

ArevaEPRDCPEm Resource

From: HOTTLE Nathan (AREVA) [Nathan.Hottle@areva.com]
Sent: Tuesday, November 19, 2013 11:41 PM
To: Wunder, George; Miernicki, Michael; Gleaves, Bill
Cc: RANSOM Jim (AREVA); LEIGHLITER John (AREVA); UYEDA Graydon (AREVA); GUCWA Len (EXTERNAL AREVA); MOLSEED Chris (AREVA); NOXON David (AREVA); WILLIFORD Dennis (AREVA); RYAN Tom (AREVA); ROMINE Judy (AREVA); DELANO Karen (AREVA); WILLS Tiffany (AREVA)
Subject: Response to FINAL- U.S. EPR Design Certification Application RAI No. 566 (6955), FSAR Ch. 6, Question 06.02.05-32 - Supplement 2
Attachments: RAI 566 Supplement 2 Response US EPR DC.pdf

George,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 566 Supplement 2 Response U.S. EPR DC.pdf" provides a technically correct and complete FINAL response to Question 06.02.05-32.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report which support the response to RAI 566 Question 06.02.05-32.

The following table indicates the respective pages in the response document that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 566 — 06.02.05-32	2	18

This completes the formal AREVA NP response to RAI 566. There are no additional questions associated with this RAI.

Sincerely,

Nathan Hottle

AREVA Inc.

3315 Old Forest Road

Lynchburg, VA 24501

Phone 434-832-3864

Mobile 434-485-4239

nathan.hottle@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Tuesday, April 30, 2013 7:54 AM
To: Amy.Snyder@nrc.gov
Cc: bill.gleaves@nrc.gov; DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); NOXON David (RS/NB)
Subject: Response to FINAL- U.S. EPR Design Certification Application RAI No. 566 (6955), FSAR Ch. 6, Supplement 1

Amy,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the single question in RAI No. 566 on March 11, 2013.

The schedule for a technically correct and complete response to Question 06.02.05-32 has been changed as provided below.

Question #	Response Date
RAI 566 — 06.02.05-32	August 9, 2013

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Monday, March 11, 2013 3:34 PM
To: Amy.Snyder@nrc.gov
Cc: bill.gleaves@nrc.gov; DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); NOXON David (RS/NB)
Subject: Response to FINAL- U.S. EPR Design Certification Application RAI No. 566 (6955), FSAR Ch. 6

Amy,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 566 Response US EPR DC.pdf," provides a schedule since a technically correct and complete response to the one question cannot be provided at this time.

The following table indicates the respective pages in the response document, "RAI 566 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 566 — 06.02.05-32	2	2

The schedule for a technically correct and complete response to the question is provided below.

Question #	Response Date
RAI 566 — 06.02.05-32	May 31, 2013

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
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From: Snyder, Amy [<mailto:Amy.Snyder@nrc.gov>]
Sent: Friday, February 08, 2013 7:17 AM
To: ZZ-DL-A-USEPR-DL
Cc: Gleaves, Bill; Grady, Anne-Marie; McKirgan, John; Segala, John
Subject: FINAL- U.S. EPR Design Certification Application RAI No. 566 (6955), FSAR Ch. 6

Attached, please find the subject requests for additional information (RAI). An advanced RAI was provided to you on November 30, 2012, and discussed with your staff on December 14, 2012, and January 7, 2013. The advanced RAI was modified as a result of those discussions. On January 31, 2013, you informed us that the advanced RAI is clear and no further clarification is needed and that the RAI does not contain any proprietary information. 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 or March 11, 2013**, 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.”

Thank You,

Amy

Amy Snyder, U.S. EPR Design Certification Lead Project Manager
Licensing Branch 1 (LB1)
Division of New Reactor Licensing
Office of New Reactors
U.S. Nuclear Regulatory Commission

 Office: (301) 415-6822

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Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 4768

Mail Envelope Properties (8D35DF68A379A34E8526B758FDCFC0420B6D80A0)

Subject: Response to FINAL- U.S. EPR Design Certification Application RAI No. 566 (6955), FSAR Ch. 6, Question 06.02.05-32 - Supplement 2
Sent Date: 11/19/2013 11:40:53 PM
Received Date: 11/19/2013 11:46:02 PM
From: HOTTLE Nathan (AREVA)

Created By: Nathan.Hottle@areva.com

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Tracking Status: None

Post Office: FUSLYNCMX03.fdom.ad.corp

Files	Size	Date & Time
MESSAGE	5213	11/19/2013 11:46:02 PM
RAI 566 Supplement 2 Response US EPR DC.pdf		5908502

Options

Priority: Standard
Return Notification: No
Reply Requested: No
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Expiration Date:
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Response to

Request for Additional Information No.566, Supplement 2

2/8/2013

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: 06.02.05

SCVB Branch

Question 06.02.05-32:

The confirmatory evaluation of U.S. EPR™ CGCS performance under design basis accident conditions was carried out using the MELCOR code, with input based on the recent AREVA model. The comparison of MELCOR and AREVA results showed that the MELCOR predicted containment hydrogen concentration is approximately 45% to 73% higher than the AREVA prediction for the design basis scenario in which PARs are not credited, and exceeds 4 %.

This discrepancy may be due to the differences in boundary conditions (break mass and energy and hydrogen sources from core oxidation, radiolysis, and corrosion of zinc and aluminum) between the MELCOR and AREVA calculations, and to a lesser degree due to the MELCOR and AREVA thermal-hydraulic model differences.

In order to resolve these differences, the following clarifications regarding the boundary conditions used in the AREVA calculations are requested.

1. Hydrogen Source Rate and Location

The following hydrogen sources are considered in the design basis calculations documented in the FSAR:

1% Core Oxidation

Radiolysis of reactor coolant system (RCS) and In-Containment Refueling Water Storage Tank (IRWST) water plus the radiolysis of Hypalon and PVC jacketed cable in the containment.

Corrosion of zinc and aluminum in containment

Volumetric rates of these sources are provided in the FSAR, where adequate information on the pressures and temperatures at which these sources are calculated is not. Furthermore, the locations or distribution of these sources in the MAAP calculations are not known. For example, it is not clear whether the 1% core oxidation source was added to the RCS or directly into the containment volumes. Therefore, please provide, for each hydrogen source, the following:

Mass rate of injection

Location or distribution of source in AREVA model computational nodes

2. Break Mass and Energy Release Rate to the Containment

Section 6.2.5.3 of the FSAR indicates that the design basis analysis was performed for a LOCA scenario. Please provide the break mass and energy release rates to the containment and the associated model nodes.

Please elaborate on any additional assumptions used in the AREVA analysis.

Response to Question 06.02.05-32:**Item 1:****Hydrogen Source Rate and Location**

AREVA Inc. has developed a calculation to show that the hydrogen concentrations in containment are controlled and remain below four percent for 24 hours following a design basis accident (DBA) loss-of-coolant accident (LOCA). Five sources are considered that produce hydrogen in the containment following a DBA LOCA. These are as follows:

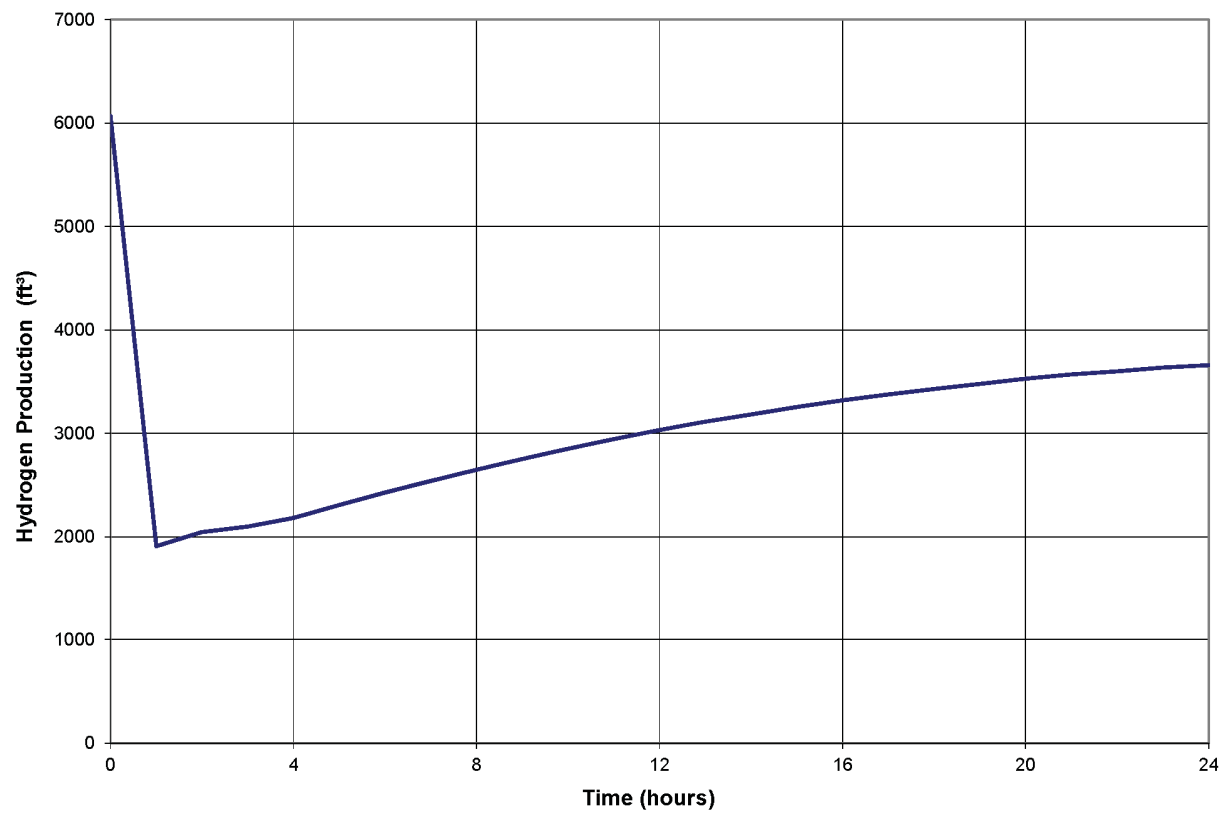
1. One percent oxidation of the zirconium in the cladding.
2. Radiolysis of the water in the RCS (including PVC and Hypalon jacketed cable).
3. Zinc from painted surfaces.
4. Zinc from steel structures.
5. Corrosion of aluminum in containment.

