

11/6/87 (Long)
BNL. APP

MEMORANDUM FOR: Vincent A. Noonan, Project Director
Project Directorate #5, DPLA

FROM: Victor Benaroya, Chief
Facilities Operations Branch, DPLA

SUBJECT: COMMENTS PERTINENT TO BNL REPORT "TECHNICAL EVALUATION OF
THE EPZ SENSITIVITY STUDY FOR SEABROOK," DRAFT TECHNICAL
REPORT A-3852, DECEMBER 5, 1986

The subject BNL report is a preliminary draft report which was hastily prepared so that information could be made available quickly.

The BNL report is particularly weak in failing to provide specific findings and recommendations in those areas where BNL has focused. We consider BNL to be familiar with the Seabrook risk assessment reports and with a number of other PRAs. BNL should be able to provide conclusions regarding the reasonableness of the Seabrook PRA(s) in contrast to those for other nuclear power plants. The report is difficult to read, especially to a reader who does not possess intimate knowledge of the Seabrook PRA and related reports.

Enclosed is information pertinent to our review.

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ENCLOSURE

DETAIL REVIEW COMMENTS PERTINENT TO
"TECHNICAL EVALUATION OF THE EPZ SENSITIVITY STUDY FOR SEABROOK,"
DRAFT TECHNICAL REPORT A-3852,
BROOKHAVEN NATIONAL LABORATORY, DECEMBER 5, 1986.

SUMMARY

The BNL report is a preliminary draft report, prepared so that information could be made available quickly. Its quality and completeness clearly reflect this status, and significant work is necessary to improve both its accuracy and overall quality. We have conducted a detailed review to assist in this task.

The report is particularly weak in:

1. The summary. This should:

- a. Be complete and clearly reflect the findings
- b. Provide comparisons (with appropriate uncertainties) to such items as the NRC safety goal
- c. Contrast BNL findings to the licensee's determinations.

Containment response, for example, isn't discussed in the summary; yet containment response is key to the licensee's claims.

2. The qualifications. BNL places too much emphasis on what they have not done. This gives the impression that BNL won't commit to quantitative conclusions. For example, considerable effort is devoted to the lack of complete review of the front end of the Seabrook PRA.

We need specific findings and recommendations in those areas where BNL has focused. Where quantitative information has not been developed,

expert opinions are sought. BNL is familiar with the Seabrook risk assessment reports and BNL is intimately familiar with a number of other PRAs. BNL should be able to provide conclusions regarding the reasonableness of the Seabrook PRA(s) in contrast to those for other nuclear power plants. BNL should also be able to provide specific conclusions regarding the Seabrook PRA(s).

3. Readability. This report is difficult to read, especially to a reader who does not possess intimate knowledge of the Seabrook PRA and related reports. Many readers are not experts in PRA technology. Major difficulties are:
 - a. Jargon. Considerable undefined jargon is used. Many items are specific to Seabrook (plant damage states for example), and others are specific to other PRA related documents (accident categories such as PWR1). Unnecessary jargon should be eliminated and what remains needs to be fully defined. A glossary in the front of the report is necessary. A brief appendix, introduced early in the report, which discusses items such as plant damage states and other concepts, would be helpful. An alternate would be to provide footnotes which introduce these concepts.
 - b. Decisiveness. Clear conclusions are seldom provided. Many sections contain a discussion of the topic, without further explanations or conclusions. Where feasible, conclusions should be provided. Where quantitative information is not practical at this time, reasonable judgements should be made with some indication of reliability and what is necessary to confirm the judgement. Where judgements are not reasonable (or subject to too high an uncertainty), some indication of what is needed so that a judgement can be made should be provided.
 - c. Completeness. As previously identified, several aspects of the report are not complete (summary, jargon, lack of recommendations). Another completeness related problem is the lack of information pertinent to figures and tables. These should generally be "stand

alone" documents which require only occasional reference to the text. Additional difficulties are lack of definition of lines, the small size which tends towards an incomprehensive presentation when multiple lines are presented on the same figure, and the lack of definition in some instances when it is not clear if median or mean representations are being provided.

- d. Writing style. Words such as "It is not therefore likely that ..." make a difficult topic more difficult. The entire document needs editing. (We note, in fairness to BNL, that they did not have time to perform this step in the rush to provide the information in written form. Similar comments may be made with respect to other criticisms.)
4. Accuracy. The preface, summary, and other sections should be consistent and correct with respect to accident sequence estimates and their validity. Risk and dose/distance "comparisons" should be provided with appropriate qualification and uncertainties discussion where feasible. Conservatisms should be clearly identified. If comparisons include means vs. medians, such items should be specified. There is repeated usage of conservative assumptions in the work described in this report, and the results are often not qualified with respect to the impact of these assumptions. There are also conclusions which are provided without proper thought, with the result that they are tenuous and perhaps incorrect. Some of these act to increase risk, and others to decrease risk. There are numerous examples of application of experimental information, and information specific to other plants, to Seabrook without proper qualification and consideration of the real applicability and uncertainty associated with such application.
5. Illustrations. A number of figures and tables are used to summarize the BNL results. We are not clear what action BNL suggests we take with these since their meaning is not clear. These at times represent uncertainty evaluations based upon highly pessimistic assumptions while meaningful assumptions might have led to different conclusions. It is also not always clear that the same things are being compared (median vs.

mean for example). The figures and tables should be appropriately characterized and the uncertainties displayed where this is feasible. Where not feasible, appropriate explanations should be provided.

