## 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**
**Sheet 1 of 5**

| 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
Sheet 2 of 5

| 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**
**Sheet 3 of 5**

| 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**
**Sheet 4 of 5**

| 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**
**Sheet 5 of 5**

| 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
Sheet 1 of 4

| | 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). | 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. | 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. 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. | 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. | 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. | a. 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. | b. Displays listed in Table 2.3.1-2 are indicated on the PICS operator workstations in the RSS. |

**Table 2.3.1-3—Combustible Gas Control System ITAAC
Sheet 2 of 4**

| | 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. | a. Tests will be performed using controls on the PICS operator workstations in the MCR.<br>b. Tests will be performed using controls on the PICS operator workstations in the RSS. | a. Controls on the PICS operator workstations in the MCR perform the function listed in Table 2.3.1-2.<br>b. Controls on the PICS operator workstations in the RSS perform the function listed in Table 2.3.1-2. |
| 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**
**Sheet 3 of 4**

| | 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. | 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.<br>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. | 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.<br>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. |
| 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**
**Sheet 4 of 4**

| | 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%. |

Next File