MEMORANDUM TO: Ralph Caruso, Senior Staff Engineer
Technical Support Staff

FROM: Graham Wallis, Chairman
Thermal-Hydraulic Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE MEETING ON THERMAL HYDRAULICS, August 19-20, 2003, ROCKVILLE, MARYLAND

I hereby certify that, to the best of my knowledge and belief, the Minutes of the subject meeting issued August 29, 2003, are an accurate record of the proceedings for that meeting.

/RA/
Graham Wallis, Chairman

11/6/2003
Date

November 6, 2003

MEMORANDUM TO: ACRS Members

FROM: Ralph Caruso, Senior Staff Engineer /***RA***/
Technical Support Staff

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE MEETING ON THERMAL-HYDRAULIC PHENOMENA, August 19-20, 2003, ROCKVILLE, MARYLAND

The minutes of the subject meeting, issued on August 29, 2003, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc: ACRS Members
R. Savio

cc via e-mail:
ACRS Members
J. Larkins
S. Bahadur
R. Savio
H. Larson
S. Duraiswamy
ACRS Staff Engineers

Issued:8/29/2003
Certified:11/6/2003

**Certified by**
**Wallis Graham**

**CERTIFIED**

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE MEETING MINUTES
EXTENDED POWER UPRATE REVIEW STANDARD
REGULATORY GUIDE 1.82, REVISION 3
AUGUST 19-20, 2003
ROCKVILLE, MARYLAND

## Introduction

The ACRS Subcommittee on Thermal-Hydraulic Phenomena held a meeting on August 19-20, 2003, with representatives of the NRC staff. The purpose of this meeting was for the Subcommittee to review (1) the Review Standard for Extended Power Uprates that has been prepared by the NRC staff, and (2) the Draft Regulatory Guide DG-1107, also known as Regulatory Guide 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident." Mr. Ralph Caruso was the cognizant ACRS staff engineer and Designated Federal Official (DFO) for this meeting. The meeting was convened at 8:30 a.m., August 19, 2003, and recessed at 5:30 p.m. that day. It re-convened at 8:30 a.m. on August 20, and adjourned at 12:40 a.m. that day.

## Attendees

ACRS Members/Staff

| | | |
|---|---|---|
| Graham Wallis | Peter Ford | Thomas Kress |
| Victor Ransom | John Sieber | Stephen Rosen |
| Graham Leitch | Ralph Caruso | |

NRC Staff

| | | |
|---|---|---|
| Zena Abdullahi, (NRR) | Francis Akstulewicz (NRR) | Martha Barillas (NRR) |
| Kevin Coyne (NRR) | Richard Eckenrods (NRR) | Barry Elliot (NRR) |
| Hukam Garg (NRR) | Donald Harrison (NRR) | Patricia Henry (NRR) |
| Gene Hsii (NRR) | Steven Jones (NRR) | Edward Kendrick (NRR) |
| Mark Kirk (RES) | Ralph Landry (NRR) | Richard Lobel (NRR) |
| Shanlai Lu (NRR) | Kamal Manoly (NRR) | Carol Moyer (NRR) |
| Duc Nguyen (NRR) | Allan Notafrancsco (RES) | K. Parczewski (NRR) |
| Sean Peters (NRR) | Robert Pettis (NRR) | L. Raghaven (NRR) |
| Devender Reddy (NRR) | Mark Rubin (NRR) | William Ruland (NRR) |
| Thomas Scarborough (NRR) | Pat Sekerak (NRR) | Angelo Stubbs (NRR) |
| Mohammed Shuaibi (NRR) | Edmund Sullivan (NRR) | David Terao (NRR) |
| Jennifer Uhle (NRR) | John Wu (NRR) | T-Y Chang (RES |
| A. Hsia (RES) | B. Letellier (LANL) | |

Others

J. Butler (NEI)

A list of attendees is attached to the Office Copy of these Minutes.

The presentation slides and handouts used during the meeting are attached to the Office Copy of these Minutes. The presentations to the Subcommittee are summarized below. The Subcommittee received no requests from members of the public to make any written or oral statements.

## Review Standard for Extended Power Uprates

### Introduction (G. Wallis, ACRS)

Dr. Wallis convened the meeting. He welcomed the staff, and noted that responsibility for coordination of the first subject of the meeting would be performed by Dr. Ransom. Thereupon, he transferred the gavel to Dr. Ransom, who introduced the subject of this session - the Review Standard for Extended Power Uprates. He briefly described the background for this topic, which flowed from the Maine Yankee Lessons Learned task force, as well as the substantial number of power uprates that had been requested by licensees over the past few years. He noted that the ACRS had encouraged the staff to prepare this Review Standard in order to ensure consistency of reviews, and so that new information was not overlooked.

