. III Main steamline Manual Isolation SW |
| 7 | Div. IV Main steamline Manual Isolation SW |
| 8 | Primary Containment Div. I Manual Isolation SW |
| 9 | Primary Containment Div. II Manual Isolation SW |
| 10 | Primary Containment Div. III Manual Isolation SW |
| 11 | RCIC Initiation SW |
| 12 | HPCF (B) Initiation SW |
| 13 | HPCF (C) Initiation SW |
| 14 | RHR (A) Initiation SW |
| 15 | RHR (B) Initiation SW |
| 16 | RHR (C) Initiation SW |
| 17 | DG(A) Start SW |
| 18 | DG(B) Start SW |
| 19 | DG(C) Start SW |
| 20 | RCIC System Standby Mode Initiation SW |
| 21 | Condensate Pump Standby Mode Initiation Switches (8) |
| 22 | Reactor Feedpump Standby Mode Initiation Switches (4) |
| 23 | Condensate Pump Startup Mode Initiation Switches (8) |
| 24 | Reactor Feedpump Startup Mode Initiation Switches (4) |
| 25 | SLC (A) Pump CS |
| 26 | SLC (B) Pump CS |
| 27 | ADS (A) Inhibit SW |
| 28 | ADS (B) Inhibit SW |
| 29 | RHR(A) Standby Mode SW |
| 30 | RHR(B) Standby Mode SW |
| 31 | RHR(C) Standby Mode SW |
| 32 | Main Steam Isolation Valve CS (8) |
| 33 | Div. I Manual/Auto Main Steamline Isolation Reset SW |
| 34 | Div. II Manual/Auto Main Steamline Isolation Reset SW |

**Table 18F-1
Inventory of Controls Based Upon the ABWR EPGs and PRA (Continued)**

| No. | Fixed Position Controls |
|-----|--|
| 35 | Div. III Manual/Auto Main Steamline Isolation Reset SW |
| 36 | Div. IV Manual/Auto Main Steamline Isolation Reset SW |
| 37 | Primary Containment Div. I Isolation Reset SW |
| 38 | Primary Containment Div. II Isolation Reset SW |
| 39 | Primary Containment Div. III Isolation Reset SW |
| 40 | RHR(A) Shutdown Cooling Mode Initiation SW |
| 41 | RHR(B) Shutdown Cooling Mode Initiation SW |
| 42 | RHR(C) Shutdown Cooling Mode Initiation SW |
| 43 | ARI(A) Manual Initiation SW |
| 44 | ARI(B) Manual Initiation SW |
| 45 | Recirculation Runback Initiation SW(A) |
| 46 | Recirculation Runback Initiation SW(B) |
| 47 | RIP Start/Stop CS (10) |
| 48 | ARI(A) Logic Reset SW |
| 49 | ARI(B) Logic Reset SW |
| 50 | CRD Charging Water Pressure Low Scram Bypass SW(A) |
| 51 | CRD Charging Water Pressure Low Scram Bypass SW(B) |
| 52 | CRD Charging Water Pressure Low Scram Bypass SW(C) |
| 53 | CRD Charging Water Pressure Low Scram Bypass SW(D) |
| 54 | Manual Scram Reset SW |
| 55 | RPS Div. I Trip Reset SW |
| 56 | RPS Div. II Trip Reset SW |
| 57 | RPS Div. III Trip Reset SW |
| 58 | RPS Div. IV Trip Reset SW |
| 59 | RHR(A) Suppression Pool Cooling Mode Initiation SW |
| 60 | RHR(B) Suppression Pool Cooling Mode Initiation SW |
| 61 | RHR(C) Suppression Pool Cooling Mode Initiation SW |
| 62 | RHR(B) Primary Containment Vessel Spray Mode Initiation SW |
| 63 | RHR(C) Primary Containment Vessel Spray Mode Initiation SW |
| 64 | SGTS(B) Initiation SW |
| 65 | SGTS(C) Initiation SW |
| 66 | Div I Manual ADS Channel 1 Initiation SW |
| 67 | Div I Manual ADS Channel 2 Initiation SW |
| 68 | Div II Manual ADS Channel 1 Initiation SW |

