March 31, 2003

COMMISSION VOTING RECORD

DECISION ITEM: SECY-02-0057

TITLE: UPDATE TO SECY-01-0133, "FOURTH STATUS REPORT ON STUDY OF RISK-INFORMED CHANGES TO THE TECHNICAL REQUIREMENTS OF 10 CFR PART 50 (OPTION 3) AND RECOMMENDATIONS ON RISK-INFORMED CHANGES TO 10 CFR 50.46 (ECCS ACCEPTANCE CRITERIA)"

The Commission (with Chairman Meserve and Commissioner Merrifield approving in part and disapproving in part and Commissioners Dicus, McGaffigan and Diaz approving) responded to the subject paper as recorded in the Staff Requirements Memorandum (SRM) of March 31, 2003.

This Record contains a summary of voting on this matter together with the individual vote sheets, views and comments of the Commission.

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Annette L. Vietti-Cook
Secretary of the Commission

Attachments:
1. Voting Summary
2. Commissioner Vote Sheets

cc: Chairman Meserve
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan
Commissioner Merrifield
OGC
EDO
PDR

VOTING SUMMARY - SECY-02-0057

RECORDED VOTES

	APRVD	DISAPRVD	ABSTAIN	NOT PARTICIP	COMMENTS	DATE
CHRM. MESERVE	X	X			X	3/4/03
COMR. DICUS	X				X	3/20/03
COMR. DIAZ	X				X	10/30/02
COMR. McGAFFIGAN	X				X	3/26/03
COMR. MERRIFIELD	X	X			X	3/17/03

COMMENT RESOLUTION

In their vote sheets, Chairman Meserve and Commissioner Merrifield approved in part and disapproved in part. Commissioners Dicus, McGaffigan, and Diaz approved the staff's paper. Subsequently, the comments of the Commission were incorporated into the guidance to staff as reflected in the SRM issued on March 31, 2003.

Commissioner Comments on SECY-02-0057

Chairman Meserve

This paper presents staff's updated recommendations on the introduction of risk-informed changes to 10 C.F.R. 50.46, Appendix K, and General Design Criterion (GDC) 35. All of the changes relate to the NRC's approach to the regulation of Emergency Core Cooling Systems (ECCS). The proposed changes encompass four technical areas: ECCS reliability, ECCS acceptance criteria, ECCS evaluation models, and the ECCS spectrum of design basis break sizes and locations. Commissioner Diaz in his helpful vote has focused on the latter element, which presents the opportunity for the most profound change in our regulatory approach. I shall address that element first.

1. Spectrum of Break Sizes. I agree with Commissioner Diaz that the Commission should consider redefining the design basis large-break loss-of-coolant accident (LBLOCA) in view of the apparent low risk associated with such events.[1] Like Commissioner Diaz, however, I conclude that we do not yet have an adequate technical basis to support such action. I thus join him in urging that the staff develop a foundation for the revision of this aspect of our regulatory system.

I also agree with Commissioner Diaz's conclusion that design basis LOCAs should be considered in the context of a realistic assessment of risk. He suggests that such an accident might be defined to include breaks up to and including a break equivalent in size to the double-ended rupture of the largest pipe in the reactor coolant system (RCS) or, and this is the new element, up to an alternate maximum break size determined by including at least XX% of the LOCA contributors to core damage frequency. This approach reflects the fact that the risk from loss-of-coolant accidents is dominated by the risks arising from breaks toward the smaller end of the spectrum, allowing the relaxation of the requirements arising from an improbable event associated with the break of the largest pipe in the RCS. Such an event would still be considered as a contributor to overall risk of the plant, but because of its small contribution to risk would not be part of the deterministic design basis. Commissioner Diaz has offered an interesting way to limit the size of the largest break that need be considered -- an approach that is fully consistent with the risk-informed philosophy that has guided the Commission in recent years. Indeed, there are safety consequences that arise from the current LBLOCA requirements, in that licensees' efforts to address issues related to compliance with LBLOCA regulatory requirements can divert attention and resources from issues of greater risk significance. Thus, the change may well serve to reduce risk overall.

