

2.3 Severe Accident Systems

2.3.1 Combustible Gas Control System

Design Description

1.0 System Description

The combustible gas control system (CGCS) prevents damage to the containment or emergency equipment in the event of an accident with ensuing mass and energy release. In addition, for a severe accident with core degradation, the system inhibits potential damage by controlling the combustible gas concentration in containment. The CGCS contains the passive autocatalytic recombiners (PAR), mixing dampers and rupture and convection foils.

The CGCS provides the following safety-related function:

- Mixing of the containment atmosphere.

The CGCS provides the following non-safety-related functions:

- Controlling combustible gas concentrations.
- Maintaining containment structural integrity by limiting the pressure to within the containment design pressure resulting from a combustible gas ignition from the most severe accident.
- Maintaining the two zone separation between accessible and equipment space.

2.0 Arrangement

2.1 The functional arrangement of the CGCS is as described in the Design Description of Section 2.3.1 and Table 2.3.1-1—CGCS Equipment Mechanical Design.

3.0 Mechanical Design Features

3.1 Equipment identified as Seismic Category I in Table 2.3.1-1 can withstand seismic design basis loads without a loss of safety function(s).

4.0 I&C Design Features, Displays, and Controls

4.1 Displays listed in Table 2.3.1-2—CGCS Equipment I&C and Electrical Design are indicated on the PICS operator workstations in the main control room (MCR) and the remote shutdown station (RSS).

4.2 Controls on the PICS operator workstations in the MCR and the RSS perform the function listed in Table 2.3.1-2.

4.3 Equipment listed as being controlled by a priority and actuator control system (PACS) module in Table 2.3.1-2 responds to the state requested and provides drive monitoring

signals back to the PACS module. The PACS module will protect the equipment by terminating the output command upon the equipment reaching the requested state.

5.0 Electrical Power Design Features

5.1 Hydrogen mixing dampers listed in Table 2.3.1-1 fail open on loss of power.

6.0 Environmental Qualifications

6.1 Equipment designated as harsh environment in Table 2.3.1-2 can perform the function listed in Table 2.3.1-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.

7.0 Equipment and System Performance

7.1 The hydrogen mixing dampers listed in Table 2.3.1-1 provide pressure relief for design basis events.

7.2 The convection foils listed in Table 2.3.1-1 provide pressure relief for design basis events.

7.3 The rupture foils listed in Table 2.3.1-1 provide pressure relief for design basis events.

7.4 The fusible link of the convection foils listed in Table 2.3.1-1 fails at the designed temperature.

7.5 The burst element of the convection foils listed in Table 2.3.1-1 opens at the designed pressure.

7.6 The burst element of the rupture foils listed in Table 2.3.1-1 opens at the designed pressure.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.3.1-3 lists the Combustible Gas Control System ITAAC.

**Table 2.3.1-1—CGCS Equipment Mechanical Design
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Description	Tag Number	Location	Function	Seismic Category
Recombiner	30JMT10AT001 ¹	Room 30UJA18019, surge line area	N/A	II
Recombiner	30JMT10AT002	Room 30UJA11007, SG loop 3 area	N/A	II
Recombiner	30JMT10AT003	Room 30UJA11008, SG loop 4 area	N/A	II
Recombiner	30JMT10AT004	Room 30UJA11003, SG loop 1 area	N/A	II
Recombiner	30JMT10AT005	Room 30UJA11004, SG loop 2 area	N/A	II
Recombiner	30JMT10AT006 ¹	Room 30UJA18018, spray valves area	N/A	II
Recombiner	30JMT10AT007 ¹	Room 30UJA23019, pressurizer area	N/A	II
Recombiner	30JMT10AT008	Room 30UJA23006, RCP loop 3 area	N/A	II
Recombiner	30JMT10AT009	Room 30UJA23015, annual space accumulator tank loop 3 (0°-90°) area	N/A	II
Recombiner	30JMT10AT010	Room 30UJA23006, RCP loop 3 area	N/A	II
Recombiner	30JMT10AT011	Room 30UJA23007, SG loop 3 area	N/A	II
Recombiner	30JMT10AT012	Room 30UJA23008, SG loop 4 area	N/A	II
Recombiner	30JMT10AT013	Room 30UJA23016, annual space accumulator tank loop 4 (90°-180°) area	N/A	II
Recombiner	30JMT10AT014	Room 30UJA23009, RCP loop 4 area	N/A	II
Recombiner	30JMT10AT015	Room 30UJA23009, RCP loop 4 area	N/A	II
Recombiner	30JMT10AT016 ¹	Room 30UJA15001, reactor cavity	N/A	II
Recombiner	30JMT10AT017	Room 30UJA23002, RCP loop 1 area	N/A	II
Recombiner	30JMT10AT018	Room 30UJA23002, RCP loop 1 area	N/A	II
Recombiner	30JMT10AT019	Room 30UJA23013, annual space accumulator tank loop 1 (180°-270°) area	N/A	II

