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May 25, 2000

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

FROM: Charles E. Rossi, Director **/RA/**
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

SUBJECT: CONCERNS OF DR. DAVID C. WILLIAMS ON THE NRC'S RESOLUTION OF THE DIRECT CONTAINMENT HEATING ISSUE

On March 9, 1997, Dr. David C. Williams transmitted a report, "An Independent Critique of Containment Loads Modeling Used in the Direct Containment Heating (DCH) Issue Resolution Effort," prepared by him, to Mr. Thomas Kress of the Advisory Committee on Reactor Safeguards. In the report, Dr. Williams expressed a number of concerns with the methodology used to calculate containment loads in the resolution of the Direct Containment Heating (DCH) issue. In a letter from you to Dr. Williams dated February 2, 1999, you responded to the concerns expressed in his report. The response included an assessment of Dr. Williams' concerns in the form of a table prepared by Mr. Wayne Hodges, who at the time was Director of the Division of Systems Technology. The table listed Dr. Williams' concerns and responded to each one.

On May 26, 1999, Dr. Williams called Ms. Jean Lee, Senior Allegations Coordinator, NRR, and indicated that he had comments on your February 2, 1999, letter and attachment. Soon thereafter you assigned me to review Dr. Williams' comments, and Dr. Williams was informed of this by Ms. Lee. In a letter to me dated August 7, 1999 (attached without Issues 30–54), Dr. Williams provided a rebuttal to the responses in the February 2, 1999, letter and attachment from you. Dr. Williams' rebuttal is divided into three sections. The first comments on your letter, the second provides general comments on Mr. Hodges' detailed responses, and the third section provides point-by-point comments on the items contained in the table prepared by Mr. Hodges to address Dr. Williams' issues. The purpose of this memorandum is to inform you of my conclusions after reviewing Dr. Williams' letter of August 7, 1999, and its attachment.

Let me first address the statements in Dr. Williams' August 1999 letter to me concerning his desire to make his March 9, 1997, report part of the public record in order that the issues he raised be available for evaluation by any interested members of the technical community. I have considered his desire and recommend placing this memorandum with the following four documents in the NRC's Public Document Room:

1) Letter from Charles G. Tinkler to Kenneth D. Bergeron dated February 7, 1996, commenting on the revised draft SAND 94-1174, "Assessment of the CONTAIN Direct Containment Heating (DCH) Model: Analyses of DCH Integral Experiments," dated August 1995.

2) D.C. Williams, "An Independent Critique of Containment Loads Modeling Used in the Direct Containment Heating (DCH) Issue Resolution Effort," dated March 9, 1997.

3) D.C. Williams, et al., "Assessment of the CONTAIN Direct Containment Heating (DCH) Model: Analyses of DCH Integral Experiments," SAND 94-1174, Sandia National Laboratories, Draft dated November 10, 1996.

4) Letter from David C. Williams to Charles E. Rossi dated August 7, 1999, Subject: "Allegation No. NRR-1997-A-0063; NRR-1999-A-0039" with its attachment, "Rebuttal to NRC Responses to the March 9, 1997, Report Entitled, 'An Independent Critique of Containment Loads Modeling Used in the Direct Containment Heating (DCH) Issue Resolution Effort' " (Issues 30-54 are not included in accordance with a statement in Dr. Williams' August 7, 1999, letter indicating that he did not believe these issues needed to be part of the public record).

Placing the above four documents in the NRC's Public Document Room along with this memorandum will address his request that his concerns be available to the public.

Comments on your letter of February 2, 1999, contained in the attachment to Dr. Williams' letter to me dated August 7, 1999.

Dr. Williams' first comment raised the question of whether the review by Mr. Hodges can be considered fully "independent" since he was the director of the division responsible for the DCH issue during much of the time the resolution work was performed. This comment has been addressed by having me do the current review. I was not in the Office of Nuclear Regulatory Research nor associated with the work during the time the DCH issue was being resolved.

Dr. Williams' second comment addresses the technical adequacy of the DCH issue resolution and is addressed later in this letter.

His third comment concerned the process used by Sandia and the NRC to deal with the technical issues raised by him which questioned the DCH issue resolution. I am not addressing this comment because his August 7, 1999, letter, in general, indicates that this issue has been satisfactorily addressed in "RES Office Letter No. 2A."