### Opening Remarks (W. Ruland - NRR)

Mr. Bill Ruland opened the staff presentation. He introduced the staff participants, and emphasized that the purpose of developing a review standard included (1) standardization of review, (2) predictability, and (3) retention of corporate memory. The standard will be a living document, and the staff will be encouraged to re-assess the guidance and update it to reflect new information that arises. Dr. Ford asked how new staff members would develop the sort of new knowledge that Mr. Ruland referred to. Mr. Ruland responded that the Standard was not a substitute for learning or professional expertise, but is intended to help grow expertise. It will document new issues as they emerge. Mr. Shuaibi added that the Standard would not serve as a substitute for professional development or training.

Dr. Wallis thought that it was important for management to allow the staff sufficient time to perform reviews in order to satisfy their professional judgement of the adequacy of each application. Dr. Kress noted that as margins decrease, operator response time is reduced, and he reminded the staff that the original ACRS concerns that sparked the development of the standard were (1) synergistic effects, (2) loss of margins, and (3) thoroughness of review.

### Development of RS-001 (M. Shuaibi - NRR)

Mr. Shuaibi again recounted the history of the Review Standard, from the Main Yankee Lessons Learned Task Force, to SECY-01-0124, to the ACRS meeting with the Commission in

December 2001, and eventually to SECY-02-0106, which described the staff plans for the Standard. The staff presented the draft version to the Committee in December 2002, and the public comment period ran from December 2002 to March 2003.

Mr. Shuaibi emphasized the goals of the review standard:

(1) Provide comprehensive guidance to the staff for reviews
(2) Provide a mechanism for retention of institutional knowledge
(3) Provide technical review criteria and procedural guidance
(4) Provide a mechanism to update this guidance as new information emerges.
(5) Implement NRR's vision for centralized work planning
(6) Improve focus, consistency, completeness and thoroughness of reviews
(7) Improve documentation of reviews

Mr. Shuaibi used the flow chart in Figure 1 of the Standard to describe how information from the many different sources, and from many different previous uprate reviews, was combined and will be used to perform future uprate reviews.

Section 1 of the Standard contains the Procedural Guidance for the Project Managers, with a flowchart for the overall process. Section 2 describes the areas of review, the acceptance review checklist, the division of responsibility among the review branches, the guidance documents, and guidance for independent analyses in each discipline.

Section 3 is intended to standardize the format and content of the safety evaluation. It is a template for the SER conclusions, with space for a regulatory evaluation and conclusion for each area of review, as well as a technical evaluation. Its form is consistent with current NRR guidance on the form of SERs. Section 4 documents the inspection procedure for power uprates, and highlights particular areas for inspection.

Dr. Wallis noted that there were several different standards for the performance of independent calculations by the staff, and some seemed to deny the need for any calculations at all. Mr. Ruland responded that the staff would reconsider this segmentation of the standard for performing independent calculations, and would get back to the Committee on this issue.

**Containment Review (R. Lobel - NRR)**

Mr. Lobel described the Review Standard for the Containment technical area. This review focuses on :

(1) Peak containment pressure and temperature analyses
(2) Subcompartment analyses
(3) Combustible gas control
(4) Containment heat removal
(5) Minimum containment pressure
(6) New positive suction head
(7) Environment qualification envelope
(8) BWR suppression pool hydrodynamic loads, and
(9) BWR drywell bypass

Mr. Lobel described the analytical methods that licensees use to perform these calculations, and Dr. Ford asked how the staff deals with old approved methods. Mr. Lobel responded that the staff had considered this situation, and for some plants(Duane Arnold and Clinton), it performed independent calculations. The staff's experience with old methods has been that they are still conservative, compared to newer, more realistic methods. If licensees want to continue to use older, conservative methods, the staff generally cannot object.

The staff has, however, observed that power uprates cause licensees to want to use some of the old conservatism. They have changed some models to be more physical, and also attempt to use more realistic input parameters. In those cases, the staff ends up reviewing the new methods. The staff uses the CONTAIN2 code to perform these independent calculations, sometimes using conservative approximations in order to better understand licensee methodologies. He presented some comparison plots of CONTAIN against GOTHIC, showing how a realistic code could be used to approximate, and understand the behavior of a conservative one.

Dr. Wallis noted that the criteria listed on page 19 of the presentation slides for containment calculations should be used for all disciplines.

**Mechanical Engineering (K. Manoly - NRR)**

Mr. Manoly described the scope of review for mechanical and civil engineering, which includes all reactor coolant system components, including vessels, pipes, valves, internal components, and supports. The staff also considers the evaluation methodologies and acceptance criteria that licensees use to evaluate this equipment. The staff considers the impact of an uprate on previous responses to generic communications, on postulated pipe rupture locations, on the dynamic response of structures, and on the qualification of equipment for service.

