Post Accident AP1000 Containment Leakage

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On March 9, 1982, former NRC Commissioner Peter A. Bradford said,

“If a Secretary of Agriculture endorsed better meat inspection, you wouldn't have a debate of near religious fervor about whether that a person was pro- or anti-meat, whether he had sold out to the vegetarians. You'd debate whether the stricter regulations made sense. It's somehow unique to nuclear power that, when one refuses to have nuclear power on the industry's terms, one gets chucked into a bin labeled 'anti-nuclear’.”

Arnie Gundersen

- MP1 MSIV
- Montague LRT briefed NRC
- MP3 Containment structural analysis
- VY NPSH
- Millstone 3 ACRS letter
- Beaver Valley ACRS letter
- AP1000 ACRS Letter
- Sr. V.P. of ASME XI inspection business


Millstone 3

Industry Experience through 2008

Detection of Aging Nuclear Power Plant Structures

Naus& Graves 1970-1999

"…at least 66 separate occurrences of degradation in operating containments…"

"…over 32 reported occurrences of corrosion of steel containments or liners…"

"Two instances … where corrosion has completely penetrated the liner."

"… four additional cases where extensive corrosion of the liner reduced the thickness … by nearly one-half."

Industry Experience through 2008

USNRC Information Notice 2004-09

Eight additional episodes of containment system degradation.

Through-wall hole in the liner of D.C. Cook, 2001

Three through-wall holes in the liner of Brunswick, 1999

Sixty pits (below minimum design value) D.C. Cook, 1998

Hatch 1 & 2 – Two through-wall cracks in steel containment.

Industry Experience through 2008

Nuclear Safety **© 2007**

Dr. Gianni Petrangeli, University of Pisa

"The picture that emerges is not very reassuring…the probability of overcoming the specification values…is…46% for PWR's"

"…for plants now under construction and for future ones, the tendency is to restrict the important consequences of severe accidents…"

Petrangeli recommends "…systems with a double containment with filtering of effluents from the annulus between the containments."

Industry Experience through 2008

OIG -07-A-15

Page 21-23

"OIG's analysis of this corrective action program indicates that the coatings aging management program had not been implemented consistent with the statements in the Oconee license renewal application."

"…the staff did not offer any indication of having conducted an independent look at coatings operating experience."

This condition existed for 10-years.

Example of Coatings Degradation at Oconee

Photo from: OIG-07-A-15

Beaver Valley 1

Industry Experience 2009 - 2010

Beaver Valley Liner Failure, April 2009

Leading up to this failure Beaver Valley told the NRC the following:

LRA 3.5-47 "Loss of material due to corrosion is not significant for inaccessible areas…"

LRA B2.8 & B2.9 "Identification of deficiencies and subsequent corrective actions, along with engineering evaluation of inspection results, provide reasonable assurance that the program will be effective for managing loss of material."

LRA B2.9 "Conclusion: Continued implementation of the ASME Section XI… provides reasonable assurance that…structures…will continue to perform their intended functions."

Industry Experience 2009 - 2010

Beaver Valley Liner Failure, April 2009

Leading up to this failure the NRC said the following about Beaver Valley:

SER, January 2009

"The applicant's assurance of the use of…ASME Section XI…ensures that the applicant's IWE program will be consistent with GALL…the staff finds the applicant's exceptions acceptable." pg. 3-102 to 107

"The applicant further stated that these additional examination requirements…provide reasonable assurance that potential corrosion on the concrete side of the containment liner plate will be identified and addressed." pg.3-102 to 107

"The staff finds the applicants inspections…in accordance with ASME Section XI…to manage the loss of material due to general pitting and crevice corrosion are adequate because the aging effect has been effectively monitored. " pg.3-589