Dr. Williams' final comment on your letter concerned publication of SAND 94-1174, and his belief that publication was denied primarily because the results obtained were in conflict with the basic phenomenological modeling assumptions used in the DCH resolution. I have found no basis for his belief that publication was denied primarily because the results obtained were in conflict with the basic phenomenological modeling assumptions used in the DCH resolution. The letter from Charles G. Tinkler to Kenneth D. Bergeron dated February 7, 1996 (Item 1 in the list above), states that the resources required to address the technical issues remaining in the report, which are discussed in the letter, far outweigh any accrued benefits to the NRC. The need to resolve differences between CONTAIN models and predictions, and the basic phenomenological modeling assumptions used in the DCH resolution are addressed later in this letter.

General Comments on Wayne Hodges' Responses Contained in the Attachment to Dr. Williams' Letter to Me Dated August 7, 1999.

Dr. Williams' first comment is that specific concerns he and other contractor staff raised after July 30, 1993, and supporting information (contained in his March 9, 1997, independent critique – Item 2 in the list above) were not provided to the peer reviewers of the DCH resolution documented in NUREG/CR-6075, Supp. 1, "The Probability of Containment Failure by Direct Containment Heating in Zion." He further states that the most important single issue was the conflict between the results of the CONTAIN analyses of the DCH experiments and the phenomenological assumptions used in the DCH Issue Resolution Models.

I did not attempt to determine if specific information developed by Dr. Williams was provided to the peer reviewers after July 30, 1993, or, if it was provided, in what form it was provided. Instead, I have reviewed the process used for the DCH Resolution, including the peer review, to determine whether an item by item assessment of each issue raised by Dr. Williams is necessary in order to ensure the adequacy of the DCH resolution which has been completed. Similarly, I have reviewed Dr. Williams' comments stating that the methodology used in resolving the DCH issue provides no means of allowing for phenomenological uncertainty in containment loads and his criticisms of the responses to the technical issues raised in his March 9, 1997, independent critique to determine whether an item by item assessment of each issue raised by Dr. Williams is necessary in order to ensure the adequacy of the DCH resolution. My conclusions are discussed later in this letter.

Dr. Williams further stated that several responses in the attachment to your letter to him dated February 2, 1999, were more or less derogatory towards CONTAIN. He stated that the NRC has spent very substantial sums (over $1,000,000) developing and validating the CONTAIN code's capabilities for DCH analysis, made the point that CONTAIN is more sophisticated than the Two-Cell Equilibrium (TCE) model, and stated some specific areas where he believes CONTAIN has capabilities not available in the TCE code. His major point is that the conflicts between the results of CONTAIN analyses and TCE modeling assumptions contained in his independent critique of March 9, 1997, must be resolved in order to ensure the adequacy of the DCH resolution. Again, this is discussed later in this memorandum.

Comments on Specific Responses Given by Wayne Hodges

I have not addressed Dr. Williams' comments on Issues 30–54 concerning process irregularities since he stated in his letter to me dated August 7, 1999, that the process irregularities should not recur if the actions outlined in your letter of February 2, 1999, are faithfully implemented. Comments 1 through 29 are concerned with Dr. Williams' belief that specific information contained in his March 9, 1997, independent critique and the draft of SAND 94-1174 should have been given to the peer reviewers and possible conflicts between this information and the eventual DCH resolution reconciled. The fundamental issue raised by these comments is whether the NRC needs to fund additional research and/or reconvene the previous or a new peer review group to resolve the conflicts with the DCH resolution which has been completed. My conclusion is that the cost of such an effort is not warranted. In support of this conclusion, I am providing a perspective of the relation of the DCH issue to reactor safety and the NRC's regulatory framework. Then I will discuss the reasons that the current DCH resolution is adequate within this perspective.

Severe accidents, including those that could lead to DCH, are beyond the design bases for reactor plants in this country. Therefore, analyses of such accidents are not required for licensing and operating a reactor. The following quotations are from NUREG-1365, Rev. 1, "Severe Accident Research Program Plan Update," published in December 1992, and the *Federal Register*, Vol. 50, No. 153, August 8, 1985, "Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants."

NUREG-1365, Rev. 1, Page 1, Section 1.1., "Background," first paragraph of the second column:

> As stated in NUREG-1365, the overall goals of the revised SARP plan are to provide the technological base for assessing containment performance over the range of risk-significant core melt events, develop the capability to evaluate the efficacy of generic containment performance improvements, provide an improved understanding of the range of phenomena exhibited by severe accidents, and reduce the uncertainties in the source term sufficiently to enable the staff to make regulatory decisions on severe accident issues.

Federal Register, Vol. 50, No. 153, Page 32144, "2. Policy for Operating Reactors," two bullets after first paragraph:

> • Operating nuclear power plants require no further regulatory action to deal with severe accident issues unless significant new safety information arises to question whether there is adequate assurance of no undue risk to public health and safety.
>
> • In the latter event, a careful assessment shall be made of the severe accident vulnerability posed by the issue and whether this vulnerability is plant or site specific or of generic importance.