He then described the staff assessment of flow induced vibration(FIV) on BWR reactor steam dryers and other internal components. This issue had become prominent because of failures at Quad Cities 2 after a power uprate. The staff also considers FIV in other components as part of power uprate reviews.

At Quad Cities (QC), the safety related function of the dryer is to maintain its structural integrity during a steam line break. In light of the QC experience, the staff will require more detailed evaluations from the next BWR that requests an EPU. Dr. Ford commented that there seemed to be no staff analysis of the safety-related determination for the dryer. Mr. Terao responded that the staff would be discussing the generic implications of this failure with the BWROG soon. The BWROG and GE are in the process of developing new guidance, and GE is expected to issue a Service Information Letter (SIL). When that letter is issued, the staff, the BWROG, and GE will hold additional meetings to consider the need for further regulatory actions. Mr. Shuaibi pointed out that any new actions arising from these discussions would be included into a new revision of the Review Standard.

Mr. Sieber commented that he did not think that the staff should go forward with any more uprates until this issue is resolved.

**Plant Systems (J. Tatum - NRR)**

Mr. Tatum described the scope of review of the plant systems branch, which includes a wide variety of issues not directly connected to the reactor coolant system. He noted that the staff had issued supplemental guidance on a number of topics related to power uprates, such as fire protection, spent fuel pool cooling, auxiliary cooling water systems, and water hammer.

**ACRS/Public Comments (M. Shuaibi - NRR)**

Mr. Shuaibi then discussed the public comments that had been received concerning the Review Standard, and he also responded to several comments from the last meeting with the ACRS.

Three public comment letters were received, from the STARS Alliance, NEI, and Framatome ANP. They addressed the following issues:

(1) Backfit/plant-specific licensing bases
(2) Burden of completing the matrices
(3) Need for independent calculations
(4) Use of precedents
(5) Impact on NRC-approved topical reports
(6) Control of future changes to the Standard
(7) Pilot use of the Standard
(8) NRC management oversight
(9) Acceptance reviews
(10) Efficiency of the new process
(11) Need for review of non-licensed plant staff training
(12) Stand-alone reference section
(13) NRC fee-billing practices

Some of the comments were resolved by incorporating minor changes to the structure or content of the Standard. Other comments will be addressed as part of the normal course of business by the staff, as it implements the standard, and makes changes that are reviewed by various stakeholders. The last item is a separate policy issue that is not unique to the uprate Review Standard.

Mr. Shuaibi also discussed how the staff had responded to past ACRS comments by structuring the Review Standard to include “Lessons Learned” from other reviews, improved documentation, enhanced communication with the inspection staff, and criteria for performing independent calculations. The staff agrees with the ACRS that the reduction in time available for operator actions is important, as are various corrosion phenomena, feedwater piping fatigue, local power oscillations, and ATWS. He also mentioned that the staff was developing a new proposal to determine when to involve the ACRS in a power uprate review, in place of the current 5% cutoff limit.

Dr. Ford and Dr. Wallis emphasized the need for the staff to stay on top of evolving issues, such as FIV and IASCC. The staff should not assume that these problems are resolved as the resolution is based on crude calculations. The staff also needs to continue to observe equipment behavior and performance after an uprate has been approved, to ensure that the

calculations properly predict equipment and material behavior. They also questioned whether it was really a burden for the staff to require the production of a high quality PRA by applicants who are seeking a power uprate.

Dr. Wallis commended Mr. Shuaibi for this perseverence in developing the Review Standard.

**Risk Evaluation (D. Harrison - NRR)**

Mr. Harrison described the staff scope of review for the risk evaluation. This includes internal events (initiating event frequencies, component reliability, success criteria, and operator actions), and external events (seismic, fires, high winds, floods, and other events). For seismic events, the staff uses a seismic margins approach, and the staff developed new guidance for this approach for the Review Standard.

The staff also considers shutdown operations, and the quality of the PRA. The review is not necessarily risk-informed, but the staff does look for risk insights. The reviews include site audits of the PRA and uprate analyses to ensure that they are performed appropriately. If necessary, independent calculations are performed when potentially significant risk impacts are identified. These calculations are also performed if the staff questions the PRA results, or the PRA quality, or when Special Circumstances are identified in accordance with Appendix D of Chapter 19 of the SRP.

Dr. Kress asked whether the staff was aware of any licensee updating their LERF results by re-performing their Level II PRA after having received their extended power uprate (EPU). Mr. Harrison replied that he was not aware of any licensee re-performing their Level II PRA after an EPU, especially since many licensees use a simplified approach to calculating LERF based on NUREG/CR-6595, "An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events."