Industry Experience 2009 - 2010

MP3 Secondary Containment Inoperable for 16 Days

Power Reactor	Event Number: 45969
Facility: MILLSTONE Region: 1 State: CT Unit: [ ] [ ] [3] RX Type: [1] GE-3,[2] CE,[3] W-4-LP NRC Notified By: NORMAN KUZEL HQ OPS Officer: VINCE KLCO	Notification Date: 06/01/2010 Notification Time: 16:57 [ET] Event Date: 06/01/2010 Event Time: 15:50 [EDT] Last Update Date: 06/01/2010
Emergency Class: NON EMERGENCY 10 CFR Section: 50.72(b)(3)(v)(C) - POT UNCNTRL RAD REL	Person (Organization): GLENN DENTEL (R1DO)

POTENTIAL LOSS OF RADIATION RELEASE CONTROLS

"On May 27, 2010, during a control board walkdown, it was discovered that two sets of auxiliary building tunnel exhaust dampers were open at the same time. This configuration created a path way from the secondary containment to the outside. The condition was immediately corrected. Additional investigation determined that this condition existed since May 11, 2010, when Millstone 3 was in Mode 5.

"Technical Specification 3.6.6.2 'Secondary Containment' is applicable in Modes 1, 2, 3, and 4. The condition discovered on May 27, 2010, rendered Secondary Containment inoperable. Further evaluation since the discovery date concludes that the secondary containment structure was in a condition which could prevent the fulfillment of the safety function for controlling the release of radioactive material. [On June 1, at 1550 EDT the licensee determined that the event was potentially reportable].

Industry Experience 2009 - 2010

ACRS Transcript July 9th, 2009 p.88, lines 6-11

Emphasis added

"MEMBER RAY: At which point the condition of the concrete can't be taken credit for. So I guess I just think that ***the idea that the leakage is going to be small from a small hole, from a hole this size, as small as Dan says, in the design-basis conditions isn't logically supportable because the concrete, you can't -- you, yourself said, you can't take credit for the concrete and the reason is because it's condition in the design-basis event can't be predicted, can't be credited. The only thing you can credit is the membrane itself.***

MEMBER SHACK: From a deterministic basis, you're correct. From a probabilistic basis, which is what they use and can take credit based on –

MEMBER RAY: I don't think so.

MEMBER SHACK: Well, that's the way it is.

MEMBER RAY: That's not right."

Probability of primary/secondary containment breach

For the period between 6/09 to 7/10 there has been a primary containment breach at Beaver Valley and a secondary containment breach at Millstone 3. Fairewinds calculates the approximate probability of a complete containment breach as follows:

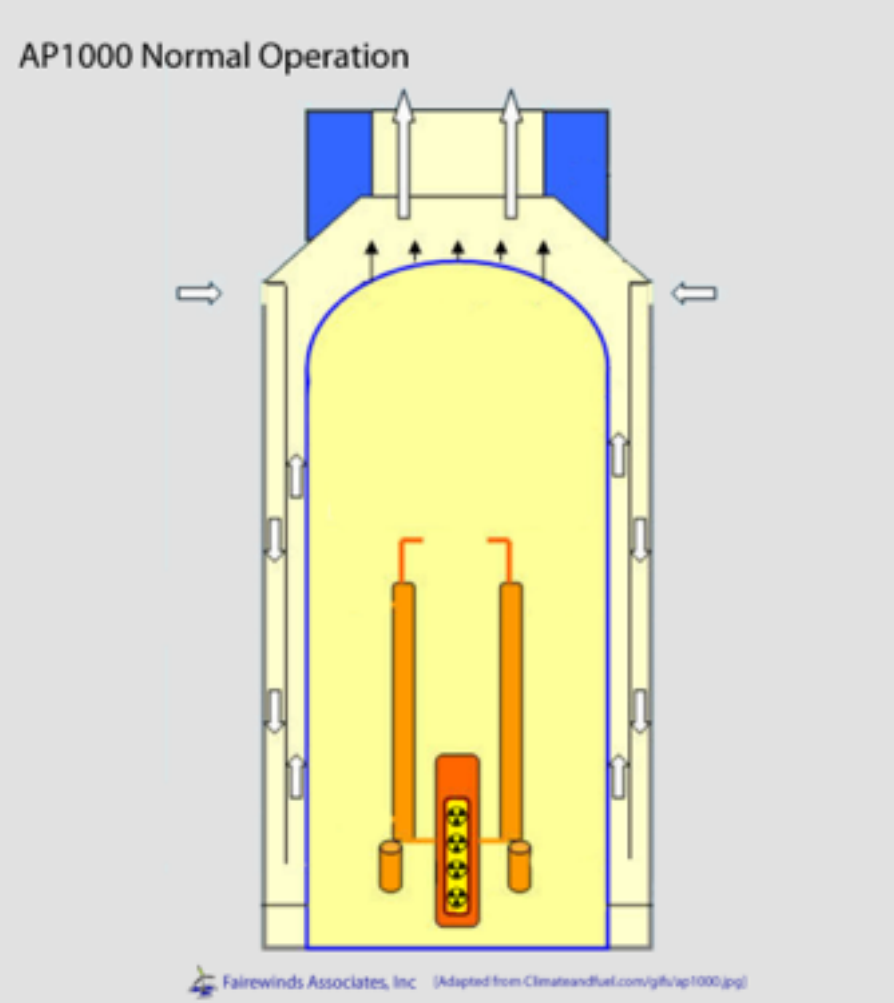
The BV primary containment hole existed for at least a year. The probability of primary containment failing would be 1% per year based on 100 reactors.