NUREG-1365, Rev. 1, Page 3, Section 1.4, "Criteria for Termination of Research," first paragraph and first sentence of the second paragraph:

> The degree to which a severe accident technical issue must be resolved depends on the needs of the related regulatory decisions and on the necessary depth for the conclusions to be widely accepted in the technical community. Ideally, an issue is considered closed when the NRC can pronounce that sufficient experimental and analytical research has been completed to allow, for the purpose of IPEs, accident management studies, or containment performance evaluations, for the prediction of reactor plant response. In addition, uncertainties have been reduced sufficiently that regulatory decisions are insensitive to further reductions in uncertainty.
>
> In practice, deciding when work is completed requires a subjective assessment of the potential benefits of further research.

Given the process used to perform and peer review the resolution of the DCH issue documented in NUREG/CR-6075, Supp. 1, it is unlikely that addressing Dr. Williams' specific issues would identify a safety problem warranting "generic containment performance improvements" or result in a new regulatory decision. To address a safety problem or make a new regulatory decision, the NRC would have to demonstrate under 10 CFR 50.109, "Backfitting," that any proposed action would result in a substantial increase in the overall protection of the public health and safety, and that the direct and indirect costs of implementation were justified in view of the increased protection.

With respect to the technical adequacy of the DCH issue resolution as documented in NUREG/CR-6075, Supp. 1, and in particular the use of the TCE model, I have concluded that it is not necessary to address each of the specific issues Dr. Williams' has raised to conclude that the resolution is acceptable to satisfy the goals in NUREG-1365, delineated above. Furthermore, it is not necessary to resolve differences between CONTAIN models and predictions, and the basic phenomenological modeling assumptions used in the DCH resolution. Both CONTAIN and TCE include somewhat conservative, but different, models to approximate DCH phenomena and would not be expected to give identical results. The TCE code was used instead of CONTAIN because in the particular cases where it was used, it had advantages over CONTAIN. First of all the TCE code had been more fully developed for use in determining containment loads at the time the work for NUREG/CR-6075 was being done. The TCE code was simpler, faster, easier to run, less dependent on user choices, and transparent. It also could be more readily linked to Monte Carlo sampling techniques.

The TCE code was developed and validated against DCH integral experiments for pressurized-water reactors (PWR) with different containment designs (Zion-like, Surry-like, and Calvert Cliffs-like) at different scales (at 1/40, 1/10 for Zion-like; at 1/10, 1/6 for Surry-like). In addition, for a Zion-like containment, separate effects tests (1/10 scale at Purdue University) were conducted to study the detailed mechanics of transport, entrainment, and de-entrainment of molten core materials under DCH conditions. These DCH integral and separate effects experiments were designed based on the severe accident scaling methodology (SASM) developed for NRC through an extensive peer review process (NUREG/CR-5809, "An Integrated Structure and Scaling Methodology for Severe Accident Technical Issue Resolution," November 1991). In the development of SASM, the methodology was specifically applied to the DCH issue (i.e., identification and prioritization of scaling groups which needed to be preserved as well as assessment of scaling distortion in small scale experimental facilities). In addition, the design, testing, and analysis of the integral and separate effects experiments were also subjected to peer reviews throughout the conduct of the experimental program. Hence, in parallel, the development of TCE and validation against experimental data benefitted from separate ongoing peer reviews.

In my review of the peer review process used for NUREG/CR-6075, Supp. 1, I have determined that the peer reviewers considered the technical issues important to DCH, including use of the TCE code, based on a fundamental technical understanding of each issue and how it was addressed in the resolution process. They posed many probing questions, and additional work was done to address the questions. The peer reviewers were acknowledged experts in their field and not employees of either the Nuclear Regulatory Commission nor Sandia.

In summary, I have concluded that the cost of further addressing the issues Dr. Williams raised in his critique of March 9, 1997, is not warranted. As I previously indicated, I do recommend placing this memorandum with the four documents previously listed in the NRC's Public Document Room to address Dr. Williams' request that his concerns and the NRC's responses to them be available to the public.

Attachment: As stated

In summary, I have concluded that the cost of further addressing the issues Dr. Williams raised in his critique of March 9, 1997, is not warranted. As I previously indicated, I do recommend placing this memorandum with the four documents previously listed in the NRC's Public Document Room to address Dr. Williams' request that his concerns and the NRC's responses to them be available to the public.

Attachment: As stated

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