December 3, 2001

MEMORANDUM TO: Ashok C. Thadani, Director
Office of Nuclear Regulatory Research

FROM: Samuel J. Collins, Director **/RA/**
Office of Nuclear Reactor Regulation

SUBJECT: PROPOSED GENERIC SAFETY ISSUE RELATED TO SECONDARY CONTAINMENT DRAWDOWN TIME

NRR requests that RES prioritize and study three concerns as a generic safety issue.

In March 2001 an individual contacted an NRR staff member concerning the adequacy of the calculations, testing, and acceptance criteria related to the creation of a vacuum in the reactor building of a boiling water reactor (BWR) facility following an engineered safeguards actuation signal. The time required to attain a vacuum in the reactor building is commonly referred to as the “drawdown time.” The vacuum is necessary to ensure that any air leakage flows *into* the building so that any radiological contamination in the building air is processed by the appropriate safety systems before being released to the environment. Guidelines for including the drawdown time in offsite and control room dose calculations are specified in Branch Technical Position CSB 6-3, which was published as an attachment to Section 6.2.3, “Secondary Containment Functional Design,” of the NRC’s Standard Review Plan (NUREG-0800, dated July 1981).

The individual initially asked only for technical information regarding the basis for the drawdown time criterion and how the drawdown time is determined. The individual then questioned the technical adequacy of the methods that some licensees use to calculate the drawdown time. The individual later provided the NRR staff member with calculation results showing that, using an analytical model that the individual considered to be technically justified, plants could potentially exceed the limits for offsite and control room doses. NRR decided that the individual’s concerns could be resolved by making the issue a Generic Safety Issue (GSI). The appropriate RES staff has agreed to this approach. Subsequently, NRR provided the available background information to your staff (see the attachment to this memorandum). The issue consists of three concerns:

Contact: R. Lobel, SPLB/DSSA/NRR
301-415-2865

CONCERN 1: Calculations for reactor facilities (primarily Brunswick, Cooper, and BWR4 plants and earlier) are performed using a single volume to represent the secondary containment. This doesn't account for the compartmentalization of the building and different heat sources in different compartments. Some compartments, perhaps compartments with sources of radioactivity, may not depressurize as fast as others and may be potential leakage paths.

CONCERN 2: Reactor facilities (primarily Brunswick, Cooper, and BWR4 plants and earlier) measure the vacuum in only one location in the secondary containment. This location may not be in the most conservative location (the last area to reach the desired vacuum).

CONCERN 3: The criterion used, 0.25 in-water vacuum, only accounts for pressure distribution around the building due to wind. It does not account for the difference in inside temperature during a cold test and during a loss-of-coolant accident.

NRR has examined this issue and talked on several occasions with the individual who raised the issue. We have examined Updated Safety Analysis Reports for several plants, discussed the issue with several licensees and resident inspectors. Based on this preliminary work, we believe the issue has merit and should be examined more closely.

Attachment: As stated

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DISTRIBUTION: SPLB r/f JHannon GHubbard GHolahan
BSheron SCollins

* See previous concurrences

DOCUMENT NAME: SEC CONTAINMENT DRAWDOWN GENERIC ISSUE.WPD

OFFICE	SPLB:DSSA:NRR	SC:SPLB:DSSA	TECH ED	BC:SPLB:DSSA	D:DSSA
NAME	RLobel:bw*	GHubbard*	PPuccio*	JHannon*	GHolahan*
DATE	9/28/01	9/28/01	09/26/01	9/28/01	10/02/01
OFFICE	ADPT:NRR	D:NRR			
NAME	BSheron*	SCollins			
DATE	11/21/01	12/03/01	/ /01	/ /01	/ /01

ATTACHMENT

From:
To: "Richard M. Lobel" <rml@nrc.gov>
Date: 3/5/01 3:12PM
Subject: Secondary Containment Drawdown

I wanted to follow up briefly on our discussion from last week regarding positive pressure period and secondary containment drawdown after a LOCA. The attached WORD file is a brief summary of two potential considerations relating to dual containment plants. With the high number of Alternative Source Term (AST) submittals being made, I believe that the NRC group responsible for reviewing the positive pressure period/drawdown portions of the AST submittals (as discussed in Appendix A to Regulatory 1.183) should probably be aware of the two considerations. I'm sure that you have much broader knowledge regarding how the general population of BWRs have performed their Standby Gas System Reactor or Auxiliary building drawdown analyses. I am aware that at least some of the Mark III, BWR-6 designs include SGTS suction points in multiple locations (i.e., at multiple elevations and in multiple compartments/rooms) which would at least appear on the surface to consider the issue of building compartmentalization.