Although I approve the pursuit of Commissioner Diaz's approach, I suggest a slight modification. There are some operating plants for which the preponderance of the overall risk results from accidents other than LOCAs (e.g., all BWRs). Thus, defining the LBLOCA on a plant-specific basis in terms of only the LOCA contributors to risk will create significant differences from plant to plant. That is, a plant with small LOCA contributors to overall core damage frequency (CDF) would have to consider initiating events with much lower frequencies

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[1]LBLOCAs beyond a newly-defined design basis would be handled by licensees in the same manner as required for other beyond-design-basis events.

than plants with relatively large contributions from LOCAs to overall CDF.[2] This would have the perverse result of penalizing a plant for which LOCAs already comprise a relatively small percentage of overall CDF. In order to avoid this dilemma, it might be appropriate to consider an approach in which the alternative maximum LOCA to be included within the design basis is established on a plant-specific basis using some percentage of the total CDF risk, rather than the risk associated only with LOCAs.

Staff's further work should include several other considerations as well. First, staff should consider the full range of contributors to LOCAs, even if those contributors do not include actual pipe breaks. I am mindful that the LBLOCA as currently defined stands as a surrogate for the initiators of a wide range of major loss-of-coolant accidents. These include not only large pipe breaks, but also failures of large components, such as steam generator manways and reactor vessel head penetrations. See SECY-01-0133, Att. 2, at A-8.
Thus, in evaluating the risks of LBLOCAs, staff should include the full range of contributors to such scenarios.

Second, I would be cautious in crediting the fact that a pipe will leak before it breaks as a justification of diminished concern for LBLOCAs. The issue is not just whether a pipe leaks, but whether the leaks are detected in a timely fashion. Recent experiences at the V.C. Summer and Davis-Besse plants have shown that it is possible for significant cracks to exist and to leak without being detected. I thus conclude that the Commission should credit leak-before-break considerations only in conjunction with the establishment by a licensee of reliable and comprehensive means to detect primary system leaks of the relevant size. Of course, determining the relationship between crack size and leak rate itself is complicated because of the need to consider material type, the degradation mechanism (e.g., the length and roughness of the crack), and the thermal-hydraulic conditions of the fluid in the pipe.

Third, there should be careful consideration of the implications of the 10-year frequency for the reexamination of LOCA frequency distributions that is proposed by Commissioner Diaz. In light of the fact that further plant experience will provide relevant data, it is appropriate to consider the frequency distributions on a periodic basis. But, although plant procedures may be amenable to periodic change resulting from the new data, it is obviously not possible to undertake modification of the basic ECCS equipment. This would suggest that the design criterion for the ECCS in construction should be based on the break of the largest pipe, but the ancillary requirements (e.g., technical specifications for safety injection flowrates and inspection frequencies for accumulator condition) should be subject to modification along the lines that Commissioner Diaz suggests. The redefinition would also provide more operational flexibility by allowing power uprates, higher peaking factors and assembly discharge burnup.

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[2] This can be illustrated using the PRA studies in NUREG-1150. For the Surry plant, (Westinghouse three-loop PWR), the mean CDF for internal events if 4.0E-5, and the mean CDF from all LOCAs is approximately 7.6E-6. Using a LBLOCA size that accounts for 95% of the LOCA CDF would thus account for about 18% of overall plant CDF and would eliminate from consideration LOCAs accounting for about 1% of CDF. However, for Peach Bottom, a BWR-4 plant, the overall mean CDF for internal events is 4.5E-6 and that from all LOCAs is 2.6E-7. Using 95% of LOCA CDF would require consideration of events that comprise about 5% of overall plant CDF, and would eliminate from consideration LOCAs that account for only about 0.3% of overall CDF.

Finally, in pursuing the approach that Commissioner Diaz has outlined (or the variant proposed here), staff must establish the appropriate risk "cutoff" for defining the maximum LOCA size. The risk metric recommended by the staff should take into account the uncertainties in PRA analysis as well as the uncertainties in estimating the initiating event frequencies for rare events (e.g., 95% probability with a 95% confidence limit).

2. Acceptance Criteria. I approve the staff's recommendation to proceed with modifications to 10 C.F.R. 50.46 and GDC 35 to provide for a more performance-based approach to meeting ECCS acceptance criteria. This includes the development of acceptance criteria for cladding performance such that licensees would be able to use materials other than Zircaloy or ZIRLO without an exemption. However, this approach should not relieve licensees of the need to provide an adequate technical basis to demonstrate that other cladding materials can meet the performance-based criteria.