[Note: Subsequent to the meeting, Mr. Harrison reported back to Mr. Caruso that he had checked some records, and was aware of a licensee who had performed a Level II PRA after having implemented an EPU. The Dresden and Quad Cities EPUs were approved in 2001. The EPU LERF model was based on NUREG/CR-6595 and did not take credit for drywell sprays. For Dresden and Quad Cities, the licensee replaced their simplified LERF models with full Level II PRAs for the SAMA evaluations that were performed as part of the EIS in support of their license renewal applications, which are still under review by the staff. The source terms were also updated to account for the EPU. In addition, subsequent to the EPU approval, the licensee updated their internal events PRAs, resulting in revised CDF estimates. Additional details of this information have been provided to the members in the e-mail from Mr. Harrison.]

**Material Engineering (T. Sullivan - NRR)**

Mr. Sullivan described the scope of review for the Materials and Chemical Engineering Branch, which includes:

(1) Reactor Vessel Material Surveillance
(2) Pressure-Temperature Limits
(3) PTS

(4) Reactor coolant system components, internals, and core supports
(5) Leak before break
(6) Protective coatings
(7) Flow accelerated corrosion(FAC) and
(8) SG tube ISI

An important consideration regarding power uprates is the fluence on the reactor vessel, and this section of the review focuses on the effect of increased fluence on $RT_{PTS}$. The review ensures that the calculated value complies with 10CFR 50.61, to ensure the structural integrity of the reactor coolant pressure boundary.

Regarding FAC, the review evaluates the effects of changes in flow rates and the thermodynamic conditions in piping on FAC corrosion rates, and evaluates licensee modeling and monitoring programs, to ensure the structural integrity of the piping systems. The staff performs independent calculations of the $RT_{PTS}$ and upper shelf energy associated with these issues.

Dr. Ford noted that IASCC can be exacerbated by the superposition of vibration loads, which can change as a result of an uprate, and he asked how the staff took this into account. He also questioned how the staff evaluated the effect of an uprate on the efficacy of the NobelChem treatment in BWRs. Mr. Elliot responded that the staff used the methods described in RG 1.190, and that the changes in flow rate due to the uprate affect the inspection frequency for reactor vessel internals.

**Reactor Systems (S. Peters, Z. Abdullahi - NRR)**

Mr. Peters described the scope of review for the Reactor Systems Branch, which includes the reactor fuel, nuclear design, thermal-hydraulic design and analyses, reactor systems response, and transients and accidents described in the FSAR for the plant. The staff has established criteria for performing independent calculations and audits of licensee calculations, depending on the novelty of the application, extensions of approved methodologies, and the knowledge of the reviewer that the methods or results may be questionable or results in a significant reduction in margin.

Dr. Wallis asked how predictable the behavior of fuel would be under the uprate conditions. Mr. Sieber added that he was more concerned about CHF/DNB and LOCA performance than neutronics. Dr. Ransom noted that the core power shapes for the uprates are different from pre-uprate conditions, and asked how the staff ensured that the analytical methods are still valid. Dr. Ford asked whether the staff had looked at the behavior of the fuel, under a higher neutronic flux, with a higher core flow rate, to see that it was behaving as intended. Mr. Akstulewicz replied that the staff could not reply to these specific phenomena, because the questions have not been asked before, but he promised to look into them, and get back to the Committee.

**Human Factors (R. Eckenrode - NRR)**

Mr. Eckenrode described the approach for review of the human factors issues involved in power uprates. For this issue, the staff consider the changes that licensees have to make to

emergency and abnormal operating procedures, operator actions that are sensitive to the power uprate, changes to control room controls, display, and alarm, and the operator training program. Several SRP sections form the basis for the review, and the staff has revised SRP Section 18 “Human Factors Engineering”, to incorporate some lessons learned.

Mr. Eckenrode stated that it is important to have operators properly trained in the plant simulators prior to the uprate, and that some licensees have used these training programs to demonstrate that operators can adequately deal with changes to required operator response times. The standard for calculating operator action times is described in ANSI/ANS-58-8, and the staff believes that this standard is conservative. Mr. Leitch asked about sites with multiple units where one plant may have implemented an uprate, while the other(s) may not. Mr. Eckenrode replied that this situation is not uncommon, and it can get tricky. Many plants limit operator licenses to a particular plant, in order to avoid these sort of conflicts.

**Power Ascension/Testing (K. Coyne, R. Pettis - NRR)**

Mr. Coyne described the scope of review, and the guidance that had been prepared regarding power ascension programs and testing. As a result of some difficult experiences reviewing some large BWR uprates, the staff developed a new SRP Section 14.2.1, which describes the criteria for performing power ascension testing. The criteria that the staff is proposing to use include:

(1) The initial plant testing has been potentially invalidated by the EPU
(2) Significant plant modifications were necessary to implement the EPU
(3) System or component performance can only be verified by integrated testing

The default requirement in the SRP would require a licensee to perform the set of initial startup tests that were originally performed at 100% of the original licensed power level. Licensees who do not believe that this testing is needed would have to justify their position.

