ArevaEPRDCPEm Resource

From: BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
Sent: Wednesday, March 03, 2010 10:01 AM
To: Tesfaye, Getachew
Cc: DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); ROMINE Judy (AREVA NP INC); GUCWA Len T (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 323, FSAR Ch 6, Supplement 1
Attachments: RAI 323 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 323 on December 17, 2009. The attached file, “RAI 323 Supplement 1 Response US EPR DC.PDF” provides a technically correct and complete response to all 8 of the questions in this RAI.

The following table indicates the respective pages in the response document, “RAI 323 Supplement 1 Response US EPR DC.PDF,” that contain AREVA NP’s response to the subject questions. Appended to this file are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the responses to RAI 323 Question 06.02.05-7 and Question 06.02.05-10.

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This concludes the formal AREVA NP response to RAI 323, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Martin (Marty) C. Bryan
Licensing Advisory Engineer
AREVA NP Inc.
Tel: (434) 832-3016
Martin.Bryan@areva.com

From: WELLS Russell D (AREVA NP INC)
Sent: Thursday, December 17, 2009 10:57 AM
To: 'Getachew Tesfaye'
Cc: Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 323, FSAR Ch 6

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 323 Response US EPR DC.pdf" provides a schedule since a technically correct and complete response to the 8 questions cannot be provided at this time.

The following table indicates the respective pages in the response document, "RAI 323 Response US EPR DC.pdf," that contains AREVA NP's response to the subject questions.

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A complete answer is not provided for 8 of the 8 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 323 — 06.02.05-7	March 3, 2010
RAI 323 — 06.02.05-8	March 31, 2010
RAI 323 — 06.02.05-9	March 31, 2010
RAI 323 — 06.02.05-10	March 3, 2010
RAI 323 — 06.02.05-11	March 31, 2010
RAI 323 — 06.02.05-12	March 3, 2010
RAI 323 — 06.02.05-13	March 31, 2010
RAI 323 — 06.02.05-14	March 31, 2010

Sincerely,

(Russ Wells on behalf of)

Ronda Pederson
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, November 19, 2009 5:14 PM
To: ZZ-DL-A-USEPR-DL
Cc: Anne-Marie Grady; Jackson, Christopher; Snodderly, Michael; Carneal, Jason; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 323 (3903), FSARCh. 6

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on October 30, 2009, and discussed with your staff on November 19, 2009. Drat RAI Questions 06.02.05-7, 06.02.05-8, 06.02.05-11, and 06.02.05-12 were modified as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 1209

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Response to

Request for Additional Information No. 323, Supplement 1

11/19/2009

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 06.02.05 - Combustible Gas Control in Containment
Application Section: 6.2.5

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

Question 06.02.05-7:

This question is a follow-up to an October 7 and 8, 2009 audit on documentation relevant to passive autocatalytic recombiners (PARs). Confirm that the PARs described in FSAR Table 6.2.5-1 are 41 large PARs with a recombination rate of 11.8 lbm/hr, and 6 small PARs, with a recombination rate of 2.6 lbm/hr. Confirm that the large and small PARs identified on FSAR Figure 6.2.5-9 represent the recombiner rates above. In FSAR Tier 1, Table 2.3.1-1, CGCS Equipment Design, the PAR individual equipment numbers and locations are provided. Confirm that the 47 PARs are identified by the equipment numbers 30JMT10AT001-047. Indicate in Table 2.3.1-1 which are the 6 small PARs.

Response to Question 06.02.05-7:

The U.S. EPR plant is equipped with 41 large and 6 small PARs. The hydrogen depletion rate is 11.8 lbm/hr for a large PAR and 2.6 lbm/hr for a small PAR. These depletion rates are represented in U.S. EPR FSAR Tier 2, Figure 6.2.5-9. U.S. EPR FSAR Tier 2, Figure 6.2.5-9 will be revised to indicate hydrogen concentration as a function of time for different assumed operation of large and small PARs.

The 47 PARs listed in U.S. EPR FSAR Tier 1, Table 2.3.1-1 are identified by equipment numbers 30JMT10AT001 through 30JMT10AT047.