3. ECCS reliability. I agree with the staff's conclusions that there is an adequate basis for the staff to move forward to eliminate, on a generic basis, the requirement for considering the loss of offsite power (LOOP) coincident with a LBLOCA. Memorandum from A. Thadani to S. Collins (July 31, 2002). The staff should move forward with the development of the necessary regulatory changes. In developing the technical bases supporting these changes, the staff should ensure that relevant issues and uncertainties that can impact plant risk are adequately considered (e.g., delayed LOOP and "double sequencing" of safety functions). This change should help to reduce wear and tear on diesel generators by lengthening the time required to bring the generators to speed and simplifying the associated testing requirements. I emphasize that while the costs of repairing the diesels is a significant issue for licensees, my concern is one of safety: the change should result in increased diesel availability by virtue of fewer required teardowns, and higher reliability in diesel generator operation.

I understand as well that a plant-specific approach to implementation of a risk-informed alternative to GDC 35 requirements concerning ECCS reliability with respect to the single failure criterion is feasible, but that a generic approach is not. Id. at 1. Accordingly, staff should pursue a plant-specific approach on this issue.

4. ECCS evaluation model. I disapprove the staff's proposal to conduct the piecemeal updating of Appendix K. Commissioner Diaz's description of the LBLOCA as having been "rendered obsolete by improvements in safety performance and analysis" is applicable to Appendix K as well. Appendix K reflects the NRC efforts to establish the required content of LOCA codes in the early 1970s, when relatively little was known about the phenomena that were being modeled. As a result, Appendix K contains conservatism with regard to decay heat, zirconium oxidation, and other phenomena that are intended in part to compensate for known phenomena, such as downcomer boiling, that are not included within the code. A reduction of the conservatism in the included phenomena without an examination of its full implications may result in a code with significant uncertainties and with potential non-conservatism. See SECY-02-0057, at 5 (acknowledging "potential non-conservatisms" that could be embedded in current evaluation models).

As a result of research conducted over the past 30 years by nuclear industry, the NRC, and our counterparts in other countries, there is now much better understanding of LOCA phenomena. This knowledge has allowed the development of more realistic computer models by which to calculate plant behavior during LOCA events. While this research continues to the

present day, the state-of-the-art codes are sufficiently advanced that the staff permits their use in analyzing LOCA behavior. As a result, 50.46 includes provisions for the use of realistic, or so-called "best-estimate" LOCA codes, subject to the requirement that uncertainties in the results can be quantified, so as to provide "a high level of probability that the [ECCS acceptance] criteria would not be exceeded." 10 C.F.R. 50.46(a)(1)(i).

Although it may not be appropriate to force licensees to change their tools for analyzing LOCA behavior, it also is not appropriate to encourage the use of obsolete approaches, as would be the case if we continue to modify Appendix K. I do not believe that our efforts to improve efficiency and effectiveness and to ensure realism in analysis are served by expending resources on modifications to Appendix K. We should provide an incentive to licensees to use improved and modern techniques.

While backfit considerations might allow existing licensees to continue to use Appendix K codes, the same consideration does not apply to future applicants. Thus, I believe 50.46 should be modified to require that future applicants for design certification or for future construction should use best-estimate codes for LOCA analyses. Moreover, licensees who seek the benefit of the changes to the design basis LBLOCA requirements that are suggested by Commissioner Diaz and myself should be required to use best-estimate codes. The staff should include such a modification in the proposed 10 C.F.R. 50.46 rulemaking.

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I approve "unbundling" the proposals and proceeding with the development of separate rulemakings. I also approve the staff's recommendation that separate rulemaking plans are not necessary for each of these actions.

Commissioner Dicus

I commend the staff on their efforts to continue to risk-inform 10 CFR Part 50 and approve the staff's recommendations. Specific comments are noted below.

Regarding ECCS acceptance criteria, I approve the staff's recommendations to proceed with developing a performance-based option for the current prescriptive ECCS acceptance criteria in 10 CFR 50.46.

I am not convinced that continuing to move forward with updating Appendix K will result in an efficient use of resources or ultimately improve safety. I recognize that the staff is aware of the problematic nature of updating Appendix K and am confident that the staff would be able to ensure a proper safety focus in evaluation models that might utilize a revised Appendix K.