Mr. Seiber noted that in order to determine whether these tests should be performed, it is important to understand why they were required in the first place. Mr. Rosen noted that this could be identified by looking through the original startup test reports. Mr. Leitch asked how much instrumentation would be required. He thought that it should not be the same as the original tests, because the information that would be sought from these tests should be a subset of the information originally gathered.

Mr. Coyne replied that the staff would consider the results and procedures used for the initial startup tests to evaluate whether they needed to be repeated. Mr. Shuaibi commented that the staff should take this into consideration in determining how much instrumentation would be required.

Mr. Sieber and Mr. Rosen both closed the presentation with the observation that they thought that some sort of integrated testing from high power should be required, because these events were certain to happen with moderate frequency during a plant’s lifetime, and it would be better if the first event were to occur while the plant operations staff was prepared for it, so that any surprises could be dealt with more effectively. Mr. Seiber also noted that he remembered that one plant that had performed an uprate had suffered some damage to piping hangers during

just such a transient, following an uprate. Mr. Shuaibi promised to investigate this scenario, and report back to the Committee.

**General Discussion, Subcommittee Comments, Concerns and Recommendations (V. Ransom, ACRS)**

Dr. Ransom then reviewed the notes that had been provided by Mr. Caruso, and he asked the members to address the commitment made by the staff in SECY-02-0106 to prepare a Review Standard that included:

(1) A clear definition of the review scope,
(2) References to existing review criteria, and
(3) Template safety evaluations

Dr. Ransom stated that he believed that the staff had met this goal, and he thought that the Committee should endorse its use for future EPU submittals.

Mr. Rosen agreed that the document would be useful for the agency, as review guidance, and as an aid to knowledge management. He was concerned that the integral system testing is not required, and he thought that the way that the standard is written, it may be interpreted in such a flexible way that the testing will not be performed. Otherwise, he thought that it should move forward.

Dr. Wallis thought that the Standard is responsive to the needs of all stakeholders. He would like to see more detail than a simple checklist for use by the staff, and he thought that the criteria for performing independent calculations should apply to all disciplines, not just the few that had developed specific guidelines. Also, the criteria for performing integrated transient testing is not clear, and there is no clear rationale whether to test or not. He also thought that there needed to be more details about the PRA review.

Dr. Kress thought that the document was impressive. It would be a good idea to use the MELCOR to see how severe accident changes the consequences for power uprates, but this sort of calculation is not included in the review standard. He also reiterated a long-standing Committee question about what particular component or phenomena actually limits the amount that power can be raised. He also wondered what sort of uprates would be allowed, or made easier, by the proposed new LBLOCA definition. Finally, he agreed with Dr. Wallis that the criteria for performing independent calculations should be uniform across the various technical disciplines.

Mr. Sieber thought that the Review Standard was a job well done. It will help the staff, licensees, and the ACRS better understand how the staff performs its job. He noted that the integral transient testing issue is still unresolved, and he agreed with the comments of Mr. Rosen. The staff also needs to better refine its definition of the need for independent calculations

Dr. Ford noted that the Standard appropriately identified material degradation issues that are related to power uprates. These issues continue to evolve, however, and the references in the

Standard are dated, so the staff needs to stay in contact with the technical community to understand new developments as they arise. Dr. Ford also thought that the staff should maintain the ability to audit vendor and licensee calculations and documents, and the Office of Research should be challenged to look beyond the current horizon for new, emerging phenomena. Synergistic effects should be kept in mind, and not be ignored.

Mr. Leitch thought that the staff had made a good presentation. The Standard meets the criteria laid out in the SECY, and the document should be presented to the full Committee for endorsement. He is still concerned about the large transient testing issue. The criteria should be betted defined now, rather than put off into the future. He thought that licensees could easily obtain a minimal set of valuable data from this sort of testing, without it being a burden.

## Regulatory Guide 1.82, Revision 3 - "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident"

### Introduction (G. Wallis - ACRS)

Dr. Wallis opened the meeting with a description of the issue, which has a long history dating back to the early days of commercial reactor power licensing. It involves the recirculation of reactor coolant from the containment sump following a LOCA. Recirculation of this fluid is needed to ensure long-term cooling of the reactor following a LOCA, in accordance with the requirements of the GDC and 10 CFR 50.46.