OVERVIEW

Several of our perceptions regarding the BNL investigation are that:

1. Too much reliance is placed on PRA. The work would be stronger and more accurately reflect Seabrook Station characteristics if more engineering judgement was provided in conjunction with the description of the PRA work which has been accomplished.
2. Methodologies tend to be mixed in describing the results. There is too much of a tendency to incorporate conservatisms into the plant description and then present the resulting figures and graphs in such a way that the reader forgets they are there. We believe the reader will tend to treat bounds as probable.
3. There is too great an emphasis on the perceived review status of the Seabrook PRA related documentation. We know much more in regard to the Seabrook PRA than is reflected in the BNL reporting.

The evaluation of selected issues needs further work.

We have difficulty with the overall philosophy which this report conveys. The message received by the reader is that insufficient information is available for meaningful conclusions to be drawn. This perspective is provided early (in the preface) with the statement that BNL cannot validate any of the risk profiles or accident sequence probability estimates.

We do not believe this is an accurate assessment of the state of technology and BNL's knowledge, nor do we believe BNL meant to provide this negative a qualification. For example, BNL emphasizes the lack of independent assessment, requantification, and validation pertinent to risk reporting by the

licensee and its contractors. The impression given is that this is a major difficulty, and little can be concluded due to this status. Yet BNL is quite familiar with the Seabrook risk assessment reports, having worked with them on a limited basis for several years, and BNL is intimately familiar with a number of other PRAs. BNL should be able to draw reasonable conclusions. For example, BNL should address whether the Seabrook PRA appears reasonable in comparison to other PRAs which have been subjected to detailed review. They should also address whether the partial reviews of the Seabrook PRA which have been accomplished can be viewed as an audit and, if so, then they should address the results. If one accepts that the Seabrook Station PRA may be somewhat open to question because of the review status, then the sensitivity one might expect should be estimated. This should be accompanied by a conclusion regarding impact upon the results. (For example, would a factor of five change in predicted core melt probability have any real impact on conclusions regarding Seabrook?) Expert judgement and application of non-PRA investigative techniques, with use of PRA as a tool to provide insight, are necessary to development an overall picture. These are missing from the BNL work. We believe BNL has the capability and knowledge to reflect all of the above in their evaluation.

The preface, summary, and body of the report need to be made consistent and correct with respect to what BNL can and cannot say about the accident sequence estimates and their validity.

Both the summary and the body of the report provide "comparisons" of risk estimates and dose/distance curves. These comparisons should be made only with an appropriate qualification and discussion of uncertainties. Where this is not reasonable due to the limited nature of this preliminary BNL review, a statement to this effect should be provided and the estimates characterized. For example, conservatisms included in the values should be identified and the potential impact of those conservatisms provided. If this information is omitted, then incomplete information is being provided. Further, the report does not appear to be consistent with the Commission Policy Statement on Safety Goals for Operation of Nuclear Power Plants, Treatment of Uncertainties, dated August 4, 1986. This reference states:

"The use of mean estimates does not however resolve the need to quantify (to the extent reasonable) and understand those important uncertainties involved in the reactor accident risk predictions.

"... the Commission intends to ensure that the quantitative techniques used for regulatory decision making take into account the potential uncertainties that exist so that an estimate can be made on the confidence level to be ascribed to the quantitative results."

BNL should address such items as:

1. The general picture of the Seabrook PRA and its reasonableness with respect to core melt.
2. Whether containment can be expected to remain intact, and whether Seabrook Station constitutes a significant risk, given the general picture from item 1.
3. Whether a core melt accident is likely to rupture containment.
4. Whether a core melt accident is likely to bypass containment.
5. The impact of the above.

Each item should be addressed briefly with respect to strengths and weaknesses, and thus a foundation established whereby reasonably competent readers could be led into the areas of importance which BNL has investigated. We would expect appropriate qualifications to be made and the related uncertainties to be discussed.

ITEM BY ITEM REVIEW COMMENTS

The remaining comments in this enclosure are detailed comments arranged in the order in which they apply to the reviewed report. The page number is given first, generally followed by the paragraph number.

- xiii 1 The review is identified as focused on PLG-0465 identified areas. This is not necessarily correct. Major review emphasis was provided to other areas, including containment bypass implications and accidents initiating from plant shutdown conditions. These are areas which PLG-0465 and other applicable documentation did not address in depth, with the exception of LOCA outside containment.

We note the review is really of several documents, including PLG-0465.

The message contained in the last sentence of the preface is excellent (although two sentences should be used). (We suggest "The current review should therefore be regarded as an evaluation of selected issues related to the potential for a large early release of radioactivity at the Seabrook Station. It is not a reassessment or validation of the total risk profile.")

- xvii This page is typical in use of jargon without definition, which makes the report difficult for most readers (NUREG-0396, WASH-1400, PRA, RSS, LOCA, BNL, maybe even NRC). Organization adds to the comprehension difficulty. For example, by the time the reader reaches a BNL conclusion regarding the first paragraph, he or she will be so lost in detail as to have forgotten the paragraph content.

