

2.5.3 Diverse Actuation System

2.5.3.1 Design Description

The DAS is a non-safety system that is diverse from the PSMS software and the digital platform of the PSMS, ~~and is also diverse from the hardware used in the reactor trip function of the RT system.~~ Therefore, a software or digital platform common cause failure (CCF) in the digital safety and non-safety systems (PSMS and PCMS), would not affect the DAS. The DAS provides monitoring, control and actuation capability of the safety and the non-safety systems required to mitigate the AOOs and the PAs, concurrent with a ~~common-cause failure (CCF)~~ that could disable the functions of the PSMS and the PCMS.

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~~The DAS design consists of equipment that is diverse and independent from the digital platforms of the PSMS and PCMS. The DAS includes internal redundancy to prevent spurious actuation of automatic or manual functions due to a single component failure.~~

C

The DAS consists of two ~~divisions~~subsystems. ~~Both divisions must actuate in a 2-out-of-2 configuration to generate diverse actuation signals to plant components.~~ Each division subsystem consists ~~includes~~ of a diverse automatic actuation cabinet (DAAC). A diverse HSI panel (DHP) located in the MCR includes HSI components for both ~~divisions~~DAS subsystems. A manual actuation permissive switch is located in the MCR, but physically separated from the DHP is required for the manual actuations identified in Tables 2.5.3-2 and 2.5.3-3.

D

~~The DAACs provide automatic actuation functions for conditions where there is insufficient time for manual operator action needed for the accident mitigation. The DHP provides indications, alarms and manual actuation for mitigation actions, where there is sufficient time for manual operation action needed for the accident mitigation. In addition, the DHP provides indications and system level manual controls to maintain critical safety functions, indications and alarms for RCS leak detection monitoring, and indications and manual controls to achieve and maintain the hot standby (refer to Tables 2.5.3-1, 2.3.3-2 and 2.5.3-3).~~

E

~~The DAACs are located in two separate I&C rooms. Each DAAC is powered by a separate non-safety uninterruptible power source (UPS). The DHP is located in the MCR.~~

F

~~The DAS sensor input signals and output actuation signals are isolated within the PSMS to prevent adverse interactions with the PSMS safety functions due to the DAS failures. Isolated the DAS actuation signals are interfaced to output modules within the SLS and PCMS. These modules consist of the Class 1E logic elements which are not affected by a PSMS and PCMS software CCF. This ensures that the DAS signal is not affected by a PSMS and PCMS software CCF. The SLS and PCMS output modules, which are also used for the DAS, are not used for the PSMS reactor trip function. Therefore, the DAS signal is not affected by a hardware CCF in the PSMS that could result in an anticipated transient without scram (ATWS). Once diverse automatic actuation signals (reactor trip, turbine trip, main feedwater isolation and emergency feedwater) are generated from the DAAC, these signals are latched.~~

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~~During the plant online operation, the system can be tested manually without causing component actuations that would disturb the plant operations.~~

~~The DAS utilizes conventional hardware circuits (analog circuits, solid-state logic processing, relay circuits, switches, etc.). Therefore, a software CCF in the digital safety and non-safety systems (PSMS and PCMS), would not affect the DAS. Figure 2.5.3-1 shows the configuration of the DAS. The quality of DAS components and modules, and the quality of the DAS design process is controlled by an augmented quality program that meets the regulatory requirements for ATWS equipment.~~

1.a The functional arrangement of the DAS is as described in the Design Description of Subsection 2.5.3.1 and as shown in Figure 2.5.3-1. Variables monitored by the DAS are as indicated in Table 2.5.3-1.

1.b The DAS is physically separated and electrically independent from the PSMS.

1.c DAS controls are provided in the MCR to manually actuate equipment identified in Table 2.5.3-2, and to manually actuate functions identified in Table 2.5.3-3.

1.d The DAS provides automatic actuation of the equipment and for the functions identified in Tables 2.5.3-2 and 2.5.3-3, respectively, when the monitored variables identified in Table 2.5.3-1 exceed predetermined limits.

1.e The DAS prevents spurious actuation due to credible single failures or due to a fire. Spurious actuations are prevented by the DAS as follows:

- Automatic DAS functions are actuated by two subsystems and DAS actuation needs coincidence of both subsystems.
- The DAS prevents spurious actuation due to a seismic event. Thus the SSE will not result in a DAS failure that adversely affects the PSMS.
- The redundant DAS cabinets are located in separate fire areas to prevent spurious actuation from a fire in one area.
- Manual DAS functions identified in Tables 2.5.3-2 and 2.5.3-3 require actuation of two switches in the MCR. Separation between the permissive switch and the DHP prevents a fire in one switch location from affecting the other switch location.