Each of these sources will have their respective hydrogen volumetric generation rate, and then these will be summed to find the total amount of hydrogen generated in the containment. This will then be converted to a percent to show total hydrogen concentration in the containment building. It will be shown that this value remains below four percent.

Zirconium Oxidation

It is assumed that 1% of the zirconium in the core oxidizes. This is conservative as it is the limit allowed for a DBA. The total mass of hydrogen generated from zirconium is calculated and remains present in the same quantity throughout the accident. However, the volume of hydrogen generated from zirconium varies based on the accident pressure and temperature profile. The mass of hydrogen produced from zirconium oxidation is calculated to be 33.3 lbm. Based on a containment pressure and temperature at the end of 24 hours of 32.5 psia and 210°F, respectively, the volume is calculated to be 3,660 ft³. The volume of hydrogen present in the containment from zirconium oxidation over time is provided in Figure 06.05.02-32-1.

The source of hydrogen from zirconium is in the core which will be transferred through the break in the lower equipment area. The oxidation is assumed to happen immediately in the initiation of the accident. The flow out the break will therefore follow the steam path up through the top of the equipment areas and accumulate in the dome.

Figure 06.02.05-32-1—Volume of Hydrogen from Zirconium

Radiolysis

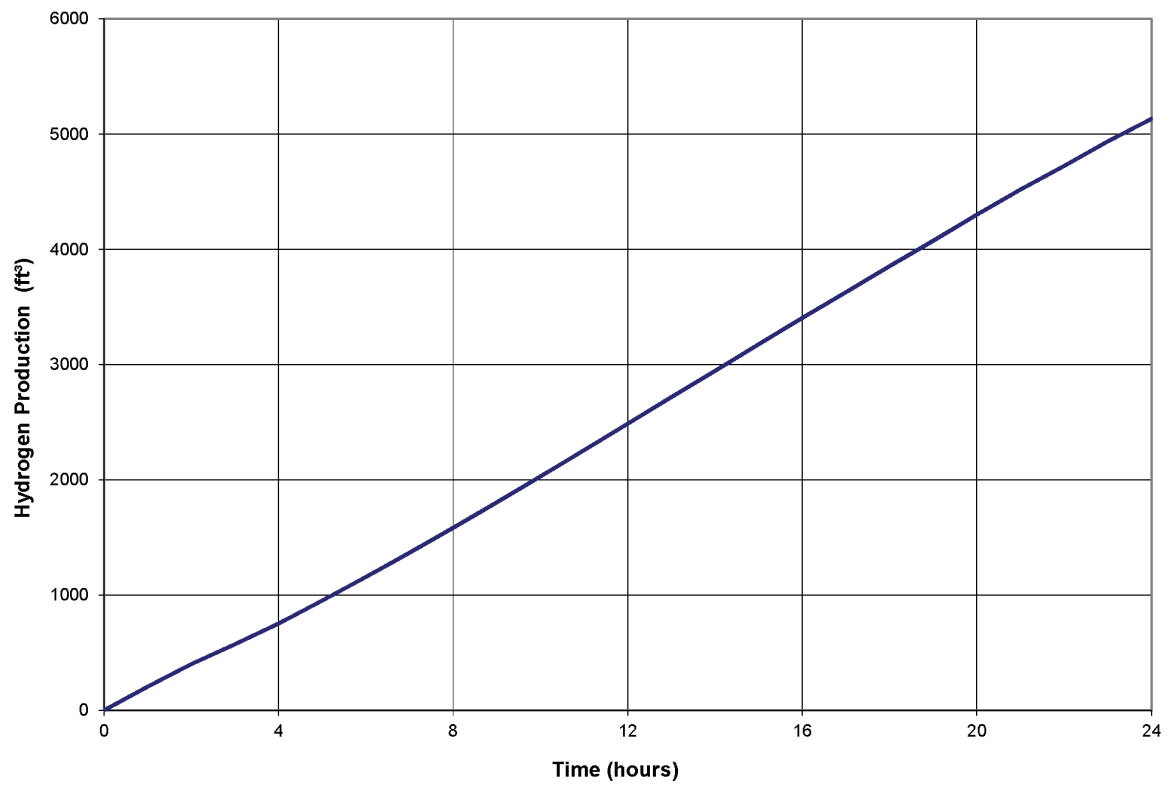
The hydrogen produced from radiolysis is calculated based on the amount of decay heat gamma energy absorbed in the coolant. It is assumed that the energy absorbed by the coolant is 10 percent of the gamma power generated in the core from decay heat. The volume of hydrogen is calculated by integrating the molar production rate from gamma energy absorbed. The total and volumetric generation rates of hydrogen from radiolysis over 24 hours can be seen in Table 06.02.05-32-1. The volumetric hydrogen production from radiolysis is shown graphically in Figure 06.02.05-32-2.

The source of hydrogen from radiolysis is in the RCS, which will be transferred to the break in the lower equipment area. Similarly to hydrogen from zirconium oxidation, the flow out the break will follow the steam path up through the top of the equipment areas and accumulate in the dome. Other sources of hydrogen from radiolysis (such as PVC and Hypalon jacketed cable) will also follow the flow path out the top of the equipment areas and accumulate in the dome. However, radiolysis is a much less significant source of hydrogen compared to the others in this analysis.

Table 06.02.05-32-1—Hydrogen Generated from Radiolysis

Time (hr)	Temperature (°F)	Total (ft³)
1	285.9	206
2	275.5	401
3	272.9	574
4	269	753
5	263.2	952
6	258	1158
7	253.5	1367
8	249.5	1583
9	246.2	1805
10	243	2029
11	239.7	2258
12	237	2487
13	234	2718
14	231	2945
15	228.3	3177
16	225.7	3405
17	223.1	3629
18	220.5	3854
19	218.4	4075
20	216.3	4301
21	214.3	4520
22	212.1	4723
23	210.8	4936
24	209.6	5134

Figure 06.02.05-32-2—Production of Hydrogen from Radiolysis



Zinc-based Paint

There will be a minimum number of concrete surfaces coated with paint; however, it is assumed in this calculation that all concrete surfaces in the containment are painted with a zinc-based paint. Hydrogen from zinc-based paint is calculated as a volumetric rate and integrated over 24 hours to determine the total volume of hydrogen generated. The total and volumetric generation rates of hydrogen from zinc-based paint over 24 hours can be seen in Table 06.02.05-32-2.

Since it is assumed that the concrete surfaces have zinc-based paint, the primary concentration of hydrogen generated from paint will be distributed in the equipment areas. The steam flow throughout the equipment areas during the accident will all be forced upwards into the dome. The hydrogen generated from paint will thus follow this flow pattern and accumulate in the dome as well.