These comments are typical of many other pages.

- xvii 3 The evaluation addressed many areas, as opposed to focusing on a few as identified here. Some of the other areas were found to be important.

- xviii 3 Suggest "sensitivity" should be "sensitivities" in the second line.

- xviii 5 Suggest "are" should be "is" in line five.

- xix 1 The safety goal is NRC's, not NR's.

xix 2 We believe BNL does not mean they "cannot" verify (in the second line), but rather that they did not attempt to do so in the work reported here.

xx We believe figures should "stand alone." Figures in the BNL report do not. This initial figure, for example, doesn't help the reader with respect to PLG-0465, RMEPS, WASH-1400, identification of who belongs to the safety goal, or identification of who generated the item labeled "PLG-0465," including the meaning of the white region of the column. Referencing the text helps, but we still don't have a definition of RMEPS. The initial reaction is that the column labeled PLG-0465 is a licensee sponsored value, but we are not clear if this is correct or whether it is really BNL's?

xxiii The SGTR optimistic assumptions are identified as off the graph. Note one of the references used to identify the likelihood of SGTR did not identify the assumption as optimistic, but instead referenced it as considered to be more likely than any other portion of the range that was discussed. The upper bound was included in this reference to cover ignorance regarding phenomena. Our opinion is that the range is between 0 and 0.3, with the most likely value close to zero.

We are mixing items in many of these comparisons. It is one thing to propagate a collection of success or failure probabilities through the process and determine the impact upon risk. It is something else entirely to propagate an individual's judgement of whether a sequence will occur as though it were a probability. For example SGTR "probability" is an estimate of the likelihood that the individual(s) guessing of SGTR response is correct in his or her assessment. In the sense of these values, if an individual decides the SG tubes will not rupture under conditions associated with core melt, and the individual is correct, then they do not rupture given a core melt at high RCS pressure. If the individual is incorrect, then the tubes may rupture every time there is a core melt at high RCS pressure. The 0.01 to 0.3 range used by BNL is not a

probability of SGTR based upon the phenomena and plant response to different conditions, but instead is simply an assessment of whether individual judgement is correct. It should not be used as a probability.

We note the above comments are applicable to other portions of the report as well, as in Table S.1 for example.

- The WASH-1400 information in Figure S.2 is identified as median results. None of the other information is so identified. Identification should be accomplished in all figures and tables where the comment is applicable.

xxvii The **** footnote does not correspond to a table entry. BNL should address whether the licensee calculations are reasonable and this is the reason they are used here, or whether they simply used.

- 1-3 1 "The focus of the BNL review reflects those areas of PLG-0465 ... where major risk reductions (when compared with the results of the SSPSA) were calculated. Thus, our review assessed the physical strength of the Seabrook containment" The SSPSA provided a conclusion that containment was effective in mitigation of risk from core melt accidents. PLG-0465 did not change this. The reason for assessing the strength of Seabrook's containment is incorrect.

We do not recall an extensive assessment of loss of containment isolation in PLG-0465 as contrasted to the SSPSA with major risk reductions either. We do, however, agree with the BNL description that LOCA outside containment represents a significant change between the two documents.

- 1-3 3 "Initially, ... those portions of PLG-0456 ... related to system failure are reviewed to determine the appropriateness of the accident sequence probabilities." This appears to be a review which should remove the qualifiers BNL reiterated earlier in this report.

- 1-3 5 (next to last line) The verb should correspond to the plural subjects.
- 1-4 - Complete references should be provided in the final report.
- 2-1 - Suggest BNL add a qualifier to clearly identify whether a careful investigation was conducted by BNL to identify containment bypass possibilities.
- 2-1 3 Suggest "The study ..." be worded "The licensee study ..."
- 2-4 1 Our recollection is that the Seabrook PRA dealt with a number of potential containment bypass paths for LOCA outside containment. This was also the topic of an RAI. The BNL wording can be taken to mean BNL considers the licensee response inadequate. This should be clarified. Either it is, or it isn't.
- 2-4 2 The reader may believe that BNL is referencing the relevant failure modes, and considers others, such as a failure mode due to MOV opening, to be irrelevant. It is not clear whether the work being described in this and following paragraphs represents BNL's work or the licensee's work. Although this is partly clarified later, it would be best to clarify it here.
- 2-6 item h One can argue that at least some of the common cause failure information is contained in the data base since, if there was a common cause failure, it would be represented in the plant experience data.
- 2-7 1 Use of total exposure time does not take into consideration differences attributable to pressure and temperature, as will apply depending upon the status of the plant.
- 2-7 3 We do not understand how the third item follows from the first two. For example, PLG usage of data from two check valves in series for representing a single valve would appear to be highly optimistic,

and would result in the opposite behavior than defined in the third item.

2-8 2 "Since the purpose of this calculation is to contrast the result with that of the PLG analysis, the same extrapolation and calculation techniques are used as those of PLG." We are not clear how this establishes the purpose if the calculation techniques are incorrect, and BNL has not commented on the techniques.

2-8 last paragraph We do not understand the applicability of Figure 2.1 in that the data include two check valves in series, as explained in the previous paragraph, and the use is for single valves.