The MP3 breach lasted for two weeks. Therefore the probability of a secondary containment breach .035% of the time (2 weeks/56 weeks * 100 reactors).

The overall probability of the failure of both primary and secondary containment would therefore be .00035% or 1 in 285,000.

This is a significantly large probability that shows that the SAMBDA approach used by the AP1000 is not conservative.

AP1000 Containment



AP1000 Containment

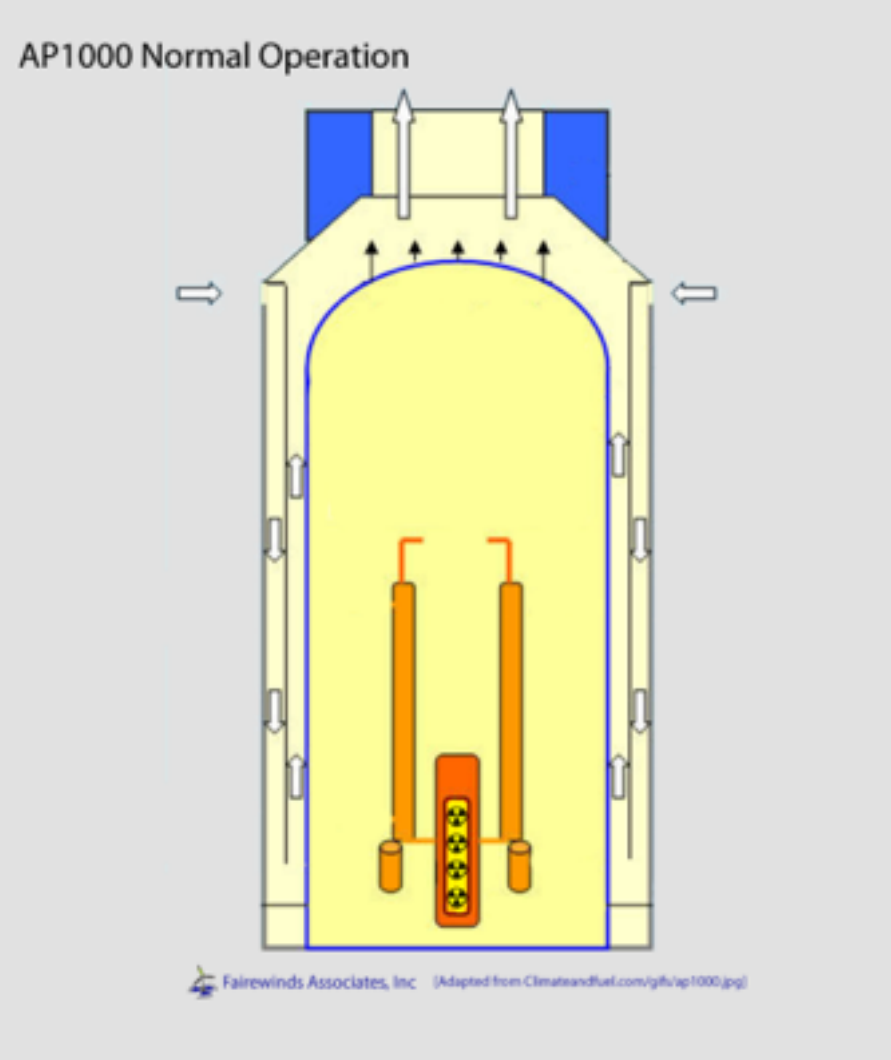
During the AP1000 review, the staff expressed concerns about corrosive attack on the AP1000 containment. In response to concerns from the NRC in 2003, Westinghouse made the containment 1/8th inch thicker and added a nuclear-grade protective coating. The AP1000 has access ports to allow for visual examination of some portions of the outside of the containment.