2. The DAS has the following capabilities:

- Operates with both DAAC subsystems operable (i.e., in a two-out-of-two configuration), or with one subsystem manually tripped and one subsystem operable.
- The system can be tested manually without causing component actuation.
- Loss of power or removal of a module does not cause spurious DAS actuation.

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- Capability to bypass failed sensors functions.
3. The DAS equipment, including input and output interfaces, signal processing and HSI, consists of conventional hardware circuits (analog circuits, solid-state logic processing, relay circuits, switches, indicators).
 4. The DAS equipment used for the ATWS mitigation (i.e., reactor trip, turbine trip and emergency feedwater actuation) is diverse from the hardware used for the reactor trip function of the PSMS. This design commitment does not apply to measurement instrumentation and signal splitters, which distribute measurement signals to the DAS and the PSMS.
 5. Deleted.

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2.5.3.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.5.3-4 describes the ITAAC for the DAS.

Table 2.5.3-1 Variables Monitored by DAS

Critical Safety Function	Variables
Reactivity Control	Wide Range Neutron Flux
RCS Integrity	Pressurizer Pressure
	Reactor Coolant Pressure
Core Heat Removal	Reactor Coolant Cold Leg Temperature
RCS Inventory Control	Pressurizer Water Level
Secondary Heat Sink	Steam Generator Water Level
	Main Steam Line Pressure
Containment Integrity	Containment Pressure

Table 2.5.3-2 Equipment Actuated by DAS

Safety Function/Associated Components	Actuation Type
Diverse Reactor Trip (M/G set trip)	Automatic/Manual (MCR)
Turbine Trip	Automatic/Manual (MCR)
Emergency Feedwater Pump	Automatic/Manual (MCR)
ECCS Safety Injection Pump	Manual (MCR)
Safety Depressurization Valve	Manual (MCR)
Main Steam Depressurization Valve	Manual (MCR)
Steam Generator Blowdown Isolation Valve	Automatic/Manual (MCR)
Main Feedwater Regulation Valve	Automatic/Manual (MCR)
Emergency Feedwater Control Valve	Manual (MCR)
Containment Isolation Valves	Manual (MCR)

V

Table 2.5.3-3 DAS Functions and Actuation Signals

DAS Function	Actuation Signal
Reactor Trip, Turbine Trip and Main Feedwater Isolation	Low Pressurizer Pressure
	High Pressurizer Pressure
	Low Steam Generator Water Level
	Manual Switch Signal
Emergency Feedwater Actuation	Low Steam Generator Water Level
	Manual Switch Signal
ECCS Actuation	Manual Switch Signal
Containment Isolation	Manual Switch Signal

Table 2.5.3-4 Diverse Actuation System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 1 of 4)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
<p>1.a The DAS has the following configuration:</p> <p>The functional arrangement of the DAS is as described in the dDesign dDescription of <u>Subsection 2.5.3.1</u> and as shown in Figure 2.5.3-1. <u>Variables monitored by the DAS are as indicated in Table 2.5.3-1.</u></p> <ul style="list-style-type: none"> Automatic and manual functions to allow coping with either an AOO or PA. Refer to Table 2.5.3-1 for monitored variables, Table 2.5.3-2 for actuated equipment and Table 2.5.3-3 for DAS functions and initiating signals. 	<p>1.a An inspection of the as-built DAS will be performed for functional arrangement and configuration of the DAS.</p>	<p>1.a The as-built DAS conforms to the functional arrangement and configuration as described in the dDesign dDescription of <u>Subsection 2.5.3.1</u> and as shown in Figure 2.5.3-1. <u>Variables monitored by the DAS are as indicated in Table 2.5.3-1.</u> The as-built DAS is configured with the monitored variables in Table 2.5.3-1, the actuated equipment in Table 2.5.3-2, and the DAS automatic and manual functions and initiating signals in Table 2.5.3-3 to allow coping with an AOO and PA.</p>
<p>1.be The DAS is physically <u>separated</u> and electrically independent from the PSMS. Physical independence is provided by distance or barriers, which prevent propagation of fire or electrical faults. Electrical independence is achieved by using independent power sources and electrical circuits and by using qualified electrical fault isolation devices.</p>	<p>1.bie An inspection of the as-built DAS will be performed for <u>physical separation independence</u> of the DAS from the <u>as-built</u> PSMS.</p>	<p>1.c The as-built DAS is physically and electrically independent from the as-built PSMS.</p> <p><u>1.b.i</u> <u>Physical independence separation of the as-built DAS from the as-built PSMS is provided by distance or barriers, which prevent propagation of fire or electrical faults, locating the as-built DAAC in separate rooms, and locating the as-built DHP in the MCR.</u></p>
	<p><u>1.b.ii</u> <u>Analyses, tests or a combination of analyses and tests of the as-built DAS will be performed to verify its electrical</u></p>	<p>1.b.ii A report exists and concludes that Electrical independence <u>of the as-built DAS from the as-built PSMS</u> is</p>

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	<u>independence from the as-built PSMS.</u>	achieved by using independent power sources <u>for the as-built DAAC and the as-built DHP, and electrical circuits</u> and by using qualified electrical fault isolation devices.