2-10 1 The use of jargon continues to make this difficult to understand. For example, the last line is more easily understood if changed from "Based on the above values, LR has a mean value of .058." to "The mean value of the fraction of initiating events in which the leak exceeds 1800 gpm, LR, is 0.058."

BNL should show how one obtains the 0.058.

2-10 3 BNL identified that check valves were assumed by PLG to behave identically to MOVs, and BNL used the PLG assumption in their analyses with the later observation that such usage is probably too conservative. BNL should identify the information that supports the conservative belief.

2-11 2 BNL has identified a number of additional considerations in potential reanalysis of MOV behavior. BNL should provide a judgement on the importance and impact.

2-12 2 BNL introduces the general topic of operator response to LOCA outside containment and then provides a brief evaluation of response to RHR pump seal failure. We suggest a paragraph prior to the second paragraph on this page which connects the general to the specific topic and which includes identification that the licensee

believes the RHR seal failure to be the most likely response if the isolation failure is greater than of the order of 1800+gpm.

- 2-13 2 The comment on valve closure is repeated on the next page. Once is sufficient.

We are not clear whether the licensee identified the need in their material or whether this is a BNL observation. The potential concern would involve whether valve closure was properly interacted with pump operation to reduce the likelihood of losing pumps.

- 2-14 2 We do not believe the material within the parentheses adds anything. Either one is provided with a reasonable assurance or one is not.

- 2-15 2 The summary is not clear. We hear both "superficial at best" and "reasonable assurance." BNL should clarify their recommendation.

- 2-15 3 "... seems to support ..." BNL should be more positive.

- 2-16 1 "... is based on IDCOR evaluations which have not been reviewed by BNL." carries the implication that review by anyone else is not sufficient. BNL should identify whether it has been reviewed by anyone else with an independent perspective (to BNL's knowledge). References which document the IDCOR evaluations should be provided.

- 2-16 2 Suggest a specific reference be provided.

- 2-16 (last sentence) Wrong verb.

- 2-17 5 Provision of the updated value of the Seabrook EPZ study here would provide better reader continuity.

We note again the potential danger of propagating through a process that may contain errors, with the result that one can be misled in regard to the uncertainty as a result. BNL should clarify whether

this of concern here and, if so, the implications should be identified at a minimum.

2-17 6 Section 2.2 needs editing.

Reference to Standard Technical Specifications and provision of numerical information from that source is not as favorable as using Seabrook specific information, all of which is readily available.

With respect to ease of use of the BNL report, it would be far more convenient for the Modes to be defined here in a list than having the reader go searching for the table which is far removed from this location.

Reference is made to technical specifications in a way as to imply that if not required by technical specifications, it will not be accomplished. While we believe it important to identify an important item that is not in technical specifications, one should not assume that if it isn't in technical specifications, it will not be accomplished. An important aspect of PRA investigations is not what is required, but what is actually accomplished since PRA and related information is supposed to represent the actual plant.

2-18 1 The 5.7×10^{-5} should be identified as for Zion. This core damage frequency is about a factor of four less than for Seabrook. BNL should state whether they consider this to be meaningful. BNL should also address whether the reader should compare the 1.8×10^{-5} to the above number and conclude the likelihood of core damage during shutdown is a factor of three less than the likelihood of core damage during power operation for Zion.

2-18 2 BNL should address the applicability of the vessel rupture probability of 10^{-3} to Zion. They should also do this for Seabrook.

2-19 1 BNL should address whether the experience base shows a time variation and, if so, whether it was factored into the BNL

considerations. This could be of significance since industry has been aware of the potential for some time and has invested significant manpower into its evaluation.

- 2-19 2 "Typically several hours are available before core uncover occurs. Therefore, the most important thing is that the operators must be able to recognize the loss of DHR." We are not convinced this is correct. For example, prompt action to avoid damage to equipment needed for recovery may be more important than recognition of loss of DHR. In some instances, one may even wish to terminate all DHR functions as the initial step in reaction to an accident, such as a LOCA which initiates while the DHR system is in operation. In general, we recommend being slow to suggest plant and plant operation changes prior to all of the facets being examined.

We suggest a portion of the next to the last line be changed from "... the plant in a partially drained condition ..." to "... the RCS in a partially drained condition ..."

- 2-20 1 In this and following paragraphs, BNL is identifying differences between Zion and Seabrook which influence the probability of an accident at Seabrook. There is no follow-up with respect to the impact upon the reported results. This is particularly important in those report sections which summarize the BNL work.

- 2-21 4 Section 2.2.2 needs review and editing. Something appears be missing near the beginning of the paragraph.

We suggest using the wording associated with operating modes rather than the nonspecific "... when the primary system is cooled down after a reactor trip."

- 2-22 1 BNL has identified four RHR relief valves, but then refers to the technical specifications as requiring both of them to be operable. Referring to "both" implies that there are only two valves, not four.

2-22 2 BNL provides an Oconee 3 core damage estimate, but does not indicate if it is in any way applicable to Seabrook.

2-22 3 We suggest Section 2.2.3 be titled more descriptively, such as "Loss of Coolant Accidents during Shutdown and Refueling." This is a long and complicated report, and the reader needs reminding that this is not a general discussion of LOCA.