In the 2003 AP1000 SER the NRC stated:

"The staff noted there was no margin in the nominal design thickness for corrosion allowance."

"The COL applicant will provide a program to monitor the coatings."

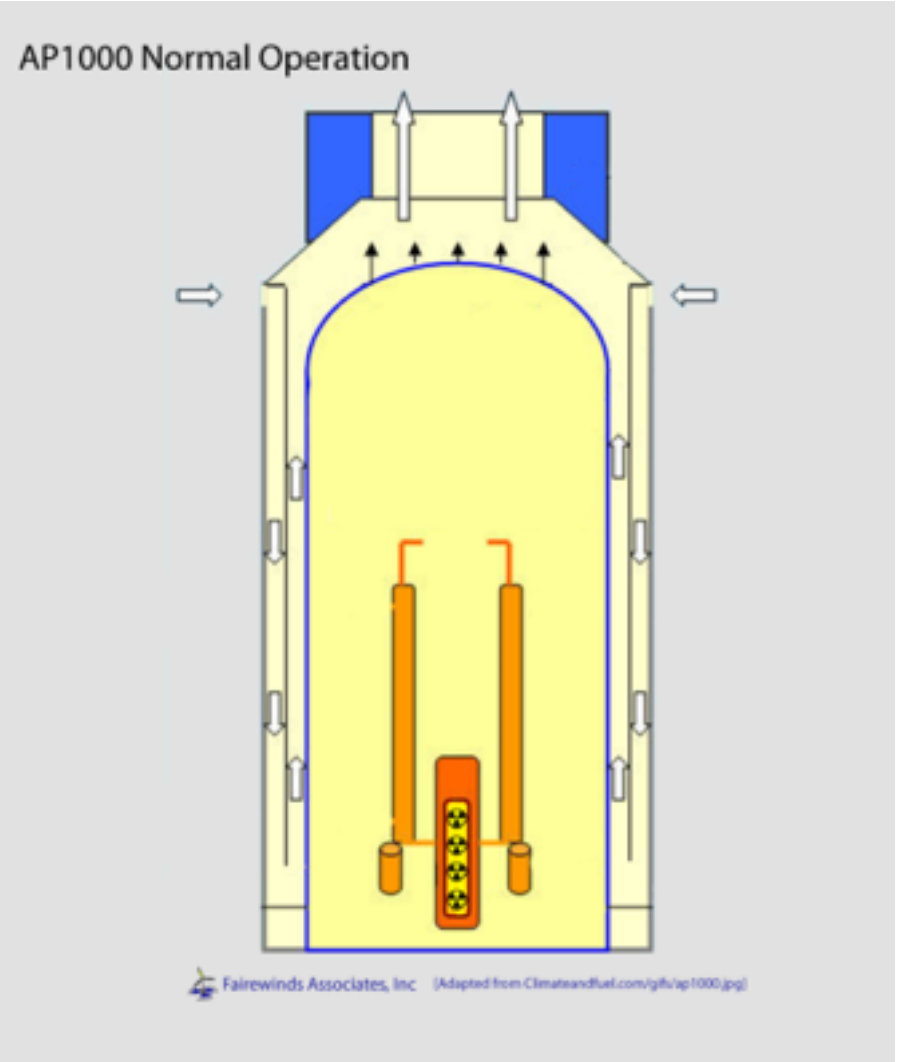
"On the basis that enough corrosion allowance and proper corrosion protection were provided, the staff found the applicant's response acceptable..."