U.S. EPR FSAR Tier 1, Table 2.3.1-1 will be revised to identify the 6 smaller PARs.

FSAR Impact:

U.S. EPR FSAR Tier 1, Table 2.3.1-1 and U.S. EPR FSAR Tier 2, Figure 6.2.5-9 will be revised as described in the response and indicated on the enclosed markup.

Question 06.02.05-8:

In response to RAI no. 69, Question 06.02.05-1, which asked the applicant to show that the assumed performance of PARs is verified by experimental evidence; consider the impact of possible poisons on PAR performance, and; discuss the time response on PAR efficiency, AREVA responded:

"EPRI Technical Report, TR-107517, “Generic Tests of Passive Autocatalytic Recombiners (PARs) for Combustible Gas Control in Nuclear Power Plants,” provides experimental evidence on the PAR performance, impact of possible containment conditions, and time response of the PARs. This experimental data is applicable to the U.S. EPR."

On 7 Oct 2009 the NRC staff audited EPRI TR-107517, volumes 1 and 3. Volume 1 is a general overview of the PAR tests at the KALI H2 facility and volume 3 presents the test results for FR90/1-150 PARs. The KALI program focused primarily on a range of hydrogen concentrations, initial ambient gas temperatures and pressures, steam and nitrogen as inert gases, and the effects of dome spray and direct spray on PAR start-up. The effect of fumes from an electric cable insulation burn was also evaluated. However, potential poisons on PAR performance during a severe accident, such as Iodine, Tellurium, Cesium, Antimony and other fission products were not evaluated in these PAR tests. Show how these potential poisons affect PAR performance. Identify experimental tests and provide test results.

Response to Question 06.02.05-8:

The KALI H2 tests examined PAR performance for a broad range of conditions consistent with those anticipated following a design-basis loss-of-coolant-accident. As noted in the question, these tests did not address PAR performance impacts from fission product poisons. In addition to the KALI H2 tests, the PAR performance database credited by AREVA NP for the U.S. EPR design is derived from

- Development and Qualification Tests in AREVA NP Laboratories in Karlstein (1989-1991).
- PAR Tests in the Battelle Containment (1990-1996).
- EDF H_2- Kali Tests with spray including chemicals (1995).
- Integrated Core-Melt-Simulation-Test (1996).
- EPRI / EDF Tests for BWR and PWR conditions (1996-1997).
- PHEBUS Catalytic Coupon Test (1998).

Among these test, the Integrated Core-Melt-Simulation-Test program in Cadarache is considered as the most important test program concerning poisoning, deposition and contamination of catalyst in a post accident atmosphere. During this program, an AREVA NP designed PAR was subjected to a realistic aerosol exposure generated by a molten core, including poisons such as iodide, tellurium, cesium and antimony.

Ten unique tests were performed considering the following environmental conditions:

Temperature: 61°C - 88°C
Steam/ Humidity Inert Gas: 0% – 66%

H2- Concentration: 6 - 10 % by volume
Pressure: 1 bar

The aerosol concentrations for the poisons of interest were:

Iodine (J): 21.1 mg in 7.6 m^3
Tellurium (Te): 21.6 mg in 7.6 m^3
Selenium (Se): 21.7 mg in 7.6 m^3
Antimony (Sb): 20.1 mg in 7.6 m^3

To simulate a realistic source term, it was necessary to produce vapors and aerosols analogous to those from the reactor core after a postulated accident. In these tests 24 unique elements were used to simulate the reactor core inventory.

A graphite induction furnace was installed inside the test facility to generate aerosols in the same composition as they occur in a core melt accident. The graphite furnace allowed a temperature up to 2900°C. Test elements were inserted in the furnace to simulate the reactor core inventory. These elements were heated to reach 2900°C. This temperature was maintained for 15 minutes to establish aerosol growth. Afterwards the aerosol yield was studied and used for the PAR test program.

The PAR test objective was to compare the depletion rate under different potential poisoning conditions with a reference PAR catalyst without poisoning. The results demonstrated that the AREVA NP PAR design has the functional capability to efficiently reduce the hydrogen concentration with no significant reduction in performance under adverse conditions as simulated by the realistic post-accident atmosphere with release of core melt aerosols, including catalytic poisons (e.g., Te, Se, Sb, I).