### Opening Remarks (T. Hsia - RES)

Mr. Hsia thanked the Subcommittee for meeting with the staff to discuss this issue. He recounted the history of the issue, and noted that this was only the latest version of a regulatory guide that has evolved as operating experience has accumulated. Revision 0 of the RG was issued in June 1974, and it was based on an assumption of 50% blockage of the sump screens. Revision 1, issued in 1985, included additional guidance based on the resolution of USI A-43. Revision 2 was issued in 1996, and it included revised guidance for BWRs, and requested licensees to implement measures to ensure ECCS functionality following a LOCA (Bulletin 96-03).

Mr. Hsia noted that this meeting was intended to present only the draft Regulatory Guide, and not the Generic Letter, which is being prepared by NRR. Additional interaction with the ACRS to discuss the Generic Letter, the Bulletin, the industry response to the bulletin, and the industry guidance documentation will occur later this fall or winter.

### Public Comments and Resolution (T.Y. Chang - RES)

Dr. Chang presented an overview of the RG, as well as a summary of the comments that had been received, and the staff response to those comments.

Revision 3 to RG 1.82 is intended to enhance the debris blockage evaluation guidance for PWRs, and to provide guidance about analytical methods that are acceptable to the staff. Research that was performed after issuance of Revision 2 indicated that it was not

comprehensive enough to ensure adequate evaluation of the susceptibility of a PWR sump to the effects of debris blockage. He noted that this RG is not a substitute for the requirements of the regulations, and compliance with it is not required. Alternative methods can be proposed by licensees, and would be considered by the staff for approval.

Eighty-nine comments were received from the public (four utilities, Westinghouse, NEI, and one individual). The comments and concerns raised most frequently included:

(1) Conformance issue for current plants
(2) Containment pressure for the design of the ECCS
(3) Screen mesh size
(4) Leak-before-break for debris source
(5) Partially submerged screens and failure criteria
(6) Basis for 1/8" thin bed value
(7) Adequate protection from missiles
(8) Use of CFD and other methods for debris transport calculations

The staff made the following response to these comments:

(1) Section D of the RG has been revised to make it clear that no backfitting is intended or approved. The RG will be used to evaluate current licensee methodologies for long-term recirculation cooling capabilities following a LOCA
(2) Conceptual features have been added to Figures 1 and 2, and Section C.1.1.1.16 has been added to clarify that it may be desirable to consider advanced strainer designs since they have demonstrated capabilities not provided by the simple screen designs.
(3) Section C.1.3.1.1 has been revised to be consistent with the licensing basis for sub-atmospheric containment plants
(4) Section C.1.1.1.12 has been modified to state that if the sump screen mesh size cannot be made fine enough to protect pump seals or bearings, then modifications should be made to pumps to be able to operate with debris.
(5) The staff did not accept the comment that LBB should be applicable to LOCA-generated debris.
(6) Section C.1.3.4.4 has been modified to allow for credit for sump screen submergence as a function of time, and pump failure criteria as a function of screen head loss have been revised.
(7) NUREG/CR-6224 has been listed as the source for the thin-bed value
(8) Section C.1.1.6 has been revised to allow credit for protection provided by surrounding structures
(9) Section C.1.3.3.4 has been modified to allow alternative methods other than CFD, if they are supported by adequate validation using experimental data.
(10) Section C.1.1.1.8 has been modified to require debris interceptors to withstand inertial and hydrodynamic loads following an SSE without loss of structural integrity.
(11) The staff acknowledged that there are no NRC-published references pertinent to chemical reactions in the pool.

No comments were received from the public regarding the ACRS request to invite public comments regarding alternative solutions to strainer blockage.

In the discussion that followed these comments, Dr. Wallis noted that the document did not contain clear guidance to the staff about how the staff or licensees were to evaluate all of the items to be considered, or how they were to weigh the different issues to determine that the regulations were satisfied. Dr. Wallis and Mr. Rosen both noted that there is still no guidance from NEI on how to address these issues. Mr. Rosen commented that he had attended a recent industry conference on this topic, and NEI did not intend to provide any guidance on how to deal with debris that passed through the sump screens, through the pumps and valves and piping systems, and became lodged on the debris filters that are now being installed on the inlet nozzles of almost all new fuel bundles. He thought that this was a matter that would have to be dealt with at some time, and he did not understand why it was being deferred.

Dr. Wallis noted that the staff guidance assumed that metallic debris, including metallic paint chips, would sink and not be suspended in the fluid stream. He asked whether the staff had taken into account the effects of flotation of these chips by the chemical interaction of the borated coolant with the metal and the subsequent generation of hydrogen. He also asked whether the staff had taken into account the presence of sheets of plastic material inside containments.

Mr. Butler, from NEI, responded that NEI was planning to issue its guidance document in September, 2003. He could not address the technical issues that the Committee had raised. Mr. Architzel noted that the industry is just starting to work on many of these questions.