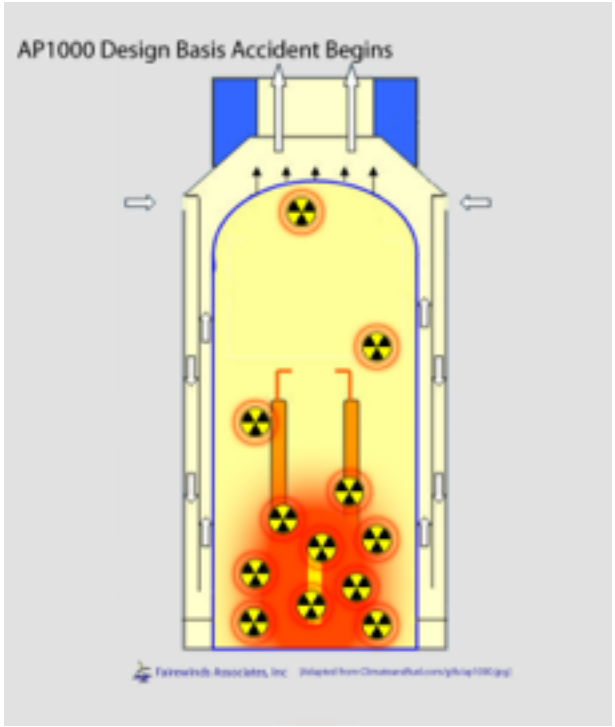
AP1000 Containment

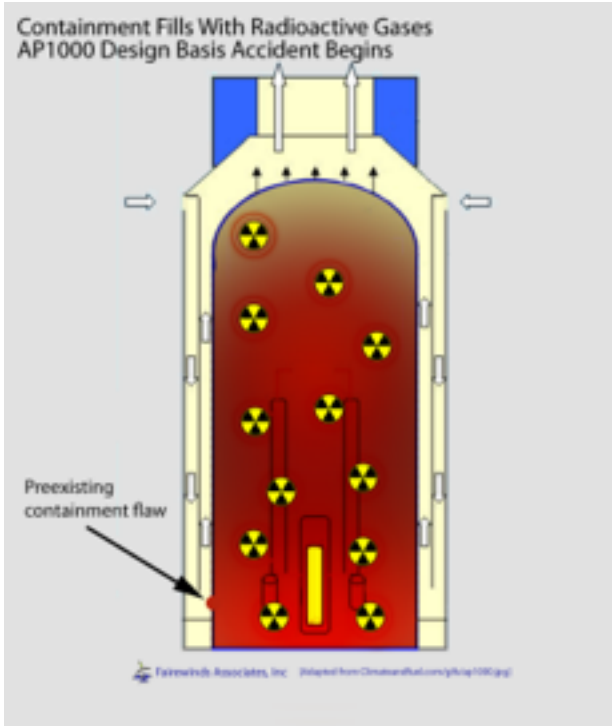
Fairewinds and Hausler have the following concerns with the NRC's analysis:

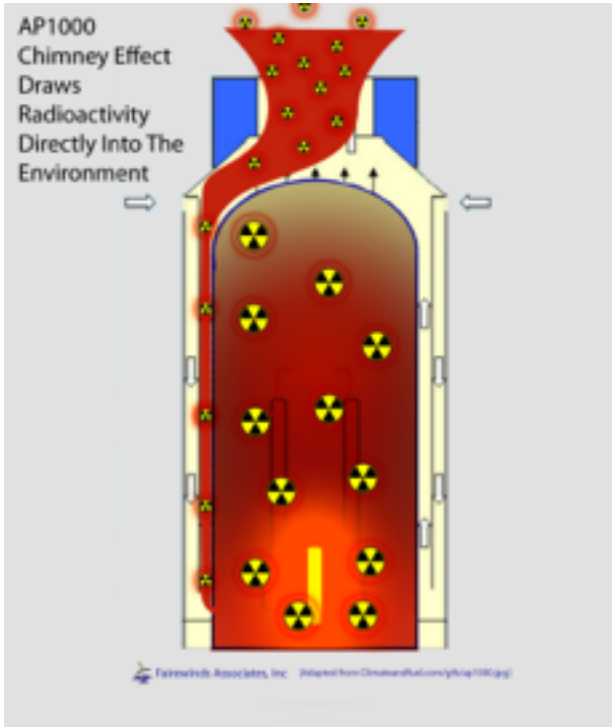
- ASME XI inspection programs have historically missed flaws in the containment.
- Application of protective coatings has historically allowed for coating degradation.
- Wall-brackets on the outside of the AP1000 containment create crevices that allow for moisture build-up and creates a corrosive environment.
- The junction between the wall and the floor creates a crevice that allows for moisture build-up and creates a corrosive environment.
- The shield building breathes in moist outside air containing contaminants that can be deposited in crevices and cause corrosion.
- Hausler estimates corrosion rates as fast as 0.15 inches per year.



Proposed Accident Sequence







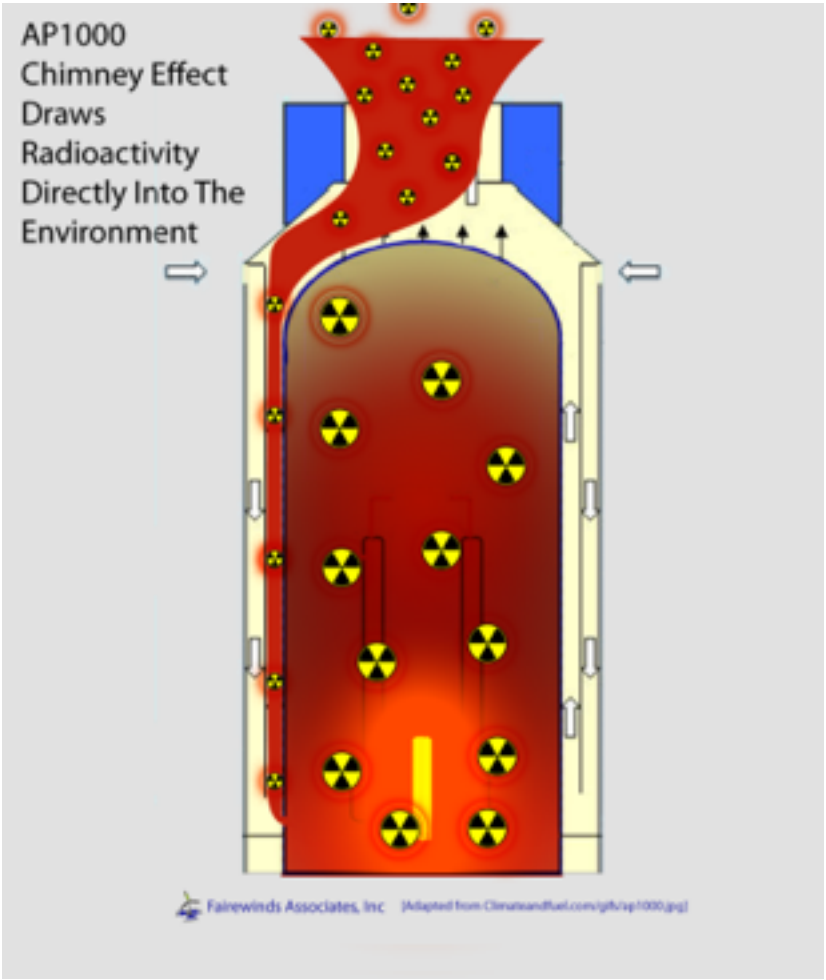
SAMDA or Design-Basis Event?