Table 18F-1
Inventory of Controls Based Upon the ABWR EPGs and PRA (Continued)

| No. | Fixed Position Controls |
|-----|--|
| 69 | Div II ADS Manual ADS Channel 2 Initiation SW |
| 70 | RCIC Div. I Isolation Logic Reset SW |
| 71 | RCIC Div. II Isolation Logic Reset SW |
| 72 | RCIC Inboard Isolation CS |
| 73 | RCIC Outboard Isolation CS |
| 74 | RHR(C) Manual Valves For Firewater Injection (F101, F102, F103)* |
| 75 | CUW Regenerative Heat Exchanger Manual Bypass Valve* |
| 76 | Turbine Building HVAC System Controls* |
| 77 | SLC Local Controls* |
| 78 | Fire Protection System Motor Pump Control SW† |
| 79 | Fire Protection System Diesel Pump Control SW† |
| 80 | Control Rod Scram Test Switches† |
| 81 | "A" Scram Solenoid Main Power Breaker CS† |
| 82 | "B" Scram Solenoid Main Power Breaker CS† |
| 83 | RPS Div. I Trip Inhibit SW† |
| 84 | RPS Div. II Trip Inhibit SW† |
| 85 | RPS Div. III Trip Inhibit SW† |
| 86 | RPS Div. IV Trip Inhibit SW† |
| 87 | Rod Worth Minimizer Bypass,† |
| 88 | CAMS(A) Operating Mode SW† |
| 89 | CAMS(B) Operating Mode SW† |
| 90 | CAMS(A) Sample Select SW† |
| 91 | CAMS(B) Sample Select SW† |
| 92 | Not Used |
| 93 | Not Used |

* Provided outside the main control room.

† To be provided at main control room area panels, not at the operator control panels.

**Table 18F-1
Inventory of Controls Based Upon the ABWR EPGs and PRA (Continued)**

| No. | Other Control Functions |
|-----|---|
| 1 | HPCF(B) System controls for terminating system flow, injecting flow, and isolation of potential discharges to reactor building areas |
| 2 | HPCF(C) System controls for terminating system flow, injecting flow, and isolation of potential discharges to reactor building areas |
| 3 | RCIC System controls for terminating system flow, injecting flow, isolation of potential discharges to reactor building areas, and venting of the RPV to the main condenser |
| 4 | RHR(A) System controls for terminating system flow, injecting flow, suppression pool cooling, wetwell spray, drywell spray, shutdown cooling, and isolation of potential discharges to reactor building areas |
| 5 | RHR(B) System controls for terminating system flow, injecting flow, suppression pool cooling, wetwell spray, drywell spray, shutdown cooling, and isolation of potential discharges to reactor building areas |
| 6 | RHR(C) System controls for terminating system flow, injecting flow, suppression pool cooling, wetwell spray, drywell spray, shutdown cooling, and isolation of potential discharges to reactor building areas |
| 7 | Main steamline drain containment isolation valve controls |
| 8 | SRV opening and closing controls for each SRV |
| 9 | SGTS(B) System controls for venting of the primary containment, and control of secondary containment (reactor building) radiation |
| 10 | SGTS(C) System controls for venting of the primary containment, and control of secondary containment (reactor building) radiation |
| 11 | RBHVAC containment isolation valves controls |
| 12 | ACS containment isolation valves controls |
| 13 | SGTS(B) room cooler fan control |
| 14 | SGTS(C) room cooler fan control |
| 15 | CAMS(A) room cooler fan control |
| 16 | CAMS(B) room cooler fan control |
| 17 | RHR(A) pump room cooler fan control |
| 18 | RHR(B) pump room cooler fan control |
| 19 | RHR(C) pump room cooler fan control |
| 20 | HPCF(B) pump room cooler fan control |
| 21 | HPCF(C) pump room cooler fan control |
| 22 | RCIC pump room cooler fan control |
| 23 | Not Used |
| 24 | Not Used |

**Table 18F-1
Inventory of Controls Based Upon the ABWR EPGs and PRA (Continued)**

| No. | Other Control Functions |
|-----|---|
| 25 | FPC(A) room cooler fan control |
| 26 | FPC(B) room cooler fan control |
| 27 | Fuel Pool Cooling System controls for isolation of discharges into reactor building areas |
| 28 | RCIC steamline isolation logic bypasses (area temperature high, RPV pressure low, steamline pressure low, RCIC turbine exhaust pressure low) |
| 29 | CUW isolation logic bypass (SLC initiation, regenerative heat exchanger area temperature high, RPV water Level 2) |
| 30 | MSIV and main steamline drain isolation logic bypass (level 1.5, main steamline high flow, main steamline tunnel area temperature high, main steamline turbine area temperature high) |
| 31 | Logic bypass (RPV Level 3) of RBHVAC system isolation valves |
| 32 | Logic bypass (RPV Level 3) of atmospheric control system isolation valves |
| 33 | Logic bypass of high drywell pressure isolation for RBHVAC |
| 34 | High RPV water level (Level 8) HPCF(B) injection valve closure logic bypass |
| 35 | High RPV water level (Level 8) HPCF(C) injection valve closure logic bypass |
| 36 | Condensate and feedwater system controls for terminating flow and injecting flow into the RPV/containment |
| 37 | CRD System controls for terminating flow and injecting flow into the RPV/containment |
| 38 | Condensate Makeup Water System controls for terminating flow and injecting flow into the RPV/containment |
| 39 | SPCU System controls for terminating flow into the containment if aligned to take suction from the condensate storage tank |
| 40 | Feedwater Control System controls for terminating flow and injecting flow into the RPV/containment |
| 41 | Pressure Control System controls for the turbine bypass valves |
| 42 | Main Steam System controls for controlling main steamline drain and head vent valves |
| 43 | CUW System controls for alternate pressure control or decay heat removal |
| 44 | Rod Control and Information System controls for control rod insertions |
| 45 | Drywell Cooling System fan control |
| 46 | Nitrogen vent and purge mode of ACS |
| 47 | Containment purge mode of containment supply and purge subsystem of RBHVAC |
| 48 | RBHVAC System controls for venting of the containment |
| 49 | Atmospheric Control System controls for venting and purging of the containment |
| 50 | Main steam/feedwater tunnel HVAC fan controls |
| 51 | Logic bypasses for Alternate Rod Insertion (ARI) (high RPV pressure, RPV Water Level 2) |