Table 06.02.05-32-2—Hydrogen Generated from Zinc-based Paint

Time (hr)	Temperature (°F)	Volume (ft³)	Total (ft³)
1	285.9	1547	1547
2	275.5	1291	2838
3	272.9	1243	4081
4	269	1174	5255
5	263.2	1075	6329
6	258	991	7321
7	253.5	924	8244
8	249.5	868	9112
9	246.2	828	9939
10	243	787	10,727
11	239.7	745	11,471
12	237	712	12,184
13	234	675	12,858
14	231	635	13,494
15	228.3	603	14,097
16	225.7	572	14,669
17	223.1	541	15,209
18	220.5	510	15,720
19	218.4	488	16,207
20	216.3	466	16,673
21	214.3	445	17,118
22	212.1	421	17,538
23	210.8	409	17,948
24	209.6	398	18,345

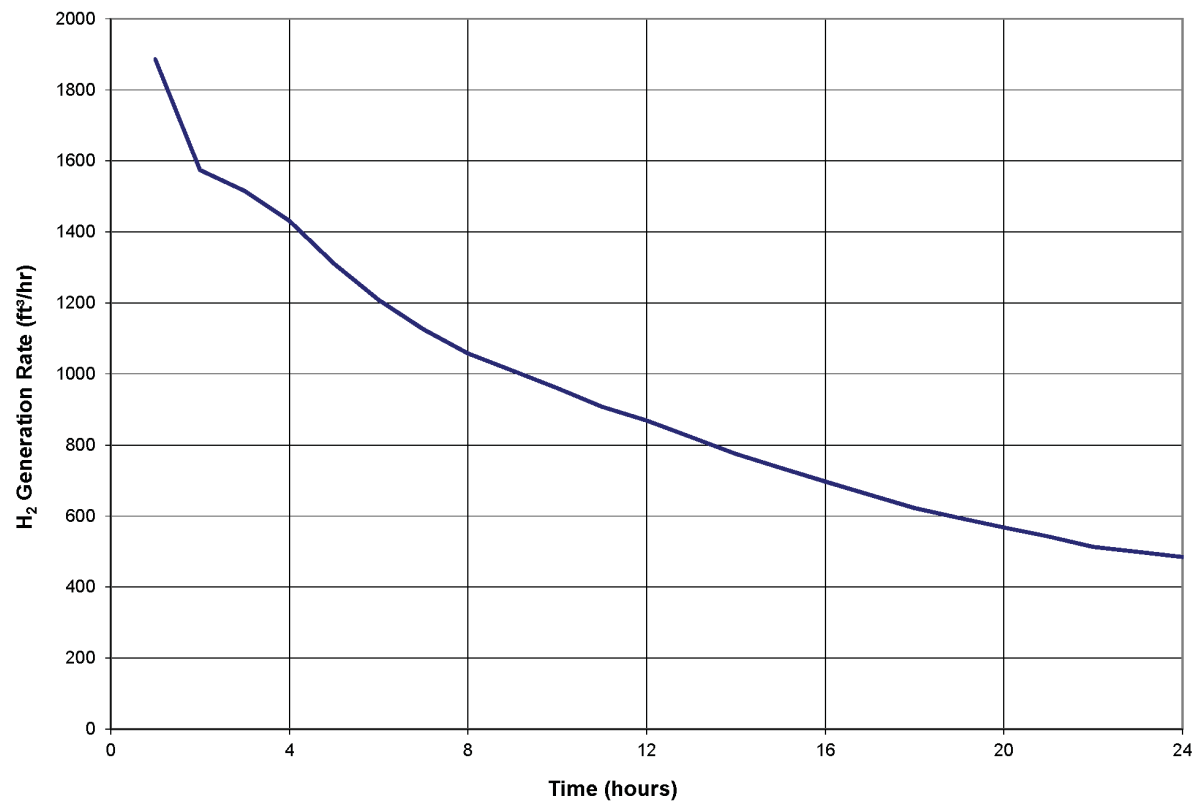
Galvanized Steel

It is assumed that all steel structures in containment and the liner are galvanized. Hydrogen from galvanized steel is calculated as a volumetric rate and integrated over 24 hours to determine the total volume of hydrogen generated. The total and volumetric generation rates of hydrogen from galvanized steel over 24 hours can be seen in Table 06.02.05-32-3. The volumetric hydrogen production from zinc sources (zinc-based paint and galvanized steel) is shown graphically in Figure 06.02.05-32-3.

It is assumed that all steel structures and the liner are galvanized; therefore, the vast majority of hydrogen generated from steel will be in the equipment areas and dome from the liner. Since the steam flow throughout the equipment areas will be upwards into the dome, the hydrogen generated from steel in the equipment areas will follow this flow pattern and accumulate with the hydrogen generated in the dome.

Table 06.02.05-32-3—Hydrogen Generated from Galvanized Steel

Time (hr)	Temperature (°F)	Volume (ft³)	Total (ft³)
1	285.9	339.1	339
2	275.5	283.1	622
3	272.9	272.5	895
4	269	257.3	1152
5	263.2	235.6	1388
6	258	217.3	1605
7	253.5	202.5	1807
8	249.5	190.2	1998
9	246.2	181.5	2179
10	243	172.6	2352
11	239.7	163.3	2515
12	237	156.2	2671
13	234	147.9	2819
14	231	139.3	2958
15	228.3	132.2	3091
16	225.7	125.4	3216
17	223.1	118.5	3334
18	220.5	111.9	3446
19	218.4	106.9	3553
20	216.3	102.1	3655
21	214.3	97.5	3753
22	212.1	92.2	3845
23	210.8	89.7	3935
24	209.6	87.2	4022

Figure 06.02.05-32-3—Production of Hydrogen from Zinc Sources

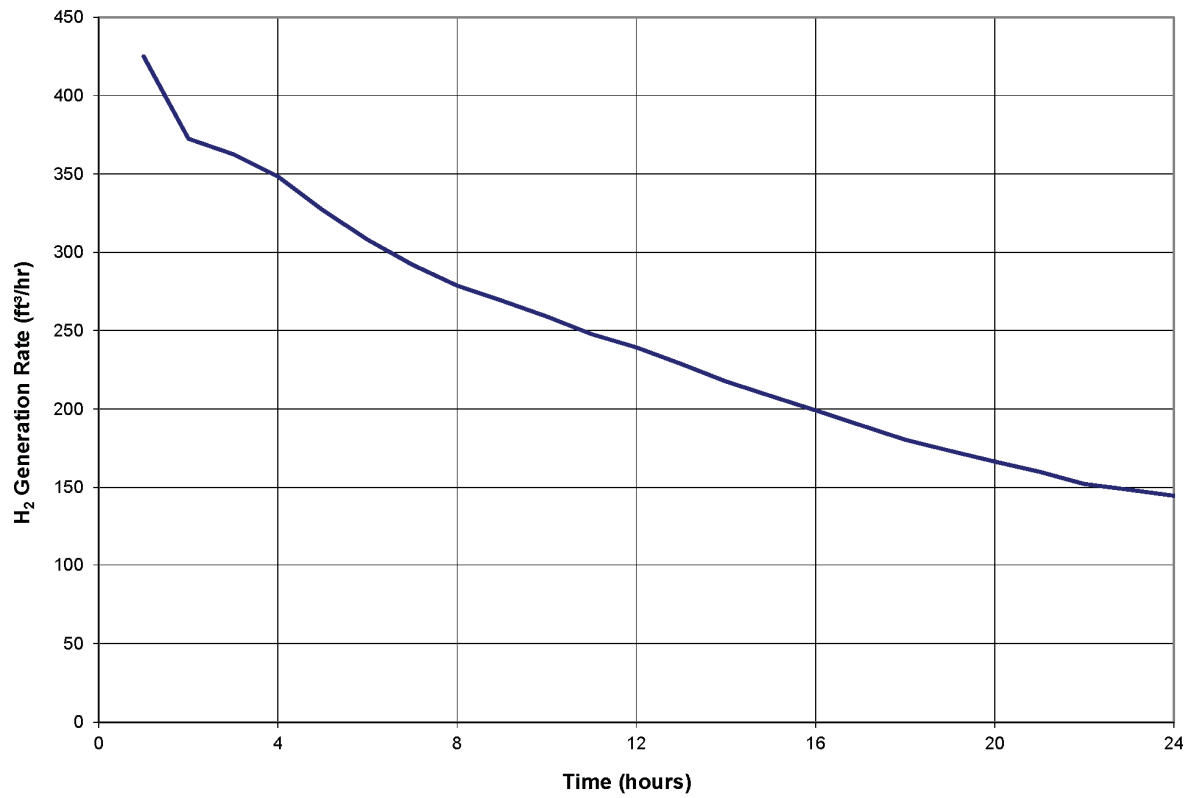
Aluminum

It is a design criterion that the surface area of aluminum in the US EPR will be kept below 1000 m² (10,764 ft²) in the containment; therefore, this is the area assumed for conservatism. Hydrogen from aluminum corrosion is calculated as a volumetric rate and integrated over 24 hours to determine the total volume of hydrogen generated. The total and volumetric generation rates of hydrogen from aluminum corrosion over 24 hours can be seen in Table 06.02.05-32-4, and graphically in Figure 06.02.05-32-4.

The two primary locations of aluminum in the containment will be in the IRWST and the polar crane. The hydrogen generated in the IRWST will follow the steam flow pattern up through the equipment areas and into the dome. The hydrogen generated from the polar crane will be accumulated with the other sources of hydrogen in the dome.

Table 06.02.05-32-4—Hydrogen Generated from Aluminum

Time (hr)	Temperature (°F)	Volume (ft³)	Total (ft³)
1	285.9	425	425
2	275.5	372	797
3	272.9	363	1160
4	269	348	1508
5	263.2	327	1835
6	258	308	2143
7	253.5	292	2436
8	249.5	279	2714
9	246.2	269	2983
10	243	259	3242
11	239.7	248	3490
12	237	239	3730
13	234	229	3958
14	231	218	4176
15	228.3	208	4384
16	225.7	199	4584
17	223.1	190	4773
18	220.5	180	4954
19	218.4	173	5127
20	216.3	167	5294
21	214.3	160	5454
22	212.1	152	5606
23	210.8	148	5754
24	209.6	145	5899

Figure 06.02.05-32-4—Production of Hydrogen from Aluminum

Total Hydrogen Generation

Using the calculated volumes of hydrogen-generated post-DBA LOCA through 24 hours, the total volume can be found by summing said volumes. Then, using the value of the total gas volume of the containment, the hydrogen concentration (in percent) can be found by simply dividing the total amount of hydrogen generated by the gas volume of the containment. This is shown below in Table 06.02.05-32-5, and graphically in Figure 06.02-5-32-5.