Westinghouse considers an Intact Containment "… to be within the design basis of the containment… "

"This is the 'no-failure' containment failure mode and it's termed intact containment. The main location for fission/product leakage from the containment is penetration leakage into the auxiliary building…"

For its SAMDA analysis, Westinghouse assumes a late containment failure (CLF), a failure of the containment to isolate (CI), and bypass through an open piping system (BP).

For the CLF, CI, and BP scenarios, Westinghouse assumes that containment leakage is into other filtered areas of the plant and is not released directly into the environment.

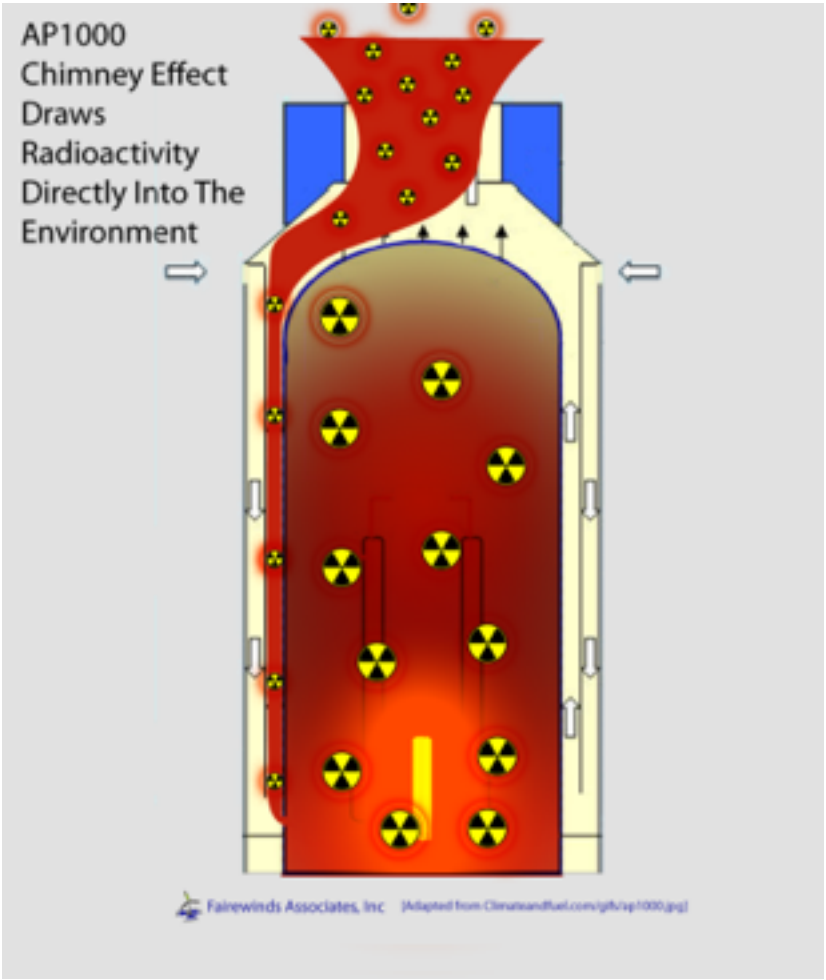


SAMDA or Design-Basis Event?