**Table 2.3.1-1—CGCS Equipment Mechanical Design
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Description	Tag Number	Location	Function	Seismic Category
Recombiner	30JMT10AT020	Room 30UJA23003, SG loop 1 area	N/A	II
Recombiner	30JMT10AT021	Room 30UJA23004, SG loop 2 area	N/A	II
Recombiner	30JMT10AT022	Room 30UJA23005, RCP loop 2 area	N/A	II
Recombiner	30JMT10AT023	Room 30UJA23014, annual space accumulator tank loop 2 (270°-0°) area	N/A	II
Recombiner	30JMT10AT024	Room 30UJA23005, RCP loop 2 area	N/A	II
Recombiner	30JMT10AT025 ¹	Room 30UJA29019, pressurizer area	N/A	II
Recombiner	30JMT10AT026	Room 30UJA29016, access area (equipment hatch)	N/A	II
Recombiner	30JMT10AT027	Room 30UJA29013, set down area operating floor	N/A	II
Recombiner	30JMT10AT028	Room 30UJA29018 operating floor access area	N/A	II
Recombiner	30JMT10AT029 ¹	Room 30UJA34019, pressurizer heat safety relief valves	N/A	II
Recombiner	30JMT10AT030	Room 30UJA34007, SG loop 3 area	N/A	II
Recombiner	30JMT10AT031	Room 30UJA34007, SG loop 3 area	N/A	II
Recombiner	30JMT10AT032	Room 30UJA34008, SG loop 4 area	N/A	II
Recombiner	30JMT10AT033	Room 30UJA34008, SG loop 4 area	N/A	II
Recombiner	30JMT10AT034	Room 30UJA34003, SG loop 1 area	N/A	II
Recombiner	30JMT10AT035	Room 30UJA34003, SG loop 1 area	N/A	II
Recombiner	30JMT10AT036	Room 30UJA34004, SG loop 2 area	N/A	II
Recombiner	30JMT10AT037	Room 30UJA34004, SG loop 2 area	N/A	II

**Table 2.3.1-1—CGCS Equipment Mechanical Design
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Description	Tag Number	Location	Function	Seismic Category
Recombiner	30JMT10AT038	Room 30UJA34015, annular area 0-120 deg	N/A	II
Recombiner	30JMT10AT039	Room 30UJA40001, dome area	N/A	II
Recombiner	30JMT10AT040	Room 30UJA40001, dome area	N/A	II
Recombiner	30JMT10AT041	Room 30UJA40001, dome area	N/A	II
Recombiner	30JMT10AT042	Room 30UJA40001, dome area	N/A	II
Recombiner	30JMT10AT043	Room 30UJA34014, annular area 240-0 deg	N/A	II
Recombiner	30JMT10AT044	Room 30UJA40001, dome area	N/A	II
Recombiner	30JMT10AT045	Room 30UJA40001, dome area	N/A	II
Recombiner	30JMT10AT046	Room 30UJA40001, dome area	N/A	II
Recombiner	30JMT10AT047	Room 30UJA40001, dome area	N/A	II
Hydrogen Mixing Damper	30JMT20AA001	Room 30UJA07015, separation of IRWST air space and the lower part of the annular rooms	Open	I
Hydrogen Mixing Damper	30JMT20AA002	Room 30UJA07015, separation of IRWST air space and the lower part of the annular rooms	Open	I
Hydrogen Mixing Damper	30JMT20AA003	Room 30UJA07015, separation of IRWST air space and the lower part of the annular rooms	Open	I
Hydrogen Mixing Damper	30JMT20AA004	Room 30UJA07015, separation of IRWST air space and the lower part of the annular rooms	Open	I