The five sources of hydrogen considered in this analysis are well distributed throughout the containment building to begin with. Hydrogen generated from zirconium oxidation and radiolysis will be deposited out the break and follow steam flow up through the equipment areas and into the dome. Hydrogen generated from zinc-based paint and galvanized steel is will distributed through the equipment areas and dome. Aluminum allocation is primarily restricted to the IRWST and polar crane. The steam flow patterns during the accident transient will move upwards through the equipment areas, accumulate in the dome, and down through the annular regions. The highest flow rates occur at the very beginning of the accident, also when a majority of the hydrogen is produced. Much of the hydrogen generated at this time will be accumulated in the dome. The blowdown flow patterns are visually represented in a nodal diagram provided in Figure 06.02.05-32-6. Later in the accident, there is very little flow across containment, and also less hydrogen is being produced. The flow patterns that still circulate later in the transient are shown in Figure 06.02.05-32-7. Only velocities greater than 1 ft/s between control volumes are represented with arrows in this diagram.

In this type of event, at the end of 24 hours, a majority of the hydrogen produced will be accumulated in the dome, with some remaining throughout the equipment and annular regions. Through this analysis it is clear that the hydrogen will be well mixed in the containment without threat of any significant build up in any one particular area.

Table 06.02.05-32-5—Hydrogen Generated from all Sources

Time (hr)	Zirconium (ft³)	Radiolysis (ft³)	Paint (ft³)	Steel (ft³)	Aluminum (ft³)	Total (ft³)	H₂ Conc. (%)
0	6069	0.0	0.0	0.0	0.0	6069	0.21
1	1911	206	1547	339	425	4428	0.16
2	2047	401	2838	622	797	6705	0.24
3	2099	574	4081	895	1160	8809	0.31
4	2182	753	5255	1152	1508	10,850	0.38
5	2308	952	6329	1388	1835	12,813	0.45
6	2429	1158	7321	1605	2143	14,656	0.52
7	2540	1367	8244	1807	2436	16,395	0.58
8	2648	1583	9112	1998	2714	18,054	0.63
9	2754	1805	9939	2179	2983	19,661	0.69
10	2851	2029	10,727	2352	3242	21,201	0.74
11	2945	2258	11,471	2515	3490	22,680	0.80
12	3031	2487	12,184	2671	3730	24,103	0.85
13	3113	2718	12,858	2819	3958	25,468	0.89
14	3185	2945	13,494	2958	4176	26,758	0.94
15	3257	3177	14,097	3091	4384	28,006	0.98
16	3320	3405	14,669	3216	4584	29,193	1.02
17	3376	3629	15,209	3334	4773	30,322	1.06
18	3430	3854	15,720	3446	4954	31,404	1.10
19	3479	4075	16,207	3553	5127	32,442	1.14
20	3529	4301	16,673	3655	5294	33,453	1.17
21	3571	4520	17,118	3753	5454	34,415	1.20
22	3601	4723	17,538	3845	5606	35,313	1.23
23	3636	4936	17,948	3935	5754	36,210	1.27
24	3660	5134	18,345	4022	5899	37,061	1.29

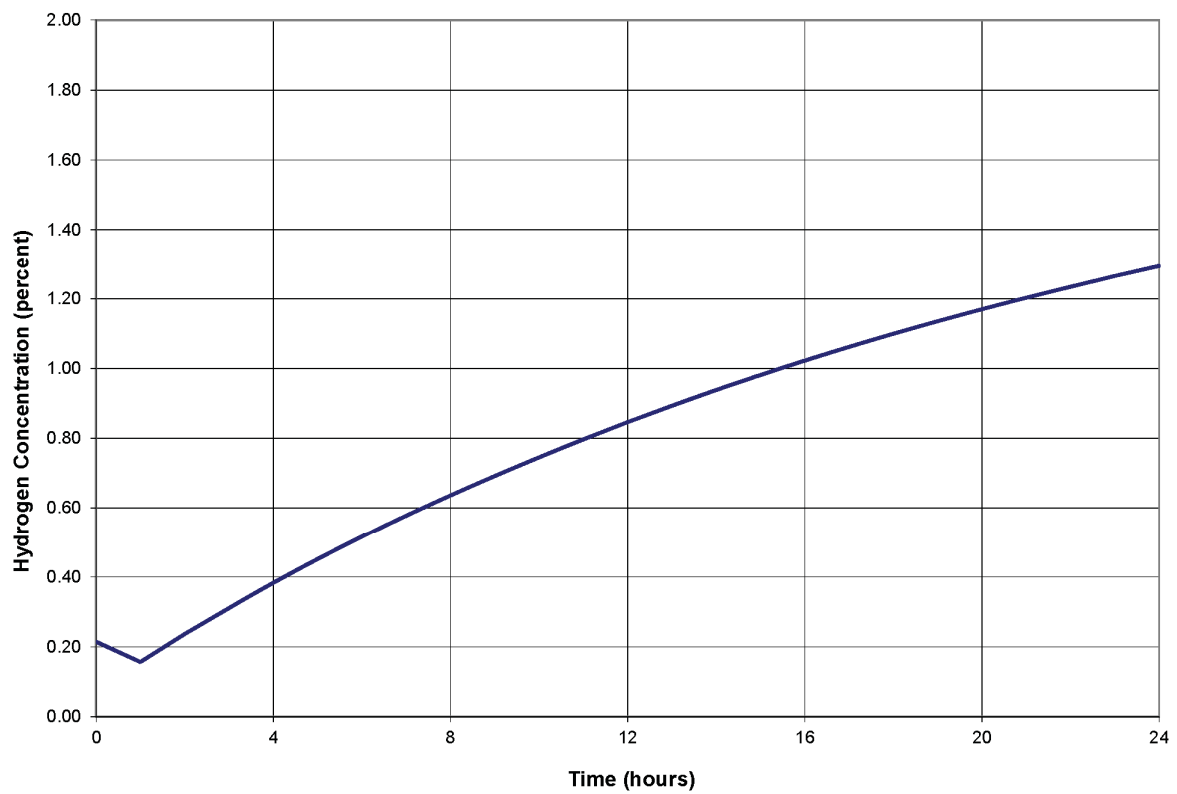
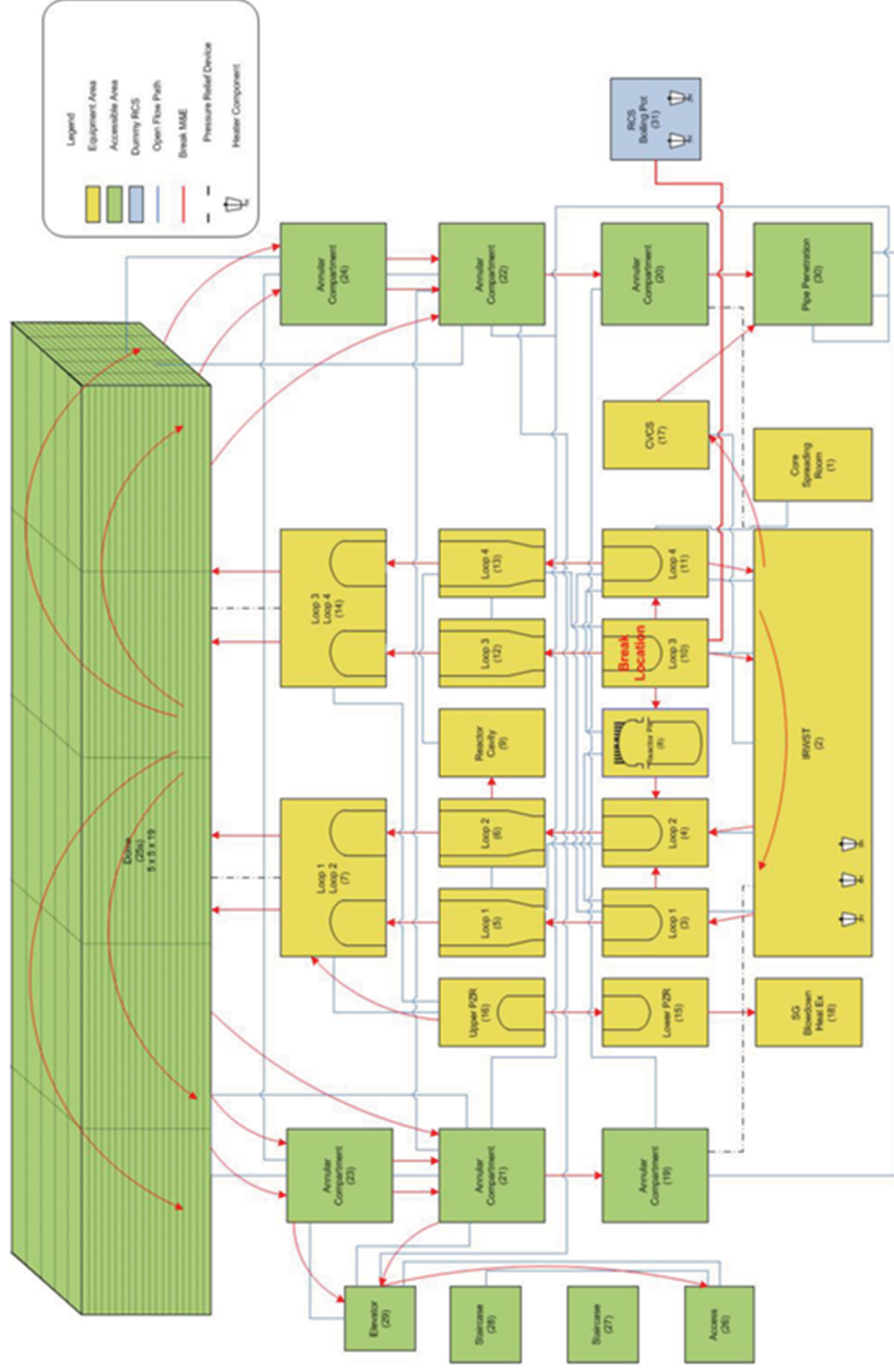
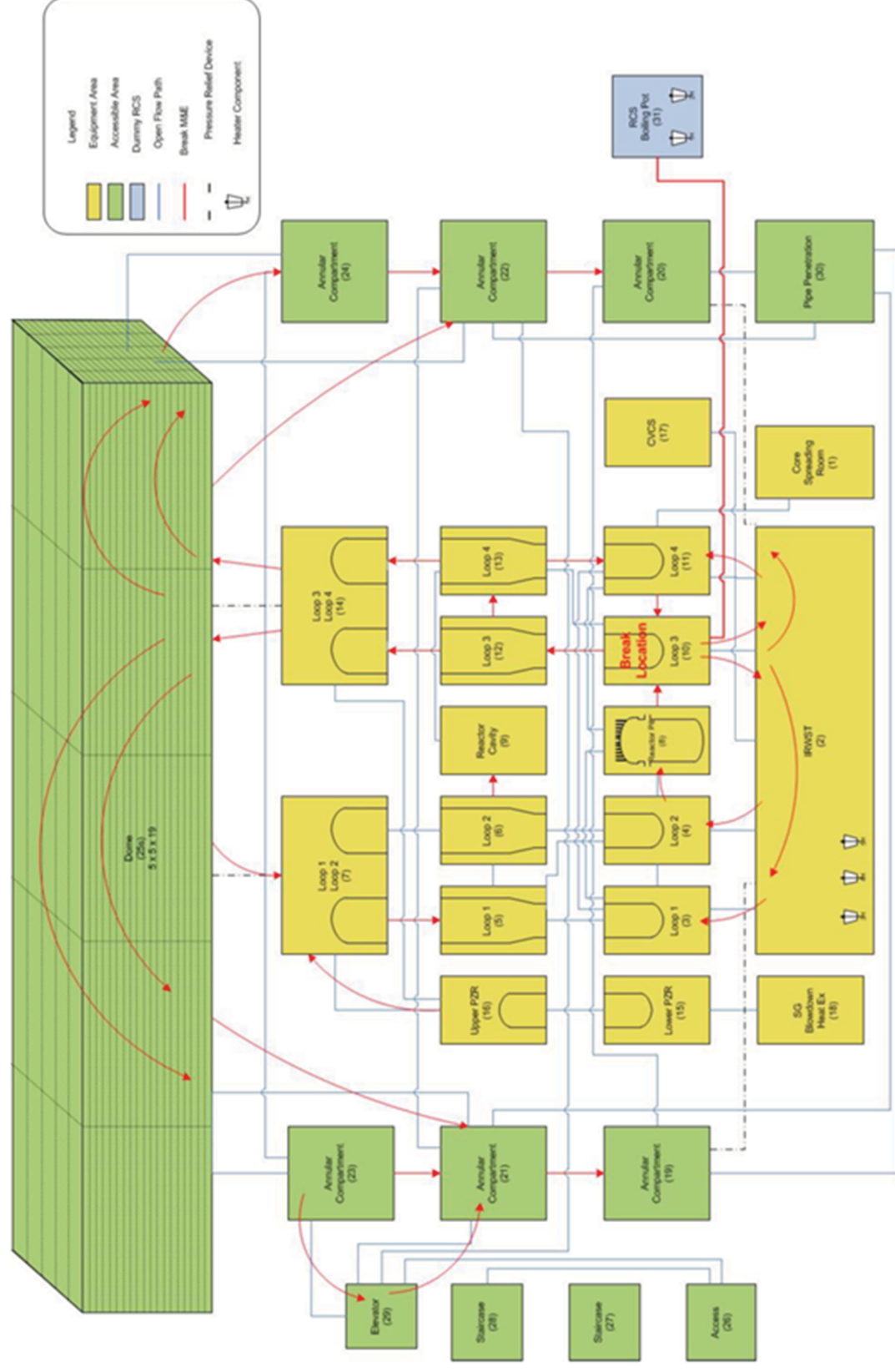
Figure 06.02.05-32-5—Concentration of Hydrogen in the Containment