**Summary of RG 1.82/Discussion of Accident Sequences (B. Letellier - LANL)**

Dr. Letellier presented a summary of the RG methodology and the accident sequences that it was intended to address. The methodology requires that a number of LOCAs, of different sizes and location, be postulated, and a Zone of Influence (ZOI) be determined for each break location. The breaks can be reactor coolant system breaks, or in some cases, main steam line breaks. All potential debris sources within the ZOI must be considered. The staff has prepared a “Knowledge Base Report,” NUREG/CR-6808, which describes sources of debris, and methods that can be used to estimate the amount of debris that may be generated by a LOCA. Dr. Letellier also described several other references that are used to support the overall RG 1.82 methodology.

The guidance also includes methods for calculating debris transport and washdown. Some of the phenomena that need to be considered are the initial placement of the debris, the condition and impingement characteristics of the spray, entrainment and trapping during drainage, and erosion from spray impingement and drainage cascades. Settling of heavy debris is also a factor, although no consideration is given to buoyancy effects due to chemical reactions and hydrogen generation. One acceptable method is a CFD simulation in combination with experimental debris transport data. Alternative methods are acceptable provided that they are supported by adequate validation of analytical techniques using experimental data.

The RG also describes methods to calculate the head losses through the sump screen. This is one area where research is ongoing, and RES is planning to issue a calcium-silicate head loss report in October 2003.

Dr. Kress asked whether the staff was considering the consequences of complete sump screen blockage, with a loss of recirculation capability. The staff responded that this scenario would be treated as a severe accident, and is not included as a design basis scenario.

Drs. Kress and Wallis asked whether the ZOI model had been benchmarked against the information that had been learned from the Barseback and Gundremmigen events. The staff reported that it had not compared the methods against these events, and did not have detailed information about the debris that was found there.

**Chemical Effects (B. Letellier - LANL)**

Dr. Letellier departed from the originally-agreed upon agenda at this point, to discuss work that was ongoing to address the effect of chemical reactions between coolant that would be released to the containment, and the debris and other materials within the containment that are not normally in contact with reactor coolant. Because PWR coolant contains soluble boric acid, and because some plants also inject other chemicals into the containment during a LOCA to control pH for purposes of severe accident dose control, there are many possible chemical reactions that can occur, creating new chemical species that have a wide variety of physical forms. Some plants have observed the formation of gelatinous materials in their containment sumps during normal operation, from the interaction of liquid leakage, condensation, and containment structural materials, and it has been postulated that this sort of material might be created during a LOCA.

The staff will convene a peer-review panel to consider these phenomena in September 2003. This is the start of additional work that will review the existing literature and establish the appropriate test conditions for more studies. The corrosion rates of iron, zinc, and aluminum will be considered, as well as the head-loss effects of chemical precipitates, and the chemical degradation of fibrous debris beds, which could lead to compaction and increasing head loss.

Some preliminary studies have shown the formation of iron, aluminum, and zinc precipitates, and Dr. Letellier showed the subcommittees photos of sample debris beds that would be created from these precipitates. The material looked quite sticky, and head-losses through the beds could be quite significant. However this work is just starting, and it will take considerably more work to establish that the chemistries described in these tests are representative of actual plant conditions during a LOCA. The results of these studies will be documented in a forthcoming report, to be issued in September 2003.

Dr. Ford cautioned the staff to be careful about getting the chemistry right, because the zinc chromate used in containment primers is different from zinc metal granules, and from galvanized iron. Dr. Wallis asked the staff whether boric acid would remove paint from its underlying substrates, and the staff responded that it depended on the paint, and the substrate, and the environmental conditions. Current corrosion data indicate that there could be large corrosion deposits formed on debris beds.

Mr. Architzel noted that the industry wants to resolve this chemistry issue before it takes action regarding the overall sump strainer issue, because chemical precipitates may have a significant effect on the resolution path.

**Closing Comments (T.Y. Chang - RES)**

Dr. Chang closed the presentation with a summary of continuing RES efforts. Besides the calcium-silicate and chemical test reports that will be issued in September, there is a long-term plan to do debris sample characterization for PWRs, perform additional head loss tests, investigate HPSI throttle valve clogging, and discuss all of these activities at an international workshop in early 2004. All RES activities are scheduled to be completed by the end of FY04.

Mr. Hsia also noted that the RG would be reviewed by the CRGR at a meeting on August 26.