Table 18F-1
Inventory of Controls Based Upon the ABWR EPGs and PRA (Continued)

| No. | Other Control Functions |
|------------|--|
| 52 | Logic bypass of High RPV Water level (Level 8) trip of reactor feedpumps |
| 53 | Logic bypasses of drywell cooling fans and associated cooling water (RCW) [Drywell Pressure High, RPV Water Level 1] |

**Table 18F-2
Inventory of Displays Based Upon the ABWR EPGs and PRA**

| No. | Fixed Position Displays | No. | Fixed Position Displays |
|-----|--|-----|---|
| 1 | RPV Water Level ★★ | 27 | RHR(C) Flow ★★ |
| 2 | RCIC Turbine Speed | 28 | RHR(C) Injection Valve Status |
| 3 | Wetwell Pressure ★★ | 29 | Emergency Diesel Generator (A) Operating Status ★★ |
| 4 | Suppression Pool Bulk Average Temperature ★★ | 30 | Emergency Diesel Generator (B) Operating Status ★★ |
| 5 | HPCF(B) Flow ★★ | 31 | Emergency Diesel Generator (C) Operating Status ★★ |
| 6 | HPCF(C) Flow ★★ | 32 | Primary Containment Water Level ★★ |
| 7 | RPV Pressure ★★ | 33 | Condensate Storage Tank Water Level ★★ |
| 8 | Drywell Pressure ★★ | 34 | SLC Pump(A) Discharge Pressure ★★ |
| 9 | Reactor Power Level, (Neutron Flux, APRM) ★★ | 35 | SLC Pump(B) Discharge Pressure ★★ |
| 10 | Reactor Power Level (SRNM) ★★ | 36 | Main Condenser Pressure |
| 11 | Reactor Thermal Power ★★ | 37 | SRV Positions ★★ |
| 12 | MSIV Position Status (Inboard And Outboard Valves) ★★ | 38 | Suppression Pool Level ★★ |
| 13 | Reactor Mode Switch Mode Indications | 39 | Main Steamline Flow ★★ |
| 14 | Not Used | 40 | SLC Boron Tank Water Level ★★ |
| 15 | Scram Solenoid Lights(8) Status | 41 | Recirculation Pump Speeds |
| 16 | Manual Scram SW(A) Indicating Light Status | 42 | Average Drywell Temperature ★★ |
| 17 | Manual Scram SW(B) Indicating Light Status | 43 | Wetwell Hydrogen Concentration Level ★★ |
| 18 | RPV Isolation Status Display ★★ | 44 | Drywell Hydrogen Concentration Level ★★ |
| 19 | RCIC Flow ★★ | 45 | Drywell Oxygen Concentration ★★ |
| 20 | RCIC Injection Valve Status | 46 | Wetwell Oxygen Concentration ★★ |
| 21 | HPCF(B) Injection Valve Status | 47 | Not Used |
| 22 | HPCF(C) Injection Valve Status | 48 | Not Used |
| 23 | RHR(A) Flow ★★ | 49 | Main Stack Radiation Level ★★ |
| 24 | RHR(A) Injection Valve Status | 50 | Time |

★★ Denotes Regulatory Guide 1.97 Parameter

Table 18F-2
Inventory of Displays Based Upon the ABWR EPGs and PRA (Continued)

| No. | Fixed Position Displays | No. | Fixed Position Displays |
|---|--------------------------------|------------|--------------------------------|
| 25 | RHR(B) Flow ★ ★ | 51 | Drywell Radiation Level ★ ★ |
| 26 | RHR(B) Injection Valve Status | 52 | Wetwell Radiation Level ★ ★ |
| ★ ★ Denotes Regulatory Guide 1.97 Parameter | | | |