Please let me know if you have any questions or comments. Since GOTHIC has proven capability for modeling subatmospheric pressure conditions, we are currently running GOTHIC models to assess the impact of compartmentalization on post-LOCA building drawdown (i.e., transient pressure results).

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Attachment to above e-mail:

<u>Potential Considerations Relating to Standby Gas Drawdown of Reactor and Auxiliary Buildings</u>

With many plants implementing Alternative Source Terms, the positive pressure period during which unfiltered leakage occurs from (secondary) containment has been re-visited. Many of the past analyses were performed either by hand calculations or with older/less sophisticated computer programs. In some cases, a single volume was used to represent the entire Reactor or Auxiliary Building and all of the contained compartments or rooms. With the advent of more realistic computer models such as GOTHIC, the following two items have been identified as having the potential to cause prior analyses to be non-conservative with respect to certain compartments or rooms.

1. Consideration of compartments

In many Standby Gas System designs, suction is taken from a single point or single elevation of a building. The flow losses between compartments with the potential for direct leakage to the environment and the Standby Gas suction point have often not been considered when performing drawdown or positive pressure analyses. This issue is compounded by the fact that in many situations the tests performed to verify either steady-state or transient pressure conditions in the (Reactor or Auxiliary) building with the Standby Gas System operating only include pressure measurements for a limited number of locations (perhaps just a single elevation).

The potential exists for certain compartments/rooms in the Reactor or Auxiliary Building to either not achieve the appropriate negative pressure or to have a longer than predicted positive pressure period. When a single or lumped volume is used to represent the entire Reactor or Auxiliary Building, the pressure difference between remote compartments or rooms and the Standby Gas suction point is generally not accounted for.

Certain plant designs include multiple suction points for Standby Gas with ductwork connecting the Standby Gas System to multiple elevations/locations. The issue may not apply to these designs.

2. Consideration of heat load locations

While some plants consider the post-LOCA heat loads (piping, equipment, lighting, panels, conduction from adjacent containment walls, etc.) in the Reactor or Auxiliary Building for Standby Gas System drawdown analyses, the heat loads are sometimes considered independent of location (i.e., as a single heat load in a single building versus individual heat loads in individual compartments). As is the situation in Item 1, the potential exists (particularly for transient positive pressure period evaluations) for certain compartments or rooms to either not achieve the appropriate negative pressure or to not achieve the appropriate negative pressure in the appropriate time period. This situation is due to increased pressure in certain compartments or rooms due to expansion of the gas in the compartment or room as a result of the heat loads in the compartment or room.

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From:
To: "Richard M. Lobel" <rml@nrc.gov>
Date: 3/12/01 11:12AM
Subject: Re: Secondary Containment Drawdown

I wanted to provide some additional information on the effects of compartments and post-LOCA heat loads on secondary containment drawdown. We have been studying the effects with GOTHIC for a BWR-4 with a single SGTS suction point (i.e., SGTS takes suction from a single elevation of the building and not from multiple elevations or compartments). One of the more significant results relates to required test acceptance criteria. For the case of interest, the following general parameters apply:

Total Reactor Building Volume (with all compartments) = approx 2.9e6 cu.ft. Net Heat Load in Building for the first hour = approx. 4e5 Btu (this is the total net heat load to the building which includes conduction in and out through walls, equipment heat, piping heat, panel heat, HVAC/coolers, etc.) SGTS starts and is at full flow at 23 seconds.
Outside conditions were varied, but the general effect of the compartments and heat loads is the same regardless of outside temperature, humidity or wind speed.

Two results from this case are discussed. The two results are based on the same input, except that the inleakage "A over root K" was varied to affect the timing of the drawdown. The inleakage was all assumed to occur in the worst location/compartment based on sensitivities; however, locating the inleakage in best-estimate locations/compartments still produced a similar effect (i.e., only slightly better results were obtained). It was discovered that the worst location in the building (the upper elevation) could be drawn down to -0.25" WG in 10 minutes after a LOCA with an inleakage "A over root K" of 86.4 sq. in. However, the acceptance criteria for a cold test (without post-LOCA heat loads) with this inleakage would be -1.5" WG at 3000 scfm SGTS flow. If the acceptable time for drawdown was increased to 36 minutes after a LOCA, then the inleakage "A over root K" equaled approximately 173 sq. in. The 36 minute post-LOCA drawdown would require a more reasonable cold test acceptance criteria value of -.39" WG at 3000 scfm.