**Table 2.3.1-1—CGCS Equipment Mechanical Design
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Description	Tag Number	Location	Function	Seismic Category
Hydrogen Mixing Damper	30JMT20AA005	Room 30UJA07014, separation of IRWST air space and the lower part of the annular rooms	Open	I
Hydrogen Mixing Damper	30JMT20AA006	Room 30UJA07014, separation of IRWST air space and the lower part of the annular rooms	Open	I
Hydrogen Mixing Damper	30JMT20AA007	Room 30UJA07014, separation of IRWST air space and the lower part of the annular rooms	Open	I
Hydrogen Mixing Damper	30JMT20AA008	Room 30UJA07014, separation of IRWST air space and the lower part of the annular rooms	Open	I
Rupture Foils	30JMT20AB101- 30JMT20AB129	SG (Loop 1) pressure equalization ceiling	Open	I
Convection Foils	30JMT20AB151-30JMT20AB180	SG (Loop 1) pressure equalization ceiling	Open	I
Rupture Foils	30JMT20AB201-30JMT20AB229	SG (Loop 2) pressure equalization ceiling	Open	I
Convection Foils	30JMT20AB251-30JMT20AB280	SG (Loop 2) pressure equalization ceiling	Open	I
Rupture Foils	30JMT20AB301-30JMT20AB329	SG (Loop 3) pressure equalization ceiling	Open	I
Convection Foils	30JMT20AB351-30JMT20AB380	SG (Loop 3) pressure equalization ceiling	Open	I
Rupture Foils	30JMT20AB401-30JMT20AB429	SG (Loop 4) pressure equalization ceiling	Open	I

**Table 2.3.1-1—CGCS Equipment Mechanical Design
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Description	Tag Number	Location	Function	Seismic Category
Convection Foils	30JMT20AB451-30JMT20AB480	SG (Loop 4) pressure equalization ceiling	Open	I

1. Small PAR; the remaining PARs are large.

Table 2.3.1-2—CGCS Equipment I&C and Electrical Design

Description	Tag Number ⁽¹⁾	Location	IEEE Class 1E ⁽²⁾	EQ – Harsh Env.	PACS	MCR/RSS Displays	MCR/RSS Controls
Hydrogen Mixing Damper	30JMT20AA001	Reactor Containment Building	3 ^N / 4 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Hydrogen Mixing Damper	30JMT20AA002	Reactor Containment Building	3 ^N / 4 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Hydrogen Mixing Damper	30JMT20AA003	Reactor Containment Building	4 ^N / 3 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Hydrogen Mixing Damper	30JMT20AA004	Reactor Containment Building	4 ^N / 3 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Hydrogen Mixing Damper	30JMT20AA005	Reactor Containment Building	1 ^N / 2 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Hydrogen Mixing Damper	30JMT20AA006	Reactor Containment Building	1 ^N / 2 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Hydrogen Mixing Damper	30JMT20AA007	Reactor Containment Building	2 ^N / 1 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Hydrogen Mixing Damper	30JMT20AA008	Reactor Containment Building	2 ^N / 1 ^A	Yes	Yes	Position / Position	Open-Close / Open-Close

1. Equipment tag numbers are provided for information only and are not part of the certified design.
2. ^N denotes the division equipment is normally powered from. ^A denotes the division equipment is powered from when alternate feed is implemented.

Table 2.3.1-3—Combustible Gas Control System ITAAC
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	Commitment Wording	Inspections, Tests, Analyses	Acceptance Criteria
2.1	The functional arrangement of the CGCS is as described in the Design Description of Section 2.3.1 and Table 2.3.1-1.	An inspection of the as built CGCS functional arrangement will be performed.	The CGCS conforms to the functional arrangement as described in the Design Description of Section 2.3.1 and Table 2.3.1-1.
3.1	Equipment identified as Seismic Category I in Table 2.3.1-1 can withstand seismic design basis loads without a loss of safety function(s).	<ul style="list-style-type: none"> a. Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment identified as Seismic Category I in Table 2.3.1-1 using analytical assumptions, or under conditions, which bound the Seismic Category I design requirements. b. An inspection will be performed of the as-built equipment identified as Seismic Category I in Table 2.3.1-1 to verify that the equipment, including anchorage, are installed in a condition bounded by the tested or analyzed condition. 	<ul style="list-style-type: none"> a. Seismic qualification reports (SQDP, EQDP, or analyses) conclude that the equipment identified as Seismic Category I in Table 2.3.1-1 can withstand seismic design basis loads without a loss of safety function(s). b. Inspection reports conclude that the equipment identified as Seismic Category I in Table 2.3.1-1, including anchorage, are installed in a condition bounded by the tested or analyzed condition.
4.1	Displays listed in Table 2.3.1-2 are indicated on the PICS operator workstations in the MCR and the RSS.	<ul style="list-style-type: none"> a. Tests will be performed to verify that the displays listed in Table 2.3.1-2 are indicated on the PICS operator workstations in the MCR. b. Tests will be performed to verify that the displays listed in Table 2.3.1-2 are indicated on the PICS operator workstations in the RSS. 	<ul style="list-style-type: none"> a. Displays listed in Table 2.3.1-2 are indicated on the PICS operator workstations in the MCR. b. Displays listed in Table 2.3.1-2 are indicated on the PICS operator workstations in the RSS.