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 06.02.05-9:

This question is a follow-up to an October 7 and 8, 2009 audit on documentation relevant to passive autocatalytic recombiners (PARs). Coking occurs when elemental carbon in carbon-bearing gases is deposited on the surface of a catalyst, blocking the reaction of the recombinants. The sources in a reactor containment severe accident are: (1) molten core/concrete interaction (MCCI) and (2) a fire, in particular the smoke and soot from electrical cable fires.

Identify all sources of elemental carbon produced as a result of the (MCCI) during and after a severe accident. Address the potential to "poison" the catalyst in the PARs. Identify experimental tests and provide test results.

Response to Question 06.02.05-9:

The most significant source of carbon that could come in contact with the PARs is CO_2 derived from the burning of CO that autoignites during MCCI. MCCI appears first in the reactor pit following failure of the reactor pressure vessel. Autoignition of combustible gas (primarily from hydrogen) creates a standing flame. Similarly, following failure of the melt plug and gate, MCCI will appear in the spreading room. MCCI ends following complete ablation of the concrete buffering the steel cooling structure. MCCI occurs roughly 4-8 hours following PRV failure. The consistency of the concrete, components, and equipment in these containment rooms has been selected to effectively eliminate sources of carbon appearing in aerosol form. As such, sources of "elemental" carbon are theoretical. Carbon that reaches the catalytic plates is either an aerosol (i.e., soot) or a gas mixture (e.g., CO, CO_2).

As discussed in EPRI TR-107517, cables typical of U.S. and French plant designs were burned resulting in fumes and soot. The following environmental conditions were simulated at the KALI tests to investigate the PAR performance impact from fumes and soot as a result of burning French cables:

Temperature: 30°C
Steam/ Humidity Inert Gas: 0% – 50%
H2- Concentration: 4 % by volume
Pressure: 1.3 bar

The test objective was to burn the cables and expose the catalytic plates to the fume and soot. Afterwards the catalyst was tested by injecting hydrogen. The documented test result is a slightly delayed (50 second) start of the catalytic reaction.

The following environmental condition was simulated at the EPRI/EDF tests to investigate the PAR performance impact from fumes and soot as a result of burning U.S. cables:

Temperature: 30°C
Steam/ Humidity Inert Gas: 0% – 50%
H2- Concentration: 4-8 % by volume
Pressure: 1.3 bar

The tested cable jacked material was chlorosulfonated polyethylene containing sulfur. Prior to exposure, the catalyst was wetted to allow the formation of sulfuric and sulfurous acid.

In this scenario, PAR depletion rate was slightly reduced by 10 percent.

In addition, the potential impact of CO was tested in the EPRI / EDF test facility. The following environmental condition was simulated:

Temperature: 30-63°C
Steam/ Humidity Inert Gas: 0%
H2- Concentration: 4-8 % by volume
Pressure: 1.3 bar

Two different tests were performed: CO was injected when the hydrogen concentration in the test vessel reached 2.5 and 3 percent by volume. In both tests, depletion of both hydrogen and CO started directly after injection. The presence of CO increased the surface catalyst temperature as a result of the additional exothermic reaction $CO + ½ O_2 \rightarrow CO_2$. The increase of the surface temperature had a positive effect of the total hydrogen depletion rate.

The following environmental conditions were simulated for additional burn tests performed at AREVA NP Laboratories in Karlstein to examine the burning of oil

Temperature: 25 - 144 °C
Steam/Humidity Inert Gas: 0 - 60 vol. %; saturated condition
H2-Concentration: 4 - 15 vol. %
Pressure: 1 - 4 bar

The recombiner worked at a nominal hydrogen depletion rate, and no significant degradation of function was observed during recombination tests on catalyst plates loaded with residues from an oil and cable fire.

The impact from sources of “elemental” carbon, as a result of cable or oil burning tests on PAR performance, was negligible.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 06.02.05-10:

This question is a follow-up to an October 7 and 8, 2009 audit on documentation relevant to passive autocatalytic recombiners (PARs).