Figure 06.02.05-32-6—Flow Patterns in Containment during LOCA Blowdown



Item 2:**Break Mass and Energy Release Rate to the Containment**

A bounding LOCA CLPS case was used for the break mass and energy release rates to the containment in this analysis. The subdivided GOTHIC model calculated the containment pressure and temperature response based on the mass and energy release rates. For input into the hydrogen generation calculation, the maximum pressure and temperature in the containment dome was taken at each hour for the duration of a 24 hour period. The source data for break mass and energy release data generated from RELAP5 is available in the U.S. EPR FSAR, Table 6.2.1-20. The pressure and temperature profile used to determine the hydrogen evolution is shown below in Table 06.02.05.2-6.

Table 06.02.05-32-6—Bounding LOCA CLPS Pressure and Temperature Profile

Time (hr)	Temperature (°F)	Pressure (psia)
0	86	15.96
1	285.9	69.27
2	275.5	63.77
3	272.9	61.96
4	269	59.29
5	263.2	55.59
6	258	52.45
7	253.5	49.84
8	249.5	47.55
9	246.2	45.5
10	243	43.75
11	239.7	42.15
12	237	40.8
13	234	39.55
14	231	38.5
15	228.3	37.5
16	225.7	36.65
17	223.1	35.9
18	220.5	35.2
19	218.4	34.6
20	216.3	34
21	214.3	33.5
22	212.1	33.12
23	210.8	32.73
24	209.6	32.46

U.S. EPR FSAR Tier 2, Section 6.2.5.3.1 and Figures 6.2.5-2 through 6.2.5-9 were revised in Revision 5 to reflect the analysis described above.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 6.2.5.3.1 and Figures 6.2.5-2 through 6.2.5-9 were revised in Revision 5 as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups



hydrogen exist in the containment following a design basis accident or a severe accident:

- Oxidation of the zirconium in the cladding.
- Radiolysis of water (RCS and IRWST) and jacketed cable.
- Corrosion of Zinc from painted surfaces.
- Corrosion of Zinc from steel structures.
- Corrosion of aluminum in containment.
- MCCI (for severe accidents only).

For design basis accidents, a series of bounding assumptions were made for the volume of hydrogen released to the containment from each source. Under these conservative assumptions, it was shown that the hydrogen concentration remains below the threshold for combustion (4 percent) during the first 24 hours following a design basis LOCA with no credit taken for recombination. Based on this analysis, hydrogen generated during and following a design basis LOCA is not a threat to containment integrity.

In the case of severe accidents, a much greater release of hydrogen is analyzed and the release depends more heavily on the scenario-specific phenomena involved. A detailed analysis using the MAAP4 computer code was performed and is discussed in Section 6.2.5.3.2.

6.2.5.3.1 Post-LOCA Hydrogen Concentration

For the post-LOCA hydrogen evaluation, the design basis maximum allowable core oxidation level of 1 percent was assumed. The calculated concentration is displayed in Figure 6.2.5-2—Integrated Production of Hydrogen from 1% Core Oxidation. The analysis assumed this amount of hydrogen to be released in an instant at the beginning of the LOCA transient.

The hydrogen produced from radiolysis is calculated based on the amount of decay heat gamma energy absorbed in the RCS coolant in accordance with Revision 2 of Regulatory Guide 1.7. Hydrogen generation from these sources are shown in Figure 6.2.5-3—Integrated Production of Hydrogen from Radiolysis.