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Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
4.2	Controls on the PICS operator workstations in the MCR and the RSS perform the function listed in Table 2.3.1-2.	<p>a. Tests will be performed using controls on the PICS operator workstations in the MCR.</p> <p>b. Tests will be performed using controls on the PICS operator workstations in the RSS.</p>	<p>a. Controls on the PICS operator workstations in the MCR perform the function listed in Table 2.3.1-2.</p> <p>b. Controls on the PICS operator workstations in the RSS perform the function listed in Table 2.3.1-2.</p>
4.3	Equipment listed as being controlled by a PACS module in Table 2.3.1-2 responds to the state requested and provides drive monitoring signals back to the PACS module. The PACS module will protect the equipment by terminating the output command upon the equipment reaching the requested state.	A test will be performed using test input signals to verify equipment controlled by a PACS module responds to the state requested and provides drive monitoring signals back to the PACS module.	Equipment listed as being controlled by a PACS module in Table 2.3.1-2 responds to the state requested and provides drive monitoring signals back to the PACS module. The PACS module will protect the equipment by terminating the output command upon the equipment reaching the requested state.
5.1	Hydrogen mixing dampers listed in Table 2.3.1-1 fail open on loss of power.	Tests will be performed to verify that hydrogen mixing dampers fail open on loss of power.	Following loss of power, the hydrogen mixing dampers listed in Table 2.3.1-1 fail open.

Table 2.3.1-3—Combustible Gas Control System ITAAC
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	Commitment Wording	Inspections, Tests, Analyses	Acceptance Criteria
6.1	Equipment designated as harsh environment in Table 2.3.1-2 can perform the function listed in Table 2.3.1-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.	<p>a. Type tests or type tests and analysis will be performed to demonstrate the ability of the equipment designated as harsh environment in Table 2.3.1-2 to perform the function listed in Table 2.3.1-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.</p> <p>b. An inspection will be performed of the as-built equipment designated as harsh environment in Table 2.3.1-2 to verify that the equipment, including the associated cables, wiring, and terminations located in a harsh environment, are bounded by the type test or combination of type tests and analyses.</p>	<p>a. EQDPs conclude that the equipment designated as harsh environment in Table 2.3.1-2 can perform the function listed in Table 2.3.1-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions, including the time required to perform the listed function.</p> <p>b. A report exists and concludes that the equipment designated as harsh environment in Table 2.3.1-2, including the associated cables, wiring, and terminations located in a harsh environment, are bounded by the type test or combination of type tests and analyses.</p>
7.1	The hydrogen mixing dampers listed in Table 2.3.1-1 provide pressure relief for design basis events.	An inspection and analysis will be performed to verify that the as-built hydrogen mixing dampers provide sufficient area for pressure relief.	The hydrogen mixing dampers listed in Table 2.3.1-1 provide a minimum combined total open area of 64 ft ² .
7.2	The convection foils listed in Table 2.3.1-1 provide pressure relief for design basis events.	An inspection and analysis will be performed to verify that the as-built convection foils provide sufficient area for pressure relief.	The convection foils listed in Table 2.3.1-1 provide a minimum combined total open area of 450 ft ² .

**Table 2.3.1-3—Combustible Gas Control System ITAAC
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Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
7.3	The rupture foils listed in Table 2.3.1-1 provide pressure relief for design basis events.	An inspection and analysis will be performed to verify that the as-built rupture foils provide sufficient area for pressure relief.	The rupture foils listed in Table 2.3.1-1 provide a minimum combined total open area of 420 ft ² .
7.4	The fusible link of the convection foils listed in Table 2.3.1-1 fails at the designed temperature.	Type tests will be performed to demonstrate the ability of the fusible link to open.	The fusible link opens at or before reaching a temperature of 185 °F.
7.5	The burst element of the convection foils listed in Table 2.3.1-1 opens at the designed pressure.	Type tests will be performed to demonstrate the ability of the burst element the convection foils to open.	The burst element of the convection foils listed in Table 2.3.1-1 opens bi-directionally at a delta pressure of 0.7 psid ± 30%.
7.6	The burst element of the rupture foils listed in Table 2.3.1-1 opens at the designed pressure.	Type tests will be performed to demonstrate the ability of the burst element the rupture foils to open.	The burst element of the rupture foils listed in Table 2.3.1-1 opens bi-directionally at a delta pressure of 0.7 psid ± 30%.

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