DCA Tier 2, Table 6.2.5-1, CGCS Design and Performance Parameters, indicates that the catalyst on both the small and the large PARs is a Pt / Pd substrate. The chemistry definition of a substrate is the reactant which is consumed during a catalytic or enzymatic reaction. For these PARs, is either the platinum or the palladium the substrate? Discuss the consumption of this substrate on the performance of the PARs. If the substrate were completely consumed, what would be the effect on the catalysts and on the PAR performance?

Response to Question 06.02.05-10:

The use of the word “substrate” in U.S. EPR FSAR Tier 2, Table 6.2.5-1 may be confusing. The catalytic plates of the PARs have a coating made of Pt / Pd. This coating remains on the catalytic plate surface and is not consumed during the catalytic reaction. The word “substrate” will be changed to “coating” in U.S. EPR FSAR Tier 2, Table 6.2.5-1.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 6.2.5-1 will be revised as described in the response and indicated on the enclosed markup.

Question 06.02.05-11:

This question is a follow-up to an October 7 and 8, 2009 audit on documentation relevant to passive autocatalytic recombiners (PARs).

EPRI TR-107517, vol. 3 documented the results of test showing that FR90/1-150 PARs when subjected to simulated containment spray did not begin recombination for ~4.5 hours and when subjected to direct spray did not begin recombination for ~ 14.5 hours. The same PAR under dry conditions started recombination almost instantaneously, and a wet PAR with a hydroscopic coating started recombination in ~ 10 minutes. Do the PARs in the US EPR design have a hydroscopic coating?

For a severe accident, the initiation of the containment spray function of the SAHRS would likely disable the PARs for ~ 4.5 hours. Has this been reflected in the chapter 19 analyses for H_2 concentration in containment? In the case of a direct spray impinging on the PAR, have the PARs likely to be affected by a high pressure line break been modeled as disabled for the ~ 14.5 hours the PARs would not be functioning?

Demineralized water was used for the spray tests. What effect on PAR performance would the borated water in the IRWST containing trisodium phosphate, HNO_3 from the radiolysis of water, and HCl from the radiolysis of the PVC and Hypalon jackets on the electrical cables following a severe accident have? Discuss these results. Identify any experimental tests and provide the test results.

Response to Question 06.02.05-11:

As addressed in Topical Report ANP-10268P-A, “U.S. EPR Severe Accident Evaluation” (Reference 1, Sections 2.2.4.2 and 5.4.1.2) and U.S. EPR FSAR Tier 2, Section 19.2.4.4.15, actuation of the U.S. EPR severe accident heat removal system sprays is delayed by 12 hours to allow the hydrogen recombiners to perform with a high degree of reliability to fulfill its design goal of reducing hydrogen concentration to four percent. As such, the situation described in the question is not plausible for the period of time in which combustible gas control is most critical.

The potential impact of sprays on the PARs is minimized. A housing surrounding the catalyst protects against direct spraying. With this design configuration the catalyst may only be impacted if water sprays through the lateral opening on the top of the housing. In addition, mounted PARs are shielded by containment walls and other structures for protection against direct spraying from the dome spray ring. Only four of the 47 installed PARs are located near the spray spargers. These four PARs are installed at the polar crane.

In addition, the PARs tested with direct spray and operating in the presence of hydrogen concentration above three percent had very high exit temperatures (i.e., above saturation) effectively maintaining dry conditions and showing no impact from sprays.

The combustible gas control system (CGCS) performance analysis presented in U.S. EPR FSAR Tier 2, Chapter 19, Section 2.4, explicitly considered performance uncertainty with regard to recombination rate and the hydrogen concentration threshold to begin recombination. The analysis assumed maximum degradation at 20 percent for recombination rate and a maximum self hydrogen concentration threshold of 1 percent by volume. These limits were applied globally to all 47 PARs. The result from that analysis showed that most of the hydrogen is removed within 12 hours (Reference U.S. EPR FSAR Tier 2, Figure 19.2-9—Hydrogen Concentration at Significant Events).