Table 2.5.3-4 Diverse Actuation System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 2 of 4)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
<p><u>1.bc Deleted</u>-DAS controls are provided in the MCR to manually actuate equipment identified in Table 2.5.3-2, and to manually actuate functions identified in Table 2.5.3-3.</p>	<p><u>1.bc Deleted</u>. Tests will be performed to verify the as-built equipment listed in Table 2.5.3-2 can be operated, and to verify the manual actuation functions in Table 2.5.3-3, using as-built DAS manual controls in the as-built MCR.</p>	<p><u>1.bc Deleted</u>. As-built DAS controls in the as-built MCR operate the as-built equipment listed in Table 2.5.3-2, and provide manual actuation capability for the actuation functions identified in Table 2.5.3-3.</p>
<p><u>1.d</u> The DAS provides automatic actuation of the equipment and for the functions identified in Tables 2.5.3-2 and 2.5.3-3, respectively, when the monitored variables identified in Table 2.5.3-1 exceed predetermined limits.</p>	<p><u>1.d</u> Tests will be performed to verify DAS automatic actuation capability for the as-built equipment listed in Table 2.5.3-2, and to verify the automatic actuation functions in Table 2.5.3-3, using simulated or actual signals.</p>	<p><u>1.d</u> The DAS provides automatic actuation of the equipment identified in Table 2.5.3-2, and automatic actuation for the functions identified in Table 2.5.3-3, when the monitored variables identified in Table 2.5.3-1 exceed predetermined limits.</p>

<p>1.ed The DAS is designed to prevents spurious actuation due to credible single failures or due to a fire <u>or seismic event</u>. Spurious actuations are prevented by the DAS design configuration <u>as follows</u>:-</p> <ul style="list-style-type: none"> • Automatic DAS functions are actuated by two subsystems and DAS actuation needs coincidence of both subsystems. • The DAS is designed to prevents spurious actuation due to a seismic event. Thus the SSE will not result in a DAS failure that adversely affects the <u>PSMS safety system</u>. • <u>The redundant DAS cabinets are located in separate fire areas to prevent spurious actuation from a fire in one area.</u> • <u>Manual DAS functions identified in Tables 2.5.3-2 and 2.5.3-3 require actuation of two switches in the MCR. Separation between the permissive switch and the DHP prevents a fire from one switch location from affecting the other switch location.</u> 	<p>1.ed.i An Test and analysis of the as-built DAS will be performed <u>to verify the as-built DAS prevents spurious actuation due to credible single failures or due to a seismic event.</u></p>	<p>1.ed.i <u>A report exists and concludes that</u> The as-built DAS is designed to prevents spurious actuation due to credible single failures or due to a fire <u>seismic event as follows</u>.</p> <ul style="list-style-type: none"> • Automatic DAS functions are actuated by two <u>as-built</u> subsystems and DAS actuation needs coincidence of both subsystems. • The <u>as-built</u> DAS is designed to prevents spurious actuation due to a seismic event.
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	<p><u>1.e.ii Test and inspection of the as-built DAS will be performed to verify the existence of a manual permissive switch, to verify the DAS permissive switch is physically located separate from the DHP, and to verify physical separation of redundant DACC cabinets.</u></p>	<p><u>1.e.ii The as-built DAS:</u></p> <ul style="list-style-type: none">• <u>Redundant DAAC cabinets are located in separate equipment rooms.</u>• <u>Includes a manual permissive switch that prevents spurious manual actuation for those signals with only one manual actuation switch, as identified in Table 2.5.3-3.</u>• <u>The manual permissive switch is physically separated from the DHP to prevent a fire that starts in one switch location from affecting the other switch location.</u>
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Table 2.5.3-4 Diverse Actuation System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 3 of 4)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
<p>2. The DAS has the following capabilities:</p> <ul style="list-style-type: none"> • Operates with both DAAC divisions <u>subsystems</u> operable (i.e., in a two-out-of-two configuration), or with one <u>subsystem</u> division manually tripped and one <u>subsystem</u> division operable. • The system can be tested manually without causing component actuation which would disturb plant operations. • Loss of power or removal of a module does not cause spurious DAS actuation. • Capability to bypass failed sensors functions. • The DHP provides system level manual controls to maintain critical safety functions as described in the Design Description. 	<p>2. Tests of the as-built DAS will be performed. The tests will include tests of the manual controls, <u>loss of power, and module removal,</u> as well as simulated signal inputs to test the system.</p>	<p>2. A report exists and concludes that the as-built DAS has the following capabilities:</p> <ul style="list-style-type: none"> • — Operates with both as-built DAAC <u>subsystems</u> divisions operable (i.e., in a two- out-of-two configuration), or with one <u>subsystems</u> division manually tripped and one <u>subsystems</u> division operable. • — The system can be tested manually without causing component actuation which would disturb plant operations. • — Loss of power or removal of a module does not cause spurious DAS actuation. • — Capability to bypass failed sensors functions. • — The as-built DHP provides system level manual controls to maintain critical safety functions as described in the Design Description.