Both Westinghouse and the NRC assume that ASME XI inspections and protective coatings applied to the outside of the AP1000 containment will reduce the risk of a pinhole leak to **ZERO**.

Fairewinds analysis of 40-years of problems associated with the integrity of containment shows there is a relatively high probability of a pinhole leak in the AP1000 containment.

Should this pinhole leak exist, post accident pressures of 50-psi inside the containment will push radioactive gases into the annular gap causing off-site doses to exceed 10 CFR 100 allowable exposure levels.

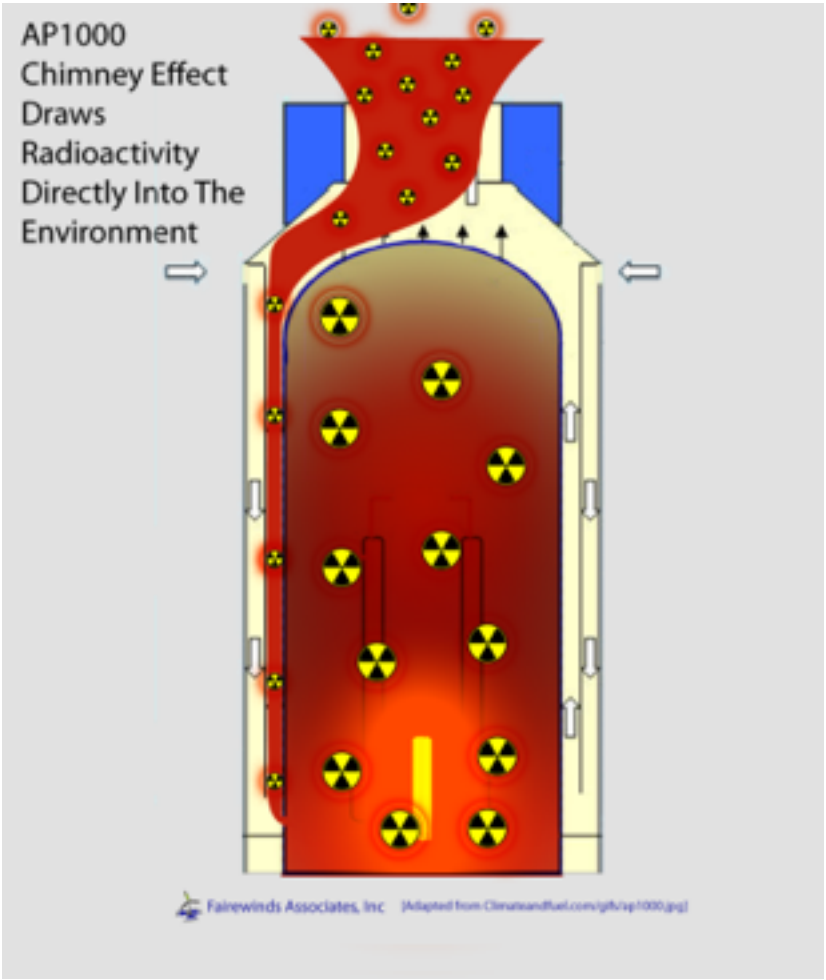


Filtered Ventilation

Westinghouse has already analyzed and then discarded the option of filtered ventilation.

"Secondary Containment Filtered Ventilation… The passive filter system is operated by drawing a partial vacuum on the middle annulus through charcoal and HEPA filters…the secondary containment would then reduce fission product release from any containment penetration."

Even this proposed option does not completely eliminate Fairewinds' concerns as leakage into the annular gap through a pinhole leak in the containment wall might not be captured.



Conclusion

Given the history of containment failures, it is reasonable to assume that a pinhole in the AP1000 containment would be undetected and present at the initiation of a LOCA.

AP1000 SAMDA analysis does not assume a containment breach concurrent with the initiating LOCA.

The AP1000 SAMDA analysis rejected the possibility of filtering some leakage.