With regard to water containing boron and sodium hydroxide, the EDF H_2-KALI tests verified the PAR efficiency under spray conditions with H_3BO_3 and NaOH. The following environmental conditions were examined:

Hydrogen concentration: 2.7 – 5.5 % by volume
Steam / Humidity Inert Gas: 44 – 72 %
Temperature: 100 -140°C
Pressure: 2.3 – 5.2 bar

The PARs were tested with and without spray system operation under saturated steam conditions. During the spray operation the pressure was maintained constant by a steam regulator. Cold water was injected by the spray system at a specific mass flow rate and a specific size of droplets. Boric acid and sodium hydroxide were dissolved in the water to provide the representative chemical concentration.

The vessel was equipped with a fan to avoid any stratification during the hydrogen injection and to provide a homogenous mixture. The PAR was affected by spray for a total of 10 hours.

The spray had a noticeable effect. It prevented temperatures in the vessel from rising as high as in the corresponding tests without spray and forced them to equalize to the saturation temperature. No thermal or hydrogen stratification was observed inside the test vessel. The efficiency of the hydrogen removal had the same trend as without spray. The PAR efficiency is slightly higher without spray.

The combination of PAR design, arrangement, and accident management effectively eliminates a performance impact from sprays and the common impurities that may reside in the water. Therefore, it is not necessary to have a hydroscopic coating on the catalytic plates.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 06.02.05-12:

This question is a follow-up to an October 7 and 8, 2009 audit on documentation relevant to passive autocatalytic recombiners (PARs). EPRI TR-107517, vol. 3 documented the results of test showing that FR90/1-150 PARs when subjected to concentrations of H_2 greater than 7% ignited and burned. Discuss the functionality of the PARs after H_2 ignition and deflagration. Identify experimental tests and provide test results.

Response to Question 06.02.05-12:

The housing of the PARs is designed with a lateral opening at the bottom and the top to avoid a pressure differential between the ambient atmosphere and the catalysts. The PAR housing is designed to protect the catalyst against direct spray impingement and to have sufficient openings for ventilation. The catalyst is also designed for higher temperature during deflagrations. These features prevent thermal damage.

To verify functionality after hydrogen deflagration, PAR tests were performed with the German inspection agency (TÜV) under an AREVA NP test program.

The following environmental conditions were examined:

Temperature: 25 - 144 °C
Steam/ Humidity Inert Gas: 0 - 60 % by volume; saturated condition
H2- Concentration: 4 - 15 % by volume
Pressure: 1 - 4 bar

The test vessel was equipped for these tests with an igniter to affect the installed PAR with a hydrogen deflagration. After three ignitions, the visual inspection established that the insert and the catalytic plates were not altered or damaged by deflagration. During the following functional test no influence of the functional behavior was detected.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 06.02.05-13:

This question is a follow-up to an October 7 and 8, 2009 audit on documentation relevant to passive autocatalytic recombiners (PARs). Discuss the effects of the operating environment in containment on the performance of the PARs. Address the effects of radiation, operational vibrations, welding fumes and solvent fumes.

Response to Question 06.02.05-13:

Radiation does not affect the PAR housing because it is made of stainless steel. The catalyst is also stainless steel with a surface layer of platinum and palladium.

Regarding vibrations and fumes, the PAR performance database credited by AREVA NP for the U.S. EPR design includes certain developmental tests performed at the AREVA NP laboratories partnered with the German inspection agency (TÜV). The following environmental conditions were simulated in the test vessel:

Temperature: 25 - 144 °C
Steam/ Humidity Inert Gas: 0 - 60 % by volume; saturated condition
H2- Concentration: 4 - 15 % by volume
Pressure: 1 - 4 bar

For this test a segment model of the PAR was used (full scale for all key dimensions, such as catalytic plates, PAR overall height and width and spacing between the catalytic plates) because the test facility could not accommodate a full size large PAR.

The influence of operational and seismic vibrations was examined relative to the international codes and standards of IEC 68-2-6, 980 and IEEE 344, 382. Under these conditions the test results verified that the PAR worked at a nominal hydrogen depletion rate, and no significant functional degradation was observed during recombination.