Table 2.5.3-4 Diverse Actuation System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 4 of 4)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
<p>3. The DAS equipment, including input and/ output interfaces, signal processing and HSI, consists of conventional hardware circuits (analog circuits, solid-state logic processing, relay circuits, switches, indicators etc.), and is diverse from software used within the PSMS.</p>	<p>3. Inspection of the as-built DAS and the software within the as-built PSMS will be performed.</p>	<p>3. The as-built DAS equipment consists of conventional hardware circuits (analog circuits, solid-state logic processing, relay circuits, switches, indicators etc.), and is diverse from software used within the as-built PSMS.</p>
<p>4. The DAS equipment used for the ATWS mitigation (i.e., reactor trip, turbine trip and emergency feedwater actuation) consists of conventional hardware circuits (analog circuits, solid-state logic processing, relay circuits, switches, etc.), and is diverse from the hardware used for the reactor trip function of the PSMS. This design commitment does not apply to measurement instrumentation and signal splitters, which distribute measurement signals to the DAS and the PSMS.</p>	<p>4. Inspection of the as-built DAS and RT system hardware within the as-built PSMS will be performed.</p>	<p>4. The as-built DAS equipment used for the ATWS mitigation (i.e., reactor trip, turbine trip and emergency feedwater actuation) consists of conventional hardware circuits (analog circuits, solid-state logic processing, relay circuits, switches, etc.), and is diverse from the hardware used for the reactor trip function of the as-built PSMS.</p>
<p>5. The quality of DAS components and modules and the quality of the DAS design process are controlled by an augmented quality program that meets the regulatory requirements.</p>	<p>5. Inspection of the QA program will be performed.</p>	<p>5. The QA program assures the quality of as-built DAS components and modules and the quality of the DAS design process are controlled by an augmented quality program that meets the regulatory requirements.</p>

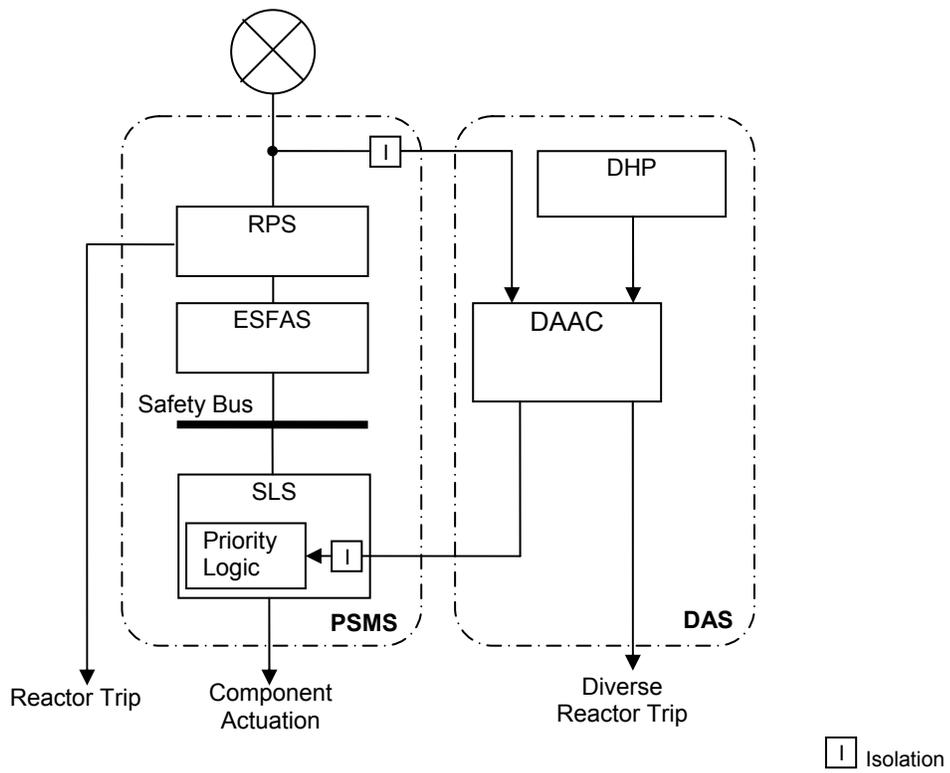


Figure 2.5.3-1 DAS Configuration