In calculating the hydrogen released from corrosion of zinc and aluminum in the containment, typical corrosion rates were assumed and were applied at the actual design basis accident pressures and temperatures calculated in the containment analysis. These are discussed in Section 6.2.1.3. The surface areas of zinc and aluminum used as input to the hydrogen generation rate equation were developed in a



Figure 6.2.5-2—Integrated Production of Hydrogen from 1% Core Oxidation

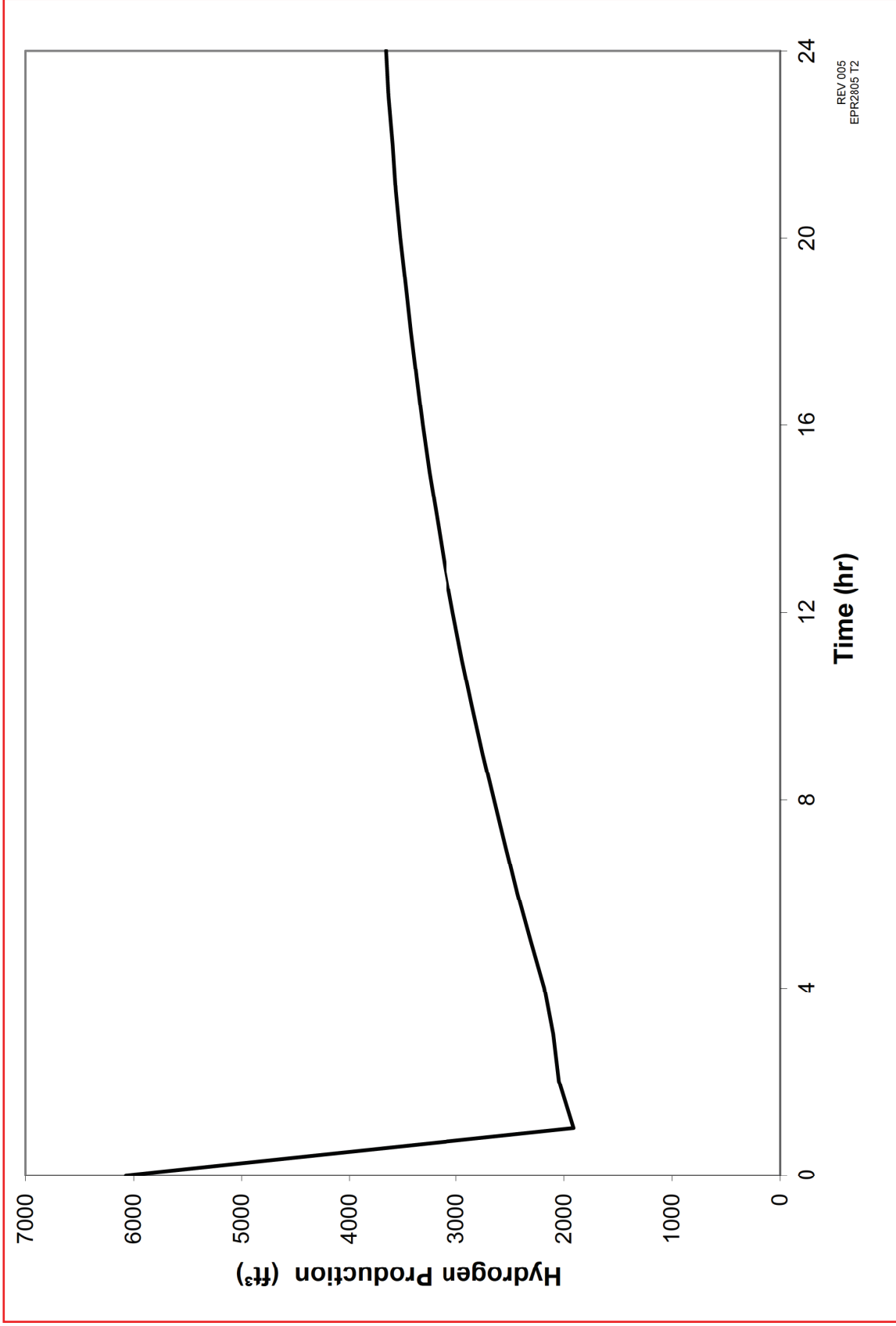




Figure 6.2.5-3—Integrated Production of Hydrogen from Radiolysis

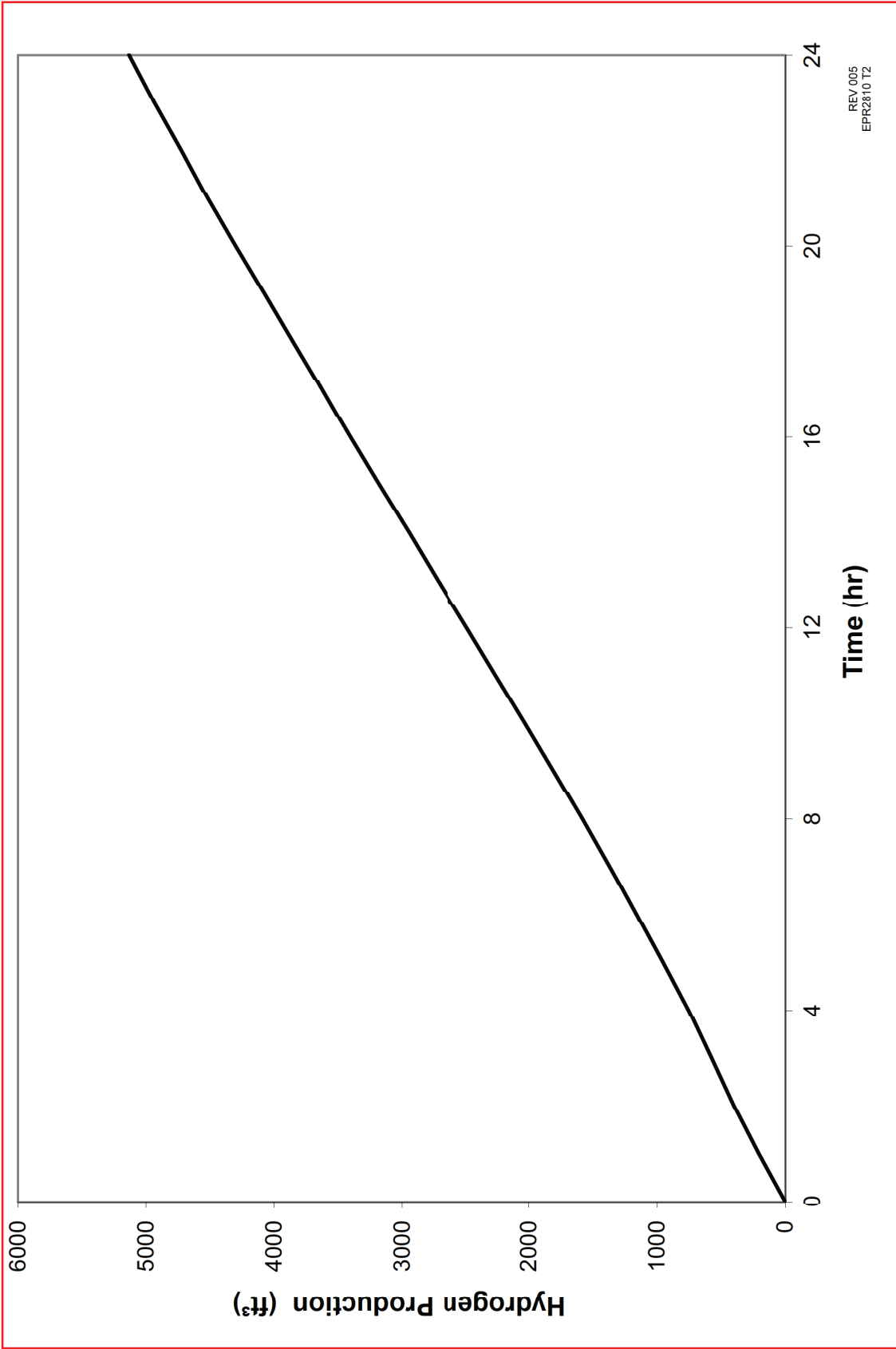




Figure 6.2.5-4—Assumed Hydrogen Generation Rate from Zinc Sources

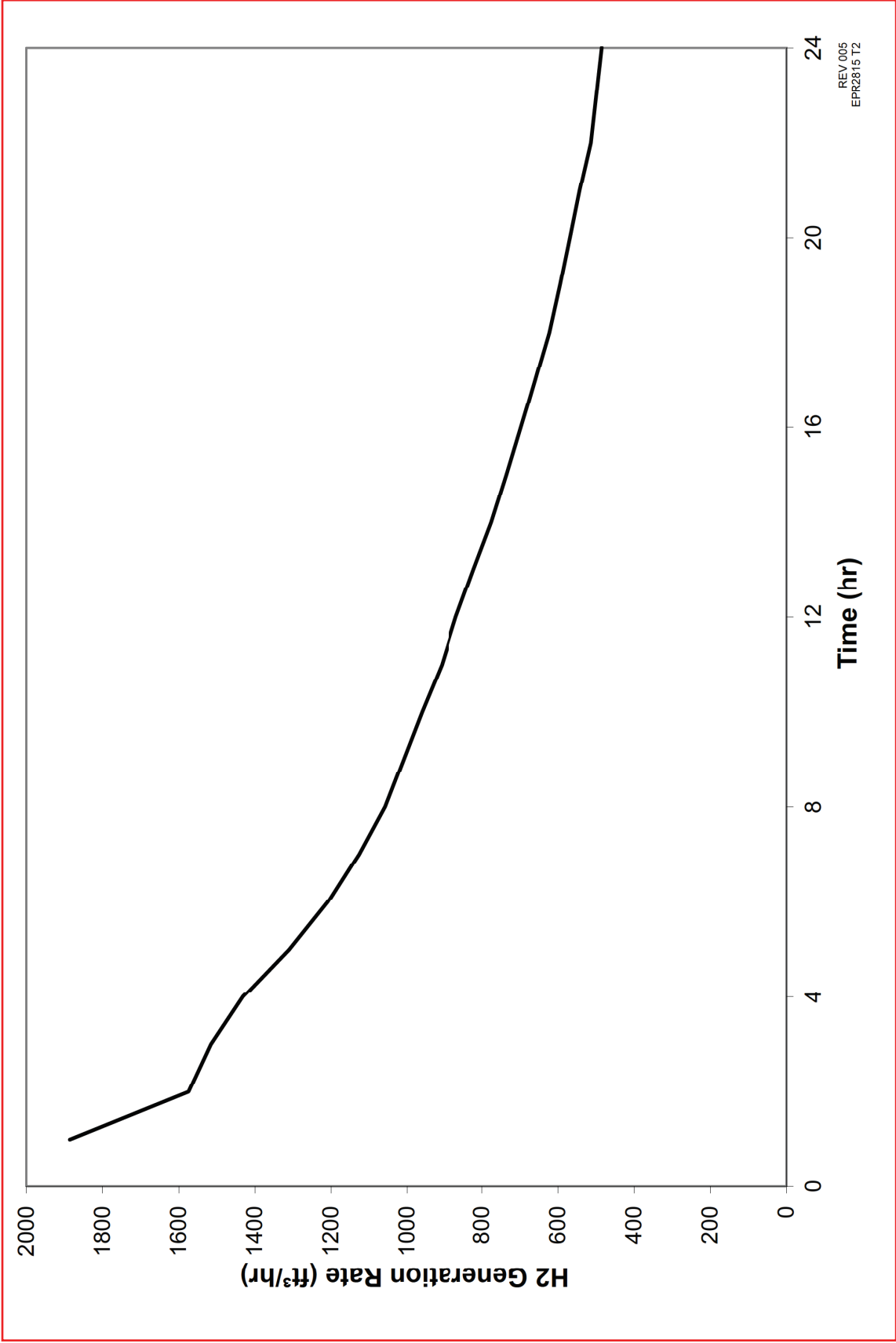




Figure 6.2.5-5—Assumed Hydrogen Generation Rate from Aluminum Sources

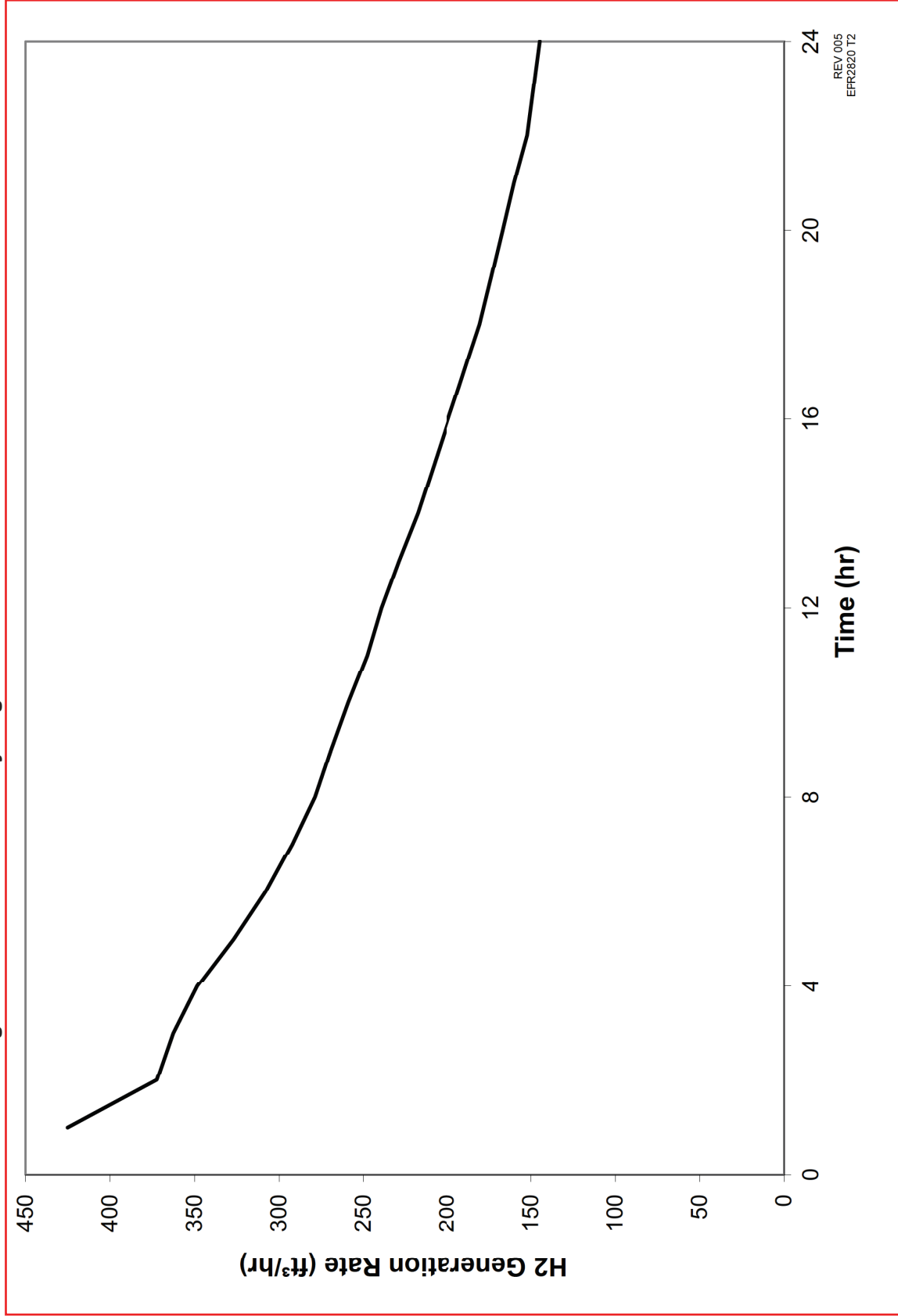