Reference is made to a study of operating experience which covered to the end of 1981. This is old in contrast to the TMI related responses and the A45 related effort which has been conducted on the part of both industry and the NRC. The information should be upgraded.

2-23 2 In referencing the dominant Zion scenario, BNL failed to identify whether this is applicable to Seabrook.

2-23 4 "This is a very important topic for review because it could potentially lead to a relatively large early release of radioactivity, and the applicant considers it to be very unlikely." We do not understand why BNL references the licensee's consideration of its being unlikely as a reason for it being very important. We suggest that this section be rewritten so as to provide more information and explanation.

2-24 1 "This estimate was considered reasonable in the NRC review...." Our statement was that since appeared to be large, it needed further consideration. That has nothing to do with its being reasonable.

2-24 3 The range quoted from Reference 19 is not accurately represented. The author indicated a strong bias toward the lower limit, and this is not reflected at this point in the BNL report. We further note that this is not really a conditional probability, but merely the author's estimate of the correctness of his assessment, and his assessment is that SGTR will not occur (based upon his statement in regard to the lower limit of the range).

2-25 1 We are not sure what to conclude from this. One possibility is that the work is of little overall applicability since only examples were considered and there were many other items which were omitted. On the other extreme, one might conclude BNL considered everything they recognized and they researched the topic in an attempt to find problems. BNL should accurately describe the basis for the work.

2-25 2 The source terms and plant damage states are not clear for those not intimately connected with the PRA field and the Seabrook terminology. Definitions of the abbreviations should be provided. We suggest that "source term" and "plant damage state" be defined in a footnote the first time these terms appear. We also suggest that the same wording be used to describe the same thing, as in release category and source term category.

2-25 5 "However, as the no evacuation assumption is already below the proposed safety goals, the changes in risk for the one and two mile evacuation assumptions are also within the NRC safety goals." We do not understand how the no evacuation assumption leads to a conclusion that changes in risk for the one and two mile evacuation assumptions are also within the goals. It is our understanding that evacuation can sometimes lead to an increased dose.

The safety goal is not proposed, it exists.

2-26 2 BNL should identify features which differ between the Seabrook configuration and the configuration assumed for the RSS work, such as water depth, or, if there are none, this should be identified.

2-26 3 Again, we encounter a statement where BNL does not feel they can stand behind the results. We continue to believe BNL is better qualified than they indicate here.

The qualifications identified here (and in other parts of the text) do not appear in the figures. We judge that a number of people may

refer to the figures without referencing the text, and as a result, may be misled as to what the figures represent.

- 2-27 3 This is another example of the mixing of probabilistic and nonprobabilistic information.
- 2-27 4 This is another example of the incorporation of information into the quantitative results where the reader may miss the qualifiers, which are buried in the text. In this case, BNL may have been misled since they state: "The risk of early fatalities assuming no evacuation and the high SGTR probability is close to and may exceed the NRC safety goals." We question if the conclusion would have been stated this way if full consideration were given to the various assumptions upon which the numerical information was based.
- 2-28 2 "The statement in PLG-0432 that 'the risk of radiological exposures for 200 rem whole body dose with no immediate protective actions is less at 1 mile than the corresponding NUREG-0396 results at 10 miles' is not affected by this particular sensitivity study related to the potential for SGTR." This BNL conclusion appears to conflict with the page 2-27 paragraph 4 conclusion discussed above. If it does not, then an explanation should be provided.

Table 2.1 The number of check valves reported is not necessarily the number involved.

There are some difficulties with these tabulations which are not adequately identified. VII.A.315 in Table 2.2 is a good example. We do not understand how the full open valves were reflected in the data base. This should be addressed. In most instances, the position of other, related, valves is not identified. Yet they may be partially or fully open. This should be addressed.

Table 2.6 Seabrook specific information should be used, not "generally" or material referenced to "... B&W, CE, and W standard"

Table 2.8 It is not clear whether the information in the center portion of the table is BNL's or the licensee's.

- 3-1 1 The dome dimension is a radius, not a diameter.
- 3-2 3 The verb in the first sentence is incorrect.
- 3-2 4 Something is missing from the last sentence.
- 3-5 1 It appears containment failure will occur at close to 157 psig from the statement that shear failure may develop at the base. Yet the first paragraph on the following page references a general yield state at 157 psig and discusses deformations which occur as pressure is increased above this level, with the implication that no failure has occurred. This is reinforced by the statement on page 3-7 that the containment will undergo a great amount of expansion before failure, with references to pressures in the range of 216 psig, which BNL later qualifies as what they believe to be an upper bound on containment failure. Still later (page 3-9), BNL again references the 157+ value. The difficulty is in the description, where the reader is apt to miss the qualifications and failure modes associated with the values.

- We understand mean values have been used for such items as the strength properties of reinforcing steel. The steel bars are used in parallel, and any bar with subpar characteristics will transmit a portion of the load it should carry to other, adjacent bars. If such a bar should fail due to its lower load carrying capability, the full load it should have been carrying will be transmitted to the remaining bars. In this sense, the use of mean properties is not appropriate.