**Committee Discussion (G. Wallis - ACRS)**

Dr. Kress commented that this is a significant safety issue, and he was surprised that no one had used a risk-informed approach to address it. He thought that LBB could be put to help resolve it. He thought that the ZOI methodology could use more thought. The chemistry issue, though, has the potential to be a real show-stopper, and he thought it would be very important to understand the chemical kinetics of the debris pool, the surrounding coolant, and associated containment materials. This is an important phenomenon. As a result he did not think that the RG was far enough along to issue. He would also like to see the NEI guidance document together with the RG before making a decision.

Mr. Butler, from NEI, commented that the industry is not waiting for resolution of the chemistry issue. He noted that the industry has held a workshop and is doing plant walkdowns to understand the current plant configurations. The final path to overall resolution is difficult, though, without knowing how the chemistry issue itself will be resolved.

Dr. Ford thought that the RG and associated materials identify all of the relevant phenomena, The kinetics of the chemistry is not resolved, and there is no quantification of the uncertainty of the analysis of the integrated behavior of the recirculation system. He thought that the staff had prepared good descriptions of the separate effects, though. He doesn't see how licensees will be able to effectively use the RG, though, and it will require a large amount of work to demonstrate compliance. He concluded with the recommendation to issue the RG with the proviso that additional work continue by both industry and the staff.

Mr. Sieber commented that there is certain to be a Revision 4 to this RG, because this is a difficult issue, and it does not deal with all of the phenomena that have been identified. He wondered whether the chemistry issue might be the over-riding phenomenon to resolve. Overall, the RG is not incorrect, even if it is incomplete. If it is issued, both industry and the staff must continue their research efforts. It will not be possible to demonstrate that plants meet the GDC without more research. He also was concerned that application of the backfit rule might allow the industry to do nothing about the issue for a long time.

Dr. Ransom thought that there should be more use of risk insights in addressing the issue. There should also be more consideration of other active/passive screen solutions, and he thought that the RG should allow for alternative solutions.

Dr. Wallis commented that the overall regulatory strategy for this issue remained unclear. He did not see that the industry could respond to this guidance very effectively, especially if the

chemistry issue turns out to be dominant. He did not see a clear route to final resolution of the question, and he thought that the industry and the NRC staff should consider how they will apply this guidance in practice.

**Staff and Industry Commitments and ACRS Comments**

**EPU Review Standard**

(1) The staff should re-consider the criteria for performing independent calculations, and will determine whether criteria can be developed that apply across all technical disciplines.

(2) The staff will investigate reports that at least one plant that implemented a power uprate subsequently experienced damage to pipe supports during a transient.

(3) The staff should re-consider its approach to requiring integral transient tests, and provide a consistent rationale for performing these tests.

**Regulatory Guide 1.82, Revision 3 - "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident"**

(1) The staff and industry needs to continue to perform research to investigate the chemical interactions that may occur between the coolant that is released to the containment, and the containment materials and debris, to determine if they can affect sump performance. This is a significant issue.

(2) The staff and industry need to provide guidance for dealing with material that passes through the sump screen, but which becomes lodged on reactor fuel element debris screens.

(3) The staff and industry need to provide a better discussion of the effects of transient materials inside containment, especially large sheets of plastic or blankets of fibrous material.

(4) The staff and industry need to consider the effect of chemical reactions and the generation of hydrogen on the bouyancy of small metallic pain chips/debris, which may not sink to the bottom of the flow stream if the hydrogen gas adheres to the debris.

(5) The staff and industry should consider using risk insights to help resolve this issue.

**Subcommittee Decisions**

The Subcommittee will report the results of this meeting to the full Committee at the September, 2003 meeting.

**Follow-up Actions**

None

**Background Material Provided to the Subcommittee Prior to this meeting**

1. "Review Standard for Extended Power Uprates", memorandum from Ledyard B. Marsh to John T. Larkins, August 1, 2003
2. SECY-02-0106, "Review of ACRS Recommendations for the Staff to Develop a Standard Review Plan for Power Uprate Reviews", June 14, 2002
3. Regulatory Guide 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Cooling Accident", August, 2003 (Draft was issued as DG-1107)
4. Resolution of Public Comments on DG-1107, July 11, 2003
5. Letter from James W. Davis(NEI) to Mohammed A. Shuaibi, March 31, 2003
6. Letter from D. R. Woodlan (STARS) to Mohammed A. Shuaibi, March 28, 2003
7. Letter from James F. Mallay (Framatome ANP) to Mohammed A. Shuaibi, May 2, 2003

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Note: Additional details of this meeting can be obtained from a transcript of this meeting available for downloading or viewing on the Internet at "http://www.nrc.gov/ACRSACNW" or can be purchased from Neal R. Gross and Co., Inc., (Court Reporters and Transcribers), 1323 Rhode Island Avenue, NW, Washington, DC 20005 (202) 234-4433

**Presentation Slides and Handouts Provided during the Subcommittee meeting**
Attached to the office copy of these minutes