However, I join with the Chairman and Commissioner Merrifield in noting the current provisions of 10 CFR 50.46 which allow for use of a realistic or "best estimate" evaluation model. Further, I agree that NRC should require use of "best-estimate" codes for current licensees that chose to redefine their break size and for applicants for new power reactors. I believe that there are other higher priority activities that can have a greater safety impact and that, in the case of updating Appendix K, the juice will not be worth the squeeze. Therefore, I disapprove the staff's proposal to update Appendix K ECCS evaluation model requirements.

With regard to ECCS reliability requirements, I approve the staff's recommendation to proceed with changes to GDC 35 that would permit more realistic approaches for demonstrating ECCS safety function reliability and providing options for replacing assumptions that call for consideration of loss of offsite power with a single additional failure.

I note the important points raised by Commissioner Diaz and the Chairman in their votes regarding the feasibility of redefining the spectrum of pipe breaks as part of ECCS performance evaluation. I continue to support the ongoing staff efforts and suggest that the central points raised in the these votes be explicitly considered in future communication with the Commission regarding the staff's analysis of LOCA frequencies and uncertainties to support the redefinition of the spectrum of pipe break sizes.

Commissioner Diaz

The Commission's vote on SECY-02-0057 is a decision that transcends the regulation of the reliability and availability of core cooling for the management and mitigation of reactor transients and accidents. This decision will reflect on our capability and our commitment to be a risk-informed agency utilizing present regulatory tools, technology and operational safety experience.

The Commission's decision to risk-inform our regulations was based on two simple principles: *if it is not risk-significant, it is not important to safety*; and, *the focus of our regulations and resources will be on the issues more important to safety*. In this regard, the low risk-significant Large Break Loss-of-Coolant-Accident (LBLOCA) is a true anachronism in today's safety construct, consuming resources that should be directed to the more risk-significant issues. The LBLOCA is a very small component of the Loss-of-Coolant-Accident (LOCA) contribution to risk, and the LOCAs are a small contributor to the total risk. Therefore, the LBLOCA is using resources disproportionate to its importance to safety, taking attention and resources from what we know is much more important. The LBLOCA was good in 1970, was so-so in 1978, but it is absurd now as a dominant Light-Water Reactor (LWR) safety criterion; it has been rendered obsolete by improvements in safety performance and analysis. Thus, I support a risk-informed alternative within the definition of a LOCA as a voluntary option for licensees.

Before I vote on the specifics, I will present an overall justification for such a change and, on the way, some recommendations on "how-to". The NRC has been using four major performance goals to direct and measure the agency's achievements: maintain safety, increase effectiveness and efficiency, increase public confidence and reduce unnecessary burden. I am convinced that only three of these goals (safety, effectiveness and efficiency, and unnecessary burden reduction) are "vectors" amenable to regulatory control, and that increasing public confidence should be the result of the good performance of those three, as well as our ability to communicate the performance well. Safety is not determined by public confidence; public confidence should be established and grow from safety performance that is factually established and is well communicated. I also believe that major changes to our regulations need to *improve* safety, not just to maintain safety.

While the decision on this SECY impacts on increasing effectiveness and reducing unnecessary burden, my vote is based on *improving the safety* of the nuclear power plants. Yet, whatever direction is set by the Commission, it will be necessary, indeed indispensable, to properly

communicate the supporting safety criteria and performance expectations. A very clear statement of the results of the Commission's decision regarding the ECCS and LOCAs will be needed, presenting the safety case and the benefits of implementation. Thus, I believe that providing rule language now, allowing for a risk-informed alternative to the present LBLOCA requirements that focuses on the appropriate LOCA events and other risk-significant issues will actually improve safety, demonstrate the Commission's commitment to risk-informed regulation and allow for early public participation. The path towards rulemaking will provide many opportunities for participation by all stakeholders and should be conducive to enhancing public confidence in our stewardship of nuclear safety issues.