However, this picture must be tempered by the knowledge that the bars must move together. Hence, the weaker bar may yield sooner, but it still continues to carry a sizeable fraction of its load. The difficulty would become important if there were a significant

difference in the deformation at which the "weak" bar failed in contrast to its neighbors, and whether this difference was in effect magnified by the different distances from the center of containment or relative locations such as utilized in moving around penetrations.

BNL should address the above and should state whether it has been eliminated insofar as having any impact on conclusions is concerned.

- 3-14 - Type A, B, and C failures are meaningless to most readers, and will additionally be meaningless to many experts unless they are specifically experienced with the Seabrook PRA.
- 3-15 3 Suppose one postulates an accident in which the containment pressure rapidly reaches approximately 100, and then the pressure increase rate becomes slow (such that it would take several days to reach a pressure which could cause a gross containment failure). Next, consider the BNL conclusion: "In the event of the seal failure of the inner containment valve, the volume between the valves must fill and achieve an elevated temperature before failure at the outer isolation valve can occur. The elapse time for this failure mode is anticipated to be long as compared to other containment failure modes and is therefore considered of little consequence." We postulate the following behavior upon failure of the inner isolation valve due to its proximity to the high temperature containment environment:
1. The high temperature containment atmosphere at 100+ psi will rapidly pressurize the volume between the two isolation valves, with a corresponding temperature increase in this region due to both the compression and the transport of thermal energy from the containment.
 2. A slight, perhaps nominally acceptable, leakage in the outer valve seal will permit continuous transport of thermal energy toward the valve, and the heating effect will be most strongly

felt where the valve is weakest; the seal where the leak is postulated to occur.

3. The increasing temperature at the seal leads to premature failure of the outer isolation valve.

Whether this scenario is reasonable depends upon the amount and rate of thermal energy transported into the region, the initial temperature increase due to the compression, the cooling effect of the valve environment, valve characteristics, and other factors. We suggest the BNL conclusion may be premature if such factors were not taken into account.

- 3-16 2 Reference to the program should be provided. The specific plan for factoring the data into BNL's review of the licensee's conclusion as referenced by BNL should be referenced or briefly described.
- 3-17 2 Reference is made to differences between dry and wet containment failure pressures, which are attributed basically to thermal effects. As we understand it, the containment liner contributes little to containment strength, and most of the pressure capability is associated with the reinforcement steel bars. These are buried in concrete, and many are located several feet from the heated inner containment surface. As such, it will be some time before they are heated significantly, and they will always be cooler than the inner surface due to cooling of the outside of containment. BNL should address whether these effects were considered in investigation of containment failure behavior. If they were not, the implications, if any, should be provided.
- 3-17 - This summary section needs an additional paragraph that ties the overall findings together as a complete picture and contrasts it to the licensee position. It should also address whether differences are considered to be significant.

- Overall, Section 3 is a good report, and reflects the more complete status of the BNL work on containment response in contrast to other sections where significant work or writing effort remains.

4-1 4 BNL should qualify the quote with respect to its applicability to containment bypass, including failure to isolate, as contrasted to applicability to the containment assuming it to be properly configured with no bypasses.

4-2 3 The wording regarding gases being generated implies that they may not be generated. Since they will be generated under the conditions which apply here, we suggest the wording be changed.

In regard to generation of combustible gases, BNL states "The applicant presented information to indicate that such loads would not seriously challenge the Seabrook containment." BNL should provide a response to this licensee position, and should indicate whether they concur.

4-2 4 We suggest the word "reactor" be inserted in front of "vessel" to clearly identify which vessel is being referenced.

"Limiting calculations were performed to demonstrate that the pressure pulses resulting from simply boiling the water would not pose a threat to the Seabrook containment." A careful reading of this quote results in the conclusion that calculations were performed, but there is no statement of the results of the calculations. BNL should provide such a statement. Further, BNL should identify who performed the limiting calculations. It would also be informative to identify if the calculations were originally intended to demonstrate the lack of a threat or whether this was a result.

4-2 5 "In some containment designs the containment boundary is directly accessible from the region below the reactor vessel. In these designs the core debris after it melts through the reactor vessel could contact the containment boundary. However, the Seabrook

containment design is not susceptible to this mode of containment failure." We do not understand this paragraph. In Seabrook, the molten fuel can fall into the cavity under the reactor vessel. This cavity is separated from the bedrock upon which containment rests by concrete and steel which we consider to be the containment boundary. Further, the concrete is not bonded to the bedrock, and we therefore consider the junction between bedrock and containment to be outside containment.

4-3 1 The word "authors" is not specific. If the reference is to the authors of the BNL report, this should be indicated. If otherwise, that should be defined.

4-3 2 We have a number of difficulties with the description of the Sandia work and its applicability to direct containment heating at Seabrook. One aspect is that we are not clear what BNL believes to be the Seabrook situation. This should be clearly defined. Another aspect regards the technical situation. We have the following comments:

1. The Sandia experiments did not involve molten core material, but rather utilized a chemically reactive mixture of other materials. We are aware of no comprehensive similitude investigation which could be used to extrapolate the experimental evidence to the behavior of molten core material. We note, however, that the results do indicate a potential problem which must be addressed for severe accident situations. One must be careful in usage of the Sandia results so that one is not misled. BNL has not made this distinction.
2. The Sandia experiments did not simulate a reactor containment. What Sandia did was to conduct experiments with a configuration which was geometrically similar to the cavity under a typical Westinghouse reactor vessel. There was no simulation of the structure, equipment, and volumes which separate the reactor vessel cavity from the large volume of upper containment.