The tests demonstrated that with exposure of the catalyst to welding and solvent fumes, no functional impairment was observed. To protect against direct welding fumes and other fouling, PARs are enclosed by a housing.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 06.02.05-14:

This question is a follow-up to an October 7 and 8, 2009 audit on documentation relevant to passive autocatalytic recombiners (PARs). Discuss the effects of seismic vibrations and aerosol exposure during and following a design basis accident.

Response to Question 06.02.05-14:

The potential affect of seismic vibrations are addressed in the response to Question 06.02.05-13. Testing of the catalyst demonstrated that its performance with operating and seismic criteria.

The response to Question 06.02.05-8 outlines the aerosol tests of the IPSN/EDF H2 PAR-Test program. The result demonstrates that the PAR has the functional capability of efficiently reducing hydrogen concentration. The test result also demonstrates that the PAR reduces hydrogen concentration even under extreme adverse conditions as simulation of realistic post-accident atmosphere with release of core melt aerosols, including catalytic poisons (e.g., Te, Se, Sb, I).

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

U.S. EPR Final Safety Analysis Report Markups

Table 2.3.1-1—CGCS Equipment Design (3 Sheets)

Equipment Description	Equipment Location
Recombiner 30JMT10AT001[2]	Room 30UJA18-019, surge line area
Recombiner 30JMT10AT002	Room 30UJA18-007, SG loop 3 area
Recombiner 30JMT10AT003	Room 30UJA18-008, SG loop 4 area
Recombiner 30JMT10AT004	Room 30UJA18-003, SG loop 1 area
Recombiner 30JMT10AT005	Room 30UJA18-004, SG loop 2 area
Recombiner 30JMT10AT006[2]	Room 30UJA18-018, spray valves area
Recombiner 30JMT10AT007[2]	Room 30UJA23-019, pressurizer area
Recombiner 30JMT10AT008	Room 30UJA23-006, RCP loop 3 area
Recombiner 30JMT10AT009	Room 30UJA23-015, annual space accumulator tank loop 3 (0°-90°) area
Recombiner 30JMT10AT010	Room 30UJA23-006, RCP loop 3 area
Recombiner 30JMT10AT011	Room 30UJA23-007, SG loop 3 area
Recombiner 30JMT10AT012	Room 30UJA23-008, SG loop 4 area
Recombiner 30JMT10AT013	Room 30UJA23-016, annual space accumulator tank loop 4 (90°-180°) area
Recombiner 30JMT10AT014	Room 30UJA23-009, RCP loop 4 area
Recombiner 30JMT10AT015	Room 30UJA23-009, RCP loop 4 area
Recombiner 30JMT10AT016[2]	Room 30UJA15-001, reactor cavity
Recombiner 30JMT10AT017	Room 30UJA23-002, RCP loop 1 area
Recombiner 30JMT10AT018	Room 30UJA23-002, RCP loop 1 area
Recombiner 30JMT10AT019	Room 30UJA23-013, annual space accumulator tank loop 1 (180°-270°) area
Recombiner 30JMT10AT020	Room 30UJA23-003, SG loop 1 area
Recombiner 30JMT10AT021	Room 30UJA23-004, SG loop 2 area
Recombiner 30JMT10AT022	Room 30UJA23-005, RCP loop 2 area
Recombiner 30JMT10AT023	Room 30UJA23-014, annual space accumulator tank loop 2 (270°-0°) area
Recombiner 30JMT10AT024	Room 30UJA23-005, RCP loop 2 area
Recombiner 30JMT10AT025[2]	Room 30UJA29-019, pressurizer area
Recombiner 30JMT10AT026	Room 30UJA29-016, access area (equipment hatch)
Recombiner 30JMT10AT027	Room 30UJA29-013, set down area operating floor
Recombiner 30JMT10AT028	Room 30UJA29-018 operating floor access area
Recombiner 30JMT10AT029[2]	Room 30UJA34-019, pressurizer heat safety relief valves

Table 2.3.1-1—CGCS Equipment Design (3 Sheets)

Equipment Description	Equipment Location
Rupture and convection foils, combined minimum area of 107ft^2.[1]	SG (Loop 3 and Loop 4) pressure equalization ceiling

1) The combined minimum area of 214 ft^2 (107 ft^2 per SG pressure equalization ceiling) is based on analyses that safety significant CGCS performance is maintained with 75% of foils failing to open. Therefore, (0.25)*(375 ft^2 rupture foils) + (0.25)*(480 ft^2 convection foils) = 214 ft^2.