There is a significant, although not always well utilized, body of knowledge regarding LOCAs and LBLOCAs. I will start with the regulatory definition of a LOCA. The term LOCA is often used quite loosely, but it is very clearly defined in our regulations as "those postulated accidents that result from the loss of reactor coolant *at a rate in excess of the capability of the reactor coolant make up system from breaks in the reactor coolant pressure boundary*, up to and including a break equivalent in size to the double ended rupture of the largest pipe of the reactor coolant system" (emphasis added).[3] So a loss of reactor coolant is only a LOCA, under NRC regulation, if the cause is a break in the reactor coolant pressure boundary, with the maximum size limited to the largest pipe of the reactor coolant system. Thus, a LOCA is a subset of possible losses of reactor coolant. Furthermore, it is only a full-fledge regulatory LOCA if the loss of coolant *exceeds the capability of the reactor coolant make up system*. Again, the set of possible loss of coolant accidents that are dealt with in regulatory space are narrowed to those losses well beyond the ordinary. The reason for repeating the obvious is to emphasize that the regulatory definition of a LOCA does not include all possible leaks or breaks. Moreover, the original selection of the break size was not based on a well-established analysis, an analysis that is now possible.

I believe that, as a matter of improving safety, the consideration of very low probability Large Break LOCAs should be addressed as severe accident scenarios rather than as the design basis accident. Effectively, the current LBLOCA would not be a design basis accident when utilizing a risk-informed approach. With the alternative definition of the LOCA the really important, risk-significant, accident scenarios would remain within the design basis; in fact, their consideration would be enhanced by a new focus on their risk-importance.

My decision to support a risk-informed alternative definition of a LOCA in the regulatory context is based primarily on several important factors: the data available (or lack thereof), the ability to "learn" from failures or potential failures and take corrective action, the excellent state of current operational safety, and the existing capability of making sound risk-informed decisions that include state-of-the-art Probabilistic Risk Assessments (PRA). Let me address each in turn.

There are many very significant aspects of the data that can be singled out in the existing body of knowledge regarding the occurrence of coolant leaks and their association with LOCAs. The first is the scarcity of actual LOCA data. There are not enough LOCAs to estimate, with confidence, the frequencies of LOCA-type failures from historical data, particularly for medium to large breaks. It is very difficult to predict medium and large break LOCAs from zero occurences. Of course, the lack of data should really be construed as a success story, but it is a curse to analysts seeking to establish failure rates. Thus, all kinds of failure data (cracks, pinholes, leaks or ruptures) are

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[3] 10 CFR Part 50, Appendix A.

brought in to substitute for actual LOCA data. Much of this failure data can be made useful to provide failure estimates. Piping failures are among the "easiest" -- but not easy -- to estimate since there is at least some reasonable body of knowledge that could be used to predict piping crack growth and potential ruptures. Failures due to human behavior (for example, failure to take corrective action) are much harder to predict. Yet, a Large Break LOCA has not occurred in any nuclear power plant in the world, good plants or bad plants, nada.

Due to the lack of actual data, medium and Large Break LOCA frequencies are very conservatively estimated by calculating the frequency of leaks or through-the-wall cracks that have challenged piping integrity. What about small-break LOCAs? They are about two orders of magnitude more probable. Of course, one very famous "small" LOCA occurred at TMI-2 from the failure of a valve to close, a failure augmented by human error. Indeed, it is in this area where data and PRAs demonstrate the need for regulatory concern. It has been more than 23 years since it has been well known that the LOCA risk is dominated by the small break LOCAs. Therefore, that is where our "attention and resources" should be focused.

Another reason for my decision to support a risk-informed alternative stems from the ability of nuclear regulators, the industry, and the technical infrastructure to learn from and correct actual or potential failures. This is especially true for significant safety-related failures or LOCA-type failures. It is not surprising that these groups have "learned to learn" from failure and lack of failure, and that everyday they should learn more efficiently from errors, because prevention and mitigation, followed by error minimization are fundamental nuclear regulatory and operational safety principles. No other TMI-type LOCA has occurred since the first occurrence, and that is probably to be expected because of the extensive actions taken to prevent another occurrence. Yet, the fact that the system "learns" and "corrects" is significant.

The capability of well-developed industrial systems to "learn" from errors is well documented. I would venture to add that error learning curves are most predictable in industrialized democracies, and that errors - especially those well publicized - are corrected rapidly in order to address the real or perceived risk that society associates with the industrial activity. Errors or failures in nuclear power plants are well publicized. Furthermore, the higher the perception of risk to society from an activity, the quicker and more successful should be the learning process.