These experiments demonstrated that the molten material was violently ejected from the reactor vessel cavity and further demonstrated that violent reaction occurred with the atmosphere outside the cavity. Again, the results indicate a potential problem which must be addressed. Again, BNL did not make the distinction between the Sandia experimental results and behavior in the Seabrook containment.

3. To our knowledge, there is no concrete evidence which supports a conclusion that direct containment heating is directly proportional to the amount of core debris ejected from the reactor vessel. Consequently, we believe the sentence "The pressure rise in containment due to direct heating is directly proportional to the quantity of core debris ejected from the reactor vessel and to how much of this core debris is dispersed into the containment atmosphere." better represents the situation if written "The pressure rise in containment due to direct heating is proportional to the quantity of core debris ejected from the reactor vessel which is finely dispersed into the containment atmosphere."

Overall, we believe the tests have accomplished the identification of a potential problem that requires consideration. BNL has been involved with concerns related to this problem for some time, and BNL personnel have walked and crawled through several plants (including Surry, Zion, and Seabrook) to obtain insight into this issue. We believe BNL is in a position to provide reasonable, although perhaps preliminary, insight. We further believe BNL is in a position to assist in evaluation of the licensee conclusions.

Perhaps an example of the insight we are requesting will be helpful. BNL is aware of the SNL test geometry and the degree to which the test geometry simulates the Seabrook containment. We expect BNL to provide an independent picture of the impact of geometric differences between the Sandia test and the Seabrook containment.

4-3 4 and 4-4 1 BNL references a methodology developed for application to the Surry plant and its extrapolation to Zion. This is then used to "... give some indication of the impact of applying this new methodology to Seabrook." We believe this section of the BNL report needs considerable work to provide a clear picture in regard to what has been accomplished and its applicability to Seabrook. BNL should address the following:

1. Differences between Surry and the Sandia experiments which significantly impact upon use of this experimental information for Surry, and some indication of the impact upon any conclusions which may be drawn with respect to Surry.
2. Differences between Surry and Zion which impact upon conclusions which may be drawn with respect to the extrapolation to Zion.
3. Differences between Zion and Seabrook as outlined in item 2 for Surry and Zion.
4. The methodology referenced as the basis for use of expert judgement, and its applicability to all of the above. Specifically, discussion should be provided and/or specific references made to documentation which clearly identifies the guidance provided to the experts; the documentation whereby each expert provided his or her understanding of the problem, pertinent assumptions, and analyses to support his or her conclusion; and the documentation which clearly shows how each expert's written submittal was combined into an estimate of the uncertainty associated with the phenomena. In addition to these topics, we are looking to BNL, as independent assessors of the applicability of this information, to provide us with recommendations and an assessment of the referenced methodology which they have chosen to apply to clarification of the picture at Seabrook.

4-4 1 The statement "It should also be noted that this work is preliminary and has not yet undergone full peer review outside of NRC and its contractors" implies review inside NRC and by its contractors. We are not aware that such a review has been completed.

4-4 2 This broadening of the subject introduces many more considerations than just containment direct heating. We suggest a new subsection is in order.

4-5 1 "The increases in risk estimates with and without evacuation were found to increase by relatively small amounts and" BNL should identify what these increases are relative to.

"... but it was assumed to be small." The source of the assumption should be identified.

"The appropriateness of this assumption was reviewed by the BNL staff in Section 3." The conclusions regarding appropriateness should be provided here.

The Section 3 material includes discussion of relatively slow pressurization and containment response to that condition. Here, we are discussing rapid pressurization and sudden loads. BNL should tie the two together and establish applicability of the Section 3 material to the topic under discussion here.

4-5 2,3 BNL discusses taking the "wet" containment pressure for evaluation of early containment failure due to short duration pressure pulses. In this approach, all of the core debris is assumed to form a coolable debris bed, and all of the decay heat goes into boiling water. This maximizes the containment pressure. However, when this is done, the energy associated with the core debris is not available to further interact or provide pressurization to containment. Since many of the contributors to short duration pressure pulses involve transfer of energy from the core debris directly to the containment atmosphere, it is not clear whether BNL has counted such energy

twice in this evaluation. BNL should provide a discussion of how they separated the energy sources to prevent this from happening or should discuss the implications if this is what was done.

- 4-6 2 "If we, therefore, focus on the 'wet' failure distribution (in Figure 4.1) as being more appropriate to determine the potential for early containment failure" This is only more appropriate for those accidents which can be classified as "wet". Accidents which are classified as "dry" will result in a lower pressure. If most of the accidents are of the "dry" category, the results of using the "wet" characteristics will be misleading. BNL does not address this topic.

Type B and type C failures are meaningless except to experts who are familiar with the Seabrook PRA.

The word "benign" is used several times in reference to type B failures. There is nothing benign about a hole of this magnitude in containment! It is even difficult to comprehend this usage in the context of comparison with a catastrophic containment failure, although academically, one can argue that type B failure impact upon people who are not close to the plant is small or negligible under many circumstances.