2) Small PAR (recombination rate of 2.6 lbm/hr). The remaining large PARs have a recombination rate of 11.8 lbm/hr.

06.02.05-7

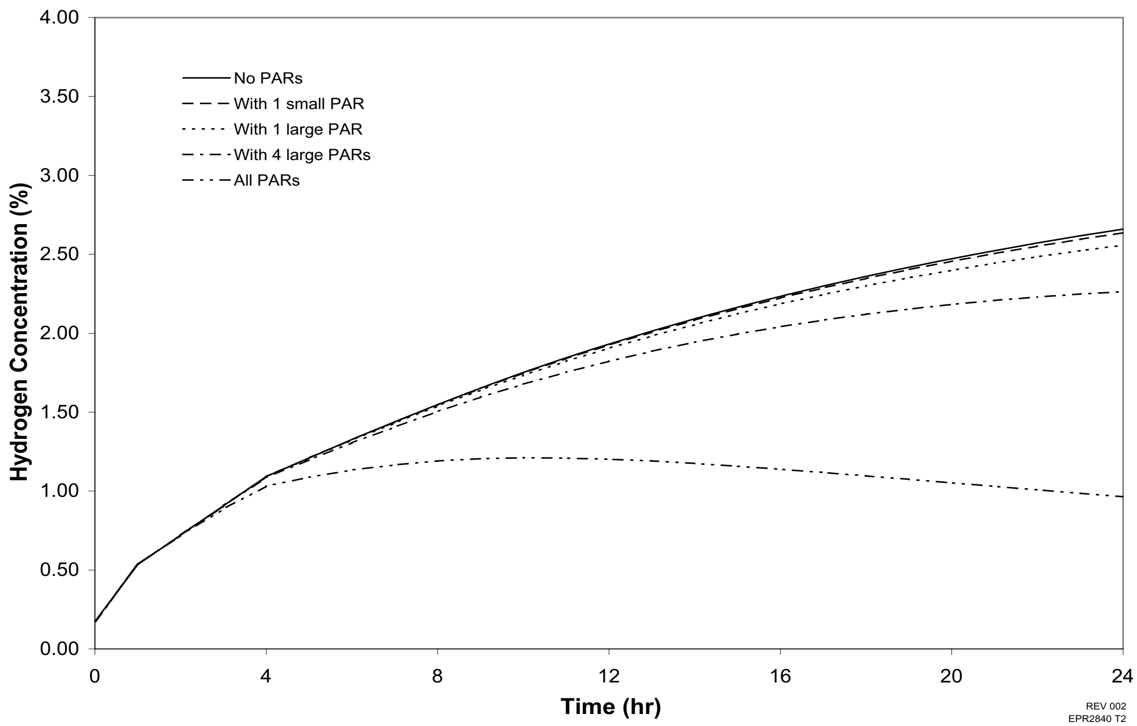
Table 6.2.5-1—CGCS Design and Performance Parameters

Parameter	Value
Large PARs	
• Number of units	41
• Nominal hydrogen reduction rate (per PAR)	11.8 lb_m/hr
• Catalyst	Pt / Pd ~~substrate~~coating
Small PARs	
• Number of units	6
• Nominal hydrogen reduction rate (per PAR)	2.6 lb^m/hr
• Catalyst	Pt / Pd ~~substrate~~coating
Hydrogen mixing dampers	
• Number of units	8
• Approximate opening cross section (total)	64 ft^2
• Nominal actuation pressure	0.5 psid or17 psia
Rupture foils	
• Approximate opening cross section (total)	375 ft^2
• Nominal actuation pressure	0.7 psid
Convection foils	
• Approximate opening cross section (total)	480 ft^2
• Nominal actuation pressure	0.7 psid
• Nominal actuation temperature	180.5°F

06.02.05-10

Figure 6.2.5-9—Concentration of Hydrogen in the Containment

06.02.05-7



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