These results are preliminary (i.e., unreviewed although a review is currently being completed). I wanted to transmit them to you as soon as possible, so you could see the combined effect of the compartmentalization and the post-LOCA heat loads. The most significant issue is not whether we can set up a model to give "acceptable" post-LOCA secondary containment drawdown values (we can certainly reduce the inleakage "A over root K" to obtain almost any drawdown time), but whether a plant can pass a cold test (without the post-LOCA heat loads) corresponding to the required inleakage "A over root K" that goes with that "acceptable" post-LOCA result.

We're not sure of the acceptance criteria that most plants are currently using for tests, but we do know that some plants test very close to or equal to the post-LOCA required value of -0.25" WG. Based on our preliminary results, this criteria may not be conservative.

With the implementation of Alternative Source Term, much of the conservative margin previously afforded by TID source terms is no longer there. This may make the positive pressure period before drawdown more significant for AST submittals.

Please do not hesitate to contact me with any questions that you have.

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From:
To: "Richard M. Lobel" <rml@nrc.gov>
Date: 3/27/01 7:43PM
Subject: Secondary Containment Drawdown/Positive Pressure Period

I wanted to let you know that the previously transmitted data regarding the subject topics (via e-mail dated 3-12-01) has been reviewed. None of the transmitted results changed significantly based on review comments. We are continuing with other studies and sensitivities related to drawdown and positive pressure period.

How is your review of the topic progressing?

I may have already mentioned it, but I noticed the Duane Arnold AST submittal (dated October 19, 2000 Accession Number ML0037623960) assumed a positive pressure period of

5 minutes (on page 2-11 of Attachment 4). Do you know if a calculation was completed to demonstrate how this time was derived? If the NRC has reviewed the calculation, we'd be interested in how the following items were addressed:

1. the compartmentalization of the secondary containment and associated pressure drops between compartments,

2. the post-LOCA heat loads, including effects of location of the heat loads in certain compartments, and

3. the negative pressure value used for testing (under "cold" [i.e., without post-LOCA heat loads] conditions).

We keep thinking that these issues must have been addressed in some fashion, but our calculation results show otherwise. Based on the SRP discussion in section 6.2.3, the -0.25" WG was intended to address wind and instrument uncertainties and not post-LOCA conditions. That is reasonable since depending on the building shape and location, a wind speed of approximately 25 to 35 mph can produce a -0.25" WG pressure outside the building.

Please do not hesitate to contact me with any questions you may have.

As we complete further studies, I will forward you our results.

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From:	
To:	"Richard M. Lobel" <rml@nrc.gov>
Date:	4/9/01 3:59PM
Subject:	Dose Consequences of Longer Positive Pressure Periods

You had mentioned that you might need additional information regarding the dose impact of extending the positive pressure period (i.e., the time to draw down the secondary containment to -.25" WG) in association with proper consideration of post-LOCA heat loads and secondary containment compartmentalization.

The October 19, 2000 Duane Arnold submittal (Accession number ML0037623960) shows the importance of positive pressure period with respect to dose on page 3-14 of Attachment 4. Note 1 to the table on page 3-14 of Attachment 4 states in the second sentence, "For CR LOCA dose calculations, the primary containment release during the PPP is dominant." The calculated Control Room dose equals 4.152 rem TEDE over 30 days. The regulatory limit is 5 rem TEDE over 30 days. Of the 4.152 rem, 2.303 rem is from primary containment leakage which is dominated by leakage during the positive pressure period.

The reasons behind the significant dose effect of the duration of the positive pressure period are twofold. The atmospheric dispersion factors (i.e., X/Q) for a ground level release are significantly higher than those for an elevated (e.g., stack) release. During the positive pressure period, a ground level release must be assumed per RG 1.183. For a ground level release from secondary containment, there is significantly less dispersion before reaching the Control Room intake than there is for an elevated (e.g., stack) release. Attachment 4 of the

Duane Arnold submittal (pages 3-7 through 3-9) shows an increase in the X/Q values for the Control Room during the first two hours by more than 30,000 (1.33E-2/3.93E-7). The second reason for the significant dose impact of extending the positive pressure period is, of course, the fact that the leakage during the positive pressure period is unfiltered (versus being processed by the Standby Gas System).