The first sentence is "If we, therefore, focus on ... to determine the potential ... then the relative contributions of ... were determined by the applicant" This sentence needs editing. In the end result, we are more interested in actual containment response as opposed to the potential for failure. Whatever BNL can do in their report to provide expected response as opposed to potential response will be helpful.

"... might impact ..." This implies an unknown. BNL should be more specific.

- 4-6 3 "It is not therefore likely that ..." needs editing. The discussion of 175 psi failure and 140 psi failure leaves the reader wondering what is happening with respect to the 134 psi failure. The discussion of Seabrook failure probability distributions being higher than for Zion does not lead clearly into which plant early failure decrease is being discussed. It is also not clear whether a higher distribution means more likely to fail or means more resistance to failure.
- 4-6 4 The statement "However, the Seabrook specific failure pressures discussed in Section 3 are lower than the distributions presented by the applicant in Figure 4.1 and closer to the Zion values. This, in turn, affects" needs editing.
- 4-7a,b The summary should be rewritten. It should address such items as:
1. A brief description of the BNL work accomplished.
 2. A brief description of the PSNH work accomplished.
 3. The adequacy of coverage and accurateness of the PSNH work, at a minimum based upon BNL's extensive experience with other PRAs and a contrast between them and the PSNH PRA reports; more desirably with the comparison based upon as much BNL appraisal of PSNH work as is practical. This should include an appraisal of the conservativeness or realisticness of the PSNH results and the applicability to the issue of emergency planning zone size and risk.
 4. The adequacy of the PSNH justification for changing the evacuation zone planning size insofar as the BNL investigation has addressed the various technical points which must be considered. Weaknesses in the PSNH work should be identified and guidance provided for strengthening those items.

5. A BNL technical opinion regarding the necessary emergency planning zone size for Seabrook Station insofar as is practical within the limited scope of the BNL investigation. If no opinion can be provided, then the information necessary to render such an opinion should be defined.

Some aspects of the PSNH work and Seabrook Station characteristics should allow straightforward appraisals. For example, the licensee has in effect stated that Seabrook Station has one of the strongest containments of any nuclear power plant and that this containment has a high probability of effectively mitigating any core melt accident. We expect BNL to address this claim with a direct, straightforward response, accompanied with any qualifications such as the influence of containment bypass. We further expect those qualifiers to be accompanied with assessments and statements of impact upon the PSNH claim. This summary does not contain such conclusions, and we believe BNL's Seabrook Station specific work and their extensive experience will allow such conclusions.

- 4-7a 2 The first paragraph states that BNL did a sensitivity study using more conservative assumptions than PSNH, and found the conditional probability of early containment failure to be 10^{-2} (vs. PSNH's 10^{-4}). It further states the BNL work was based on inferred results taken from Zion, and therefore is not Seabrook specific, but allows assessment of the robustness of the PSNH work. These statements are not useful for the following reasons:

1. Clearly, more conservative assumptions will result in a higher calculated value of containment failure probability. This is not useful information. What we need is a realistic value and an assessment of the uncertainty of that value.
2. Results for another plant with no assessment of the applicability provide limited quantitative insight and cannot be used for Seabrook Station. Seabrook Station may be better; or worse. Such results have a high likelihood of being misleading if

applied in a quantitative manner, and normally one has a tendency to do so.

3. We cannot find the BNL conclusion regarding robustness of the PSNH work.

4-7a 3 The reader will have difficulty understanding what BNL is trying to say, but after study probably will end with something like if one takes the highest containment failure probability and combines it with the worst type of failure, one affects the PSNH results and gets a small impact upon cancers and less than a factor of two increase in early fatality risk with no immediate protective actions. If this is the message BNL is trying to convey, it could be conveyed more easily. It should also be accompanied by a conclusion regarding the EPZ technical picture.

We are looking for a BNL response to the question "Has PSNH substantiated their claim regarding a smaller EPZ and why or why not?" Although we do not expect BNL to completely respond to the question on the basis of their limited study, we do expect a more definitive response than reflected in this BNL draft document.

5-2 2 This paragraph needs editing to better identify the points. It ends with "The appropriateness of the interfacing system LOCA frequency was reviewed in Section 2." This leaves the reader in a quandary regarding the Section 2 results and how they apply to the topic of this paragraph.

6-3 1,2 and preceding page The reasonableness of these assumptions, including possible correlations between weather and population distribution, should be addressed by BNL. Impact upon study results should be assessed.

6-6 5 We believe this is the type of summary statement that should be provided more often by BNL. It is clear and to the point. However, this particular point is too narrow unless accompanied by a broader

picture. (The point being made by BNL here is that the PSNH consequence modeling is "fairly presented". The broad point where BNL response is needed is whether the consequence modeling is realistic or distorted by conservative or nonconservative assumptions.)

- 6-7 1 Rates and durations are referenced as assumed. Our recollection is that they were based upon analyses.
- 6-7 bottom The incorrect statement that the BNL technical evaluation focused on the areas that were identified in PLG-0465 is repeated.
- 6-9 - We do not agree that a better assessment of risk cannot be provided. We simply did not try within the limited scope of the BNL investigation.
- 6- - The figures in this section are difficult to read and understand.