18F-2 Inventory of Displays Based Upon the ABWR EPGs and PRA (Continued)

| No. | Other Displays |
|---|--|
| 1 | Reactor building differential pressure |
| 2 | Reactor building HVAC exhaust radiation level |
| 3 | Fuel handling area ventilation exhaust radiation level |
| 4 | RHR(A) pump room cooler operation status |
| 5 | RHR(B) pump room cooler operation status |
| 6 | RHR(C) pump room cooler operation status |
| 7 | HPCF(B) pump room cooler operation status |
| 8 | HPCF(C) pump room cooler operation status |
| 9 | RCIC pump room cooler operation status |
| 10 | Not Used |
| 11 | Not Used |
| 12 | FPC(A) room cooler operation status |
| 13 | FPC(B) room cooler operation status |
| 14 | SGTS(B) room cooler operation status |
| 15 | SGTS(C) room cooler operation status |
| 16 | CAMS(A) room cooler operation status |
| 17 | CAMS(B) room cooler operation status |
| 18 | Main Steamline Radiation ★ ★ |
| ★ ★ Denotes Regulatory Guide 1.97 Parameter | |

**Table 18F-3
Inventory of Alarms Based Upon the ABWR EPGs and PRA**

| No. | Fixed Position Alarms | No. | Fixed Position Alarms |
|-----|--|-----|---|
| 1 | Indicated RPV Water Level Abnormal | 29 | Leak Detection Isolation |
| 2 | RPV Water Level 3 | 30 | CUW System Status |
| 3 | RPV Pressure High | 31 | Reactor Period Short |
| 4 | Drywell Pressure High | 32 | ADS Div. I Inhibited/Auto Out Of Service |
| 5 | Neutron Flux High-High | 33 | ADS Div. II Inhibited/Auto Out Of Service |
| 6 | Neutron Monitoring System Inoperative | 34 | Suppression Pool Bulk Average Temperature High |
| 7 | MSIV Closure | 35 | Drywell Average Temperature High, |
| 8 | CRD Charging Water Pressure Low | 36 | Suppression Pool Water Level High/Low |
| 9 | Rapid Core Flow Decrease | 37 | CAMS H ₂ /O ₂ Level High |
| 10 | Main Turbine Trip | 38 | CAMS(A) System Abnormal |
| 11 | Main Generator Trip | 39 | CAMS(B) System Abnormal |
| 12 | Not Used | 40 | Reactor Building ΔP Low |
| 13 | Reactor Scram | 41 | Area Temperature High |
| 14 | RPV Level 3 Isolation Incomplete | 42 | Area HVAC ΔT High |
| 15 | RPV Level 2 Isolation Incomplete, | 43 | RBHVAC Exhaust Radiation High |
| 16 | RPV Level 1.5/Drywell Pressure High Isolation Incomplete | 44 | Reactor Building Area Radiation High |
| 17 | RPV Water Level 2 | 45 | Reactor Building Floor Drain Sump Water Level High-High |
| 18 | RPV Water Level 1.5 | 46 | RBHVAC System Status |
| 19 | RPV Water Level 1 | 47 | Stack Radioactivity High |
| 20 | Control Rod Not Inserted To/Beyond MSBWP ★ ★ | 48 | RCW Radioactivity High |
| 21 | RPV Water Level 8 | 49 | Radwaste Effluent Radioactivity High |
| 22 | Fire Protection System Status | 50 | Turbine Building Ventilation System (TBVS) Status |
| 23 | ADS(A) Logic Initiated | 51 | Radiation Monitor High |
| 24 | ADS(B) Logic Initiated | 52 | RCIC System Status |
| 25 | SRV Open | 53 | HPCF (B) System Status |
| 26 | Main Steamline Flow High | 54 | HPCF (C) System Status |
| 27 | HPIN(A) System Status | | |

★ ★ Denotes Regulatory Guide 1.97 Parameter.

**Table 18F-3
Inventory of Alarms Based Upon the ABWR EPGs and PRA (Continued)**

| No. | Fixed Position Alarms | No. | Fixed Position Alarms |
|--|-----------------------|-----|-----------------------|
| 28 | HPIN(B) System Status | | |
| ★ ★ Denotes Regulatory Guide 1.97 Parameter. | | | |

**Table 18F-3 Inventory of Alarms Based Upon the ABWR EPGs and
PRA (Continued)**

| No. | Other Alarms |
|-----|---|
| 1 | RPS Div. I Trip Inhibited |
| 2 | RPS Div. II Trip Inhibited |
| 3 | RPS Div. III Trip Inhibited |
| 4 | RPS Div. IV Trip Inhibited |
| 5 | RPV Water Level \leq Zero—Injection Water Level |
| 6 | Drywell Radiation Upscale |
| 7 | Wetwell Radiation Upscale |
| 8 | Lower Drywell Water Level High |
| 9 | APRM Downscale |
| 10 | Main Steamline Radiation High |