We will also provide sample Control Room Dose results for a BWR-4, Mark I configuration with a 5, 10 and 30 minute positive pressure period to give you a better idea of the approximate dose impacts of extending the positive pressure period through proper consideration of post-LOCA heat loads and compartmentalization. As we discussed, once an appropriate post-LOCA analysis of secondary containment is completed, setting up "cold" test conditions that are consistent with the post-LOCA analysis is an additional area of concern.

Please do not hesitate to contact me with any questions.

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From:
To: "Richard M. Lobel" <rml@nrc.gov>
Date: 4/10/01 1:08PM
Subject: Sensitivity of Control Room Dose to PPP

We completed a quick sensitivity study of a BWR-4, Mark I with respect to positive pressure period effects on dose. The study was completed with **NAME OF COMPUTER PROGRAM** and somewhat generic inputs. I have attached a Microsoft PowerPoint file showing the general noding, as well as a Microsoft Word file describing the flow paths.

We ran three cases focusing on just the primary containment leakage dose component. The three cases used a positive pressure period of 5 minutes, 10 minutes and 30 minutes. The dose results are as follows:

Control Room (Limit 5 rem TEDE)

5 minute PPP - 2.28 rem TEDE
10 minute PPP - 2.93 rem TEDE (28.5% increase)
30 minute PPP - 10.8 rem TEDE (473.6% increase)

EAB (Limit 25 rem TEDE)

5 minute PPP - 0.1 rem TEDE
10 minute PPP - 0.6 rem TEDE
30 minute PPP - 6.6 rem TEDE

LPZ (Limit 25 rem TEDE)

5 minute PPP - 0.3 rem TEDE
10 minute PPP - 0.4 rem TEDE
30 minute PPP - 1.9 rem TEDE

The primary containment leakage dose component is only one of several dose components. For the previously referenced Duane Arnold submittal (Accession number ML0037623960), the primary containment leakage component made up over 55% of the total Control Room Dose (2.303 rem/4.152 rem, see page 3-14 of Attachment 4 of the submittal).

Note that prior sensitivity studies indicate that current draw down times may be increased to over 30 minutes, when post-LOCA heat loads and compartmentalization are properly considered.

Please do not hesitate to contact me with any questions.

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This excerpt from a file sent by the individual identifies the leakage paths used in the individual's analysis.

Pathways

1 Drywell/Primary Containment leakage to Reactor Building after PPP

2 SGTS filtered exhaust to environment

3 (deleted)

4 unfiltered flow into Control Room

5 Control Room exhaust to environment

6 Drywell/Primary Containment leakage to environment during PPP

7 bypass around SGTS filter (after PPP)

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From:
To: Richard Lobel <RML@nrc.gov>
Date: 5/30/01 5:05PM
Subject: Re: Secondary Containment Drawdown

Thank you for the update.

Does this decision have the potential to impact the health and safety of the public based on assumptions in current BWR dose analyses and based on plants such as Duane Arnold (and **ANOTHER PLANT** soon to follow) making Alternative Source Term submittals that "assume" 5 minute positive pressure periods without sound bases? It would seem to be clear that utilizing existing calculations or performing drawdown tests without proper consideration of compartmentalized post-LOCA heat loads and leakage locations would not provide a conservative licensing basis for drawdown/positive pressure period.

It would also seem that approval of any BWR AST submittals without a thorough understanding of the drawdown issue would allow utilities to implement AST (and associated relaxations) with a strong potential to have to stop implementation when the study is complete (or at least complete extensive modifications to make the original positive pressure period assumption/calculation valid).

I'm certainly not familiar with the normal NRC process for presenting an issue to the industry, but it would seem that the utilities should at least be notified as soon as possible that the NRC is studying the issue. The utilities could then consider the heat loads and leakage paths in their analyses if they chose to consider them. A utility might then present an accurate drawdown analysis as part of a submittal and assist the NRC in addressing the potential issue.

I apologize if I seem dismayed. It seems that addressing the drawdown issue after SERs are issued for BWR AST submittals would cost the industry significantly more than addressing the issue beforehand.

Should a Part 21 be written against the Standard Technical Specifications (such as NUREG-1433 General Electric Plants BWR/4)? Section 3.6.4.3 and the associated bases of NUREG-1433 do not specifically address post-LOCA heat loads, temperatures or pressures. That would appear to make the Standard Technical Specifications deficient. The Standard Technical Specifications appear to be a key contributing factor to the problem.

Thank you in advance for any feedback that you may provide.