Figure 6.2.5-6—Integrated Production of Hydrogen from Zinc-Based Paint

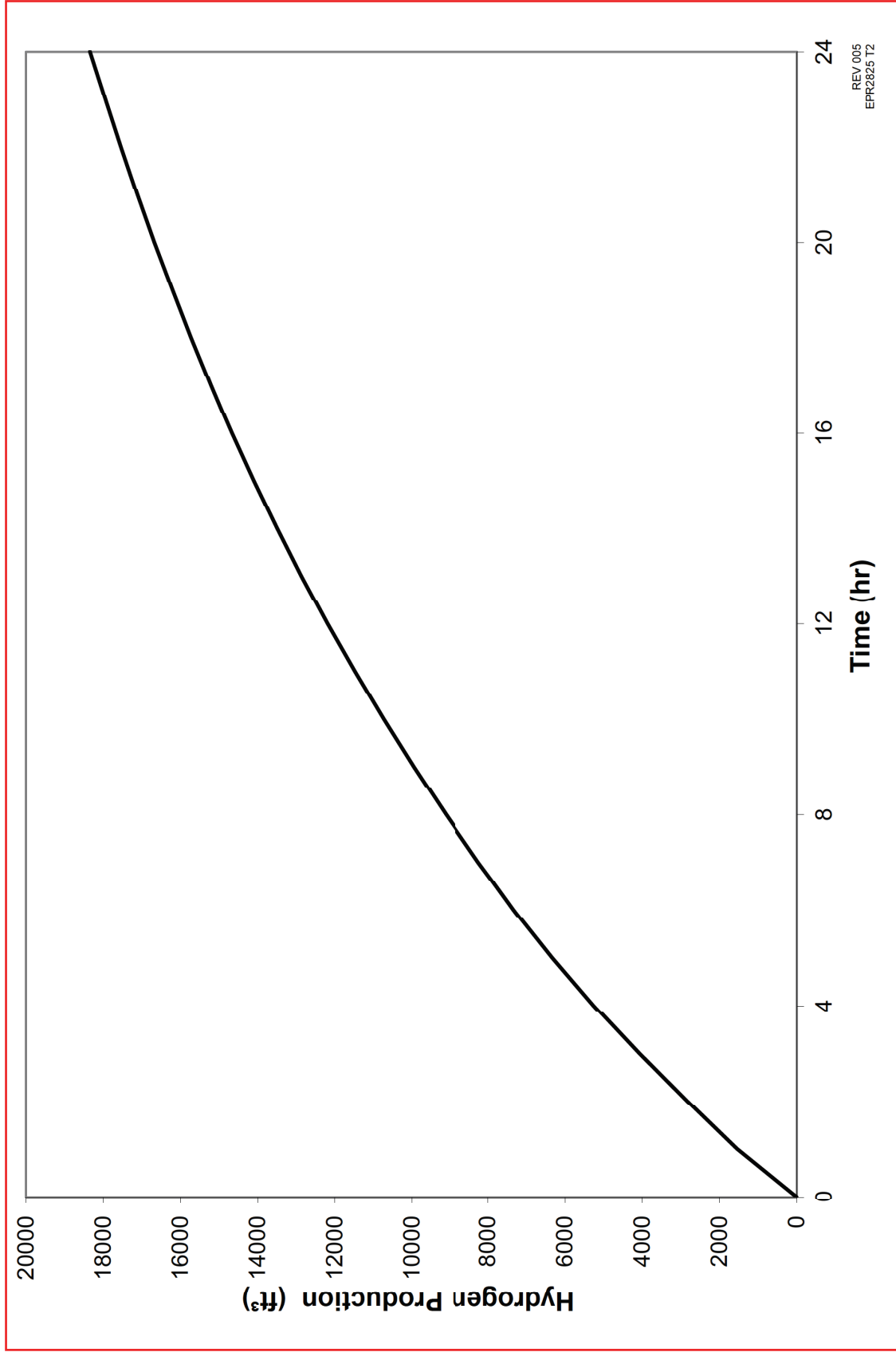




Figure 6.2.5-7—Integrated Production of Hydrogen from Galvanized Steel

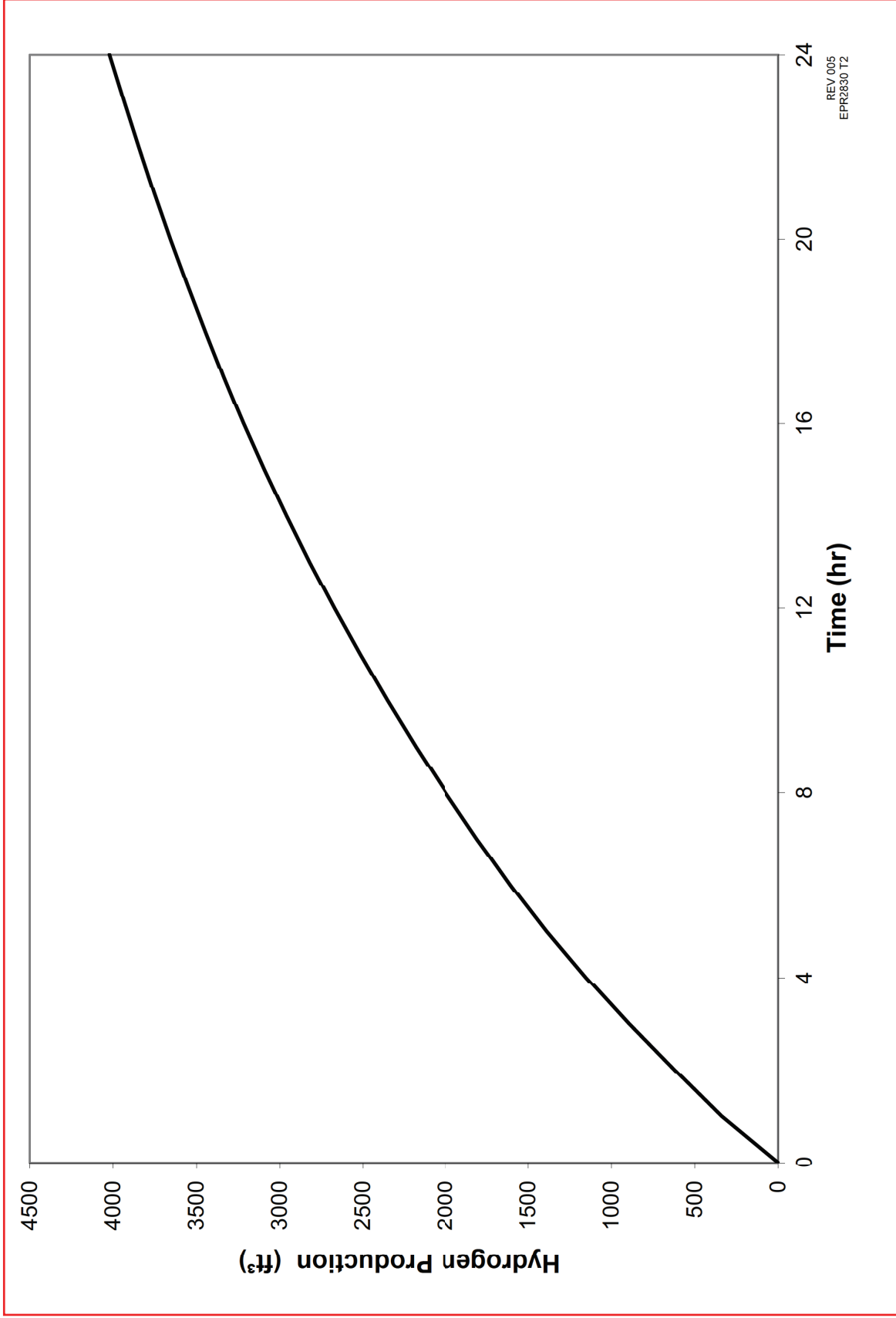




Figure 6.2.5-8—Integrated Production of Hydrogen from Aluminum

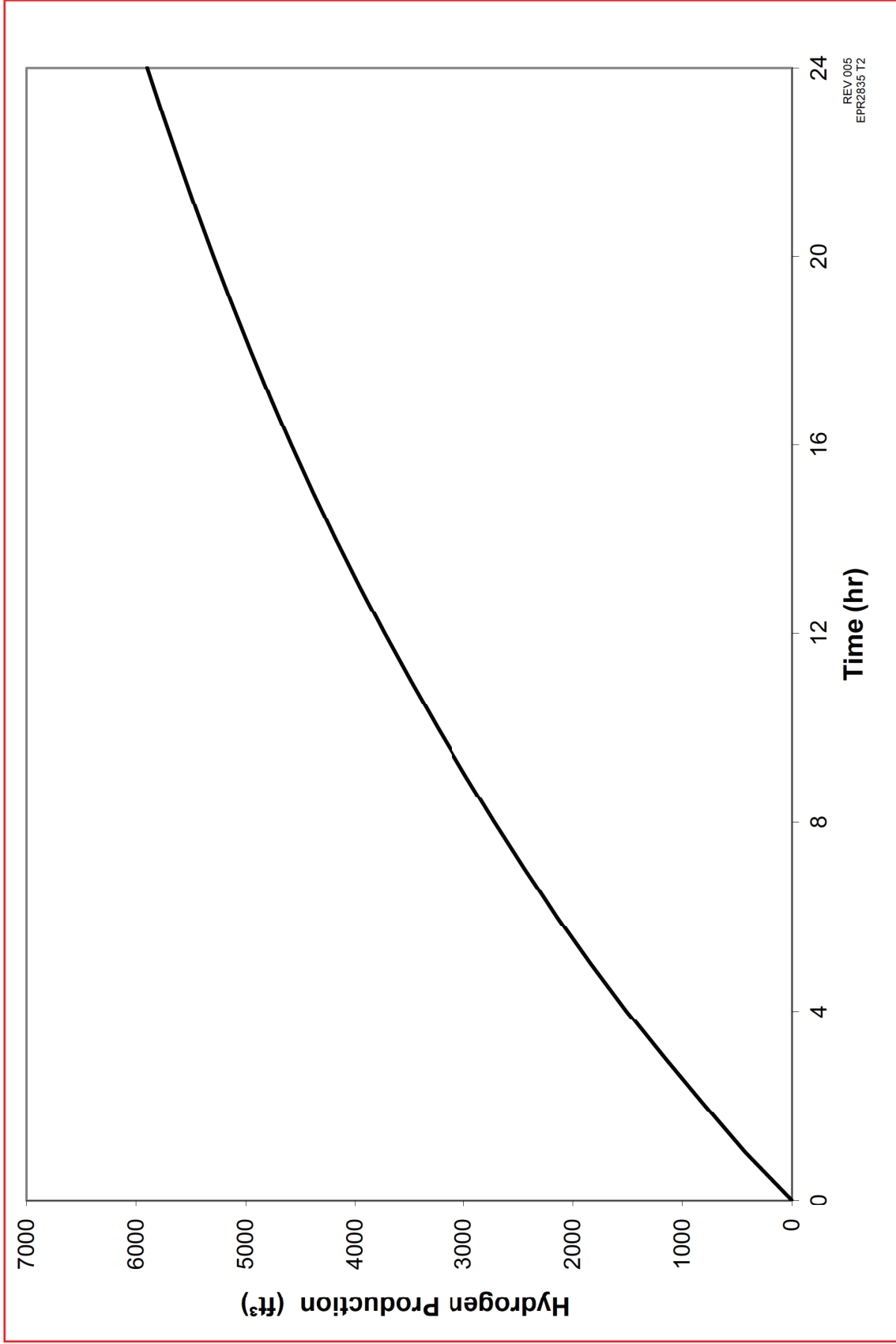




Figure 6.2.5-9—Concentration of Hydrogen in the Containment