The nuclear industry, after a somewhat shaky start --- due mostly to human errors in the design, construction and operation of a complex system new to the marketplace --- learned well after the shock of TMI. When a rare and significant event like the Davis-Besse hole-in-the-head occurs, the industry and the regulator are forced to learn and act quickly. It is highly improbable that another Davis-Besse type failure will occur in the U.S.A. because of the corrective actions that have been and are being taken based on what has been learned. One hole-in-the-head is bad enough. Other new and unknown occurrences will surely take place and, therefore, capabilities to mitigate the more probable and risk-significant spectrum of failures should be given more attention.

The learning has not been limited to major events - a la TMI - but also has included a significant part of operational safety issues. For example, once Intragranular Stress Corrosion Cracking (IGSCC) and Flow-Assisted Corrosion were identified as emergent failure mechanisms, the industry "learned" and the failure rates decreased almost exponentially as a function of accumulated experience. This is neither unique nor laudable: it is normal and expected.

Presently, the NRC and licensees are justifiably focused on the cracks found on PWR vessel head penetration nozzles and welds. I expect that this issue, due to the attention it is properly receiving, should not result in changes to the medium or Large Break LOCAs' frequencies. In the realm of reasonable assurance, it is reassuring to observe that in this country no error or failure from the operation of nuclear power plants has come close to breaching the very stringent safety standards established for the protection of public health and safety embodied in the NRC's strategic goals. We are committed to maintaining this record. The point is, the NRC now regulates in a "learned" and "learning" environment, a statement supported by the present operational safety performance of the plants in this mature industry. This fact allows us to conclude that significant new "errors" should be discovered and corrected before progressing to large failures, and more specifically, this environment should further decrease the probability of a LBLOCA.

When estimating failure rates, regulators today should focus not only on the existence of failures or errors --- many of which are due to human performance --- but also on the ability of the learned systems to cope with the failure, to detect deficiencies, to minimize consequences, to prevent --- or decrease significantly --- recurrence, and to properly value success. A truly effective regulatory system should balance the error data with the expected learned-system behavior to estimate future failure rates. This would be directly applicable to potential failures of the reactor coolant pressure boundary, and certainly applicable to LBLOCAs.

Another consideration in my decision to support a risk-informed alternative is the fact that the capability for making risk-informed decisions, based on relevant experience, deterministic models, defense in-depth and state-of-the-art PRA exists today. This capability is not equally utilized by everyone, but it is here. Selecting a risk-informed alternative to the LOCA rupture size will require this capability at the expert level, with an acceptable - in regulatory space - high quality PRA. It is important to point out that I believe that the precise size of the large break is not a risk determinant issue; there are many other more risk-significant issues.

I now offer the following specific proposal on how to better reduce to practice the "LOCA failure analysis and frequency estimation":

> By December 31, 2003, the staff shall present to the Commission a comprehensive "LOCA failure analysis and frequency estimation" that is realistically conservative and amenable to decision-making. Realistically conservative estimations, with appropriate margins for uncertainty, should be used. Unrealistic extrapolation of estimates to time periods beyond the knowledge base and those requisite time periods used by the industry to inspect, monitor, and correct should not be used. Full understanding of the LOCA frequencies has always been important, but it is time that it becomes a short-term high priority. The goal is to achieve a predictive and well managed safety envelope emboding the best data and the best methods.

To achieve the objective of the above proposal I believe the following must be done:

a. *Use a 10-year period for the estimation of LOCA frequency distributions,* with a rigorous re-estimation conducted every 10 years and a sanity check for new types of failures every 5 years. This periodicity is consistent with the In-Service Inspection (ISI) program required of all reactor licensees. Longer periods do not make sense, neither technically nor from a regulatory perspective.

b. *Conduct a practical reconciliation of LOCA frequency distributions by the 1) expert use of service-data, 2) Probabilistic Fracture Mechanics (PFM) and 3) expert elicitation to converge the results*. Limiting the interval to 10 years will benefit significantly all three methods, using realistic predictability and convergence of results as necessary criteria. I strongly recommend that both service-data and PFM estimates be "reduced" to an appropriate set by "expert discrimination" of what data should be treated. Not all data is "born" equally nor should it be treated equally. For the purpose of LOCA estimation, a better discrimination of failure data is needed before it is used as predictive data. This is an area that needs prompt and expert attention. Service-based LOCA estimates (a statistical analysis of service experience data) are more useful than PFM, especially if the projection is limited to 10 years. PFM (a phenomena-based method using fracture and failure analysis) can make a contribution, more so if it is used to selectively converge to service data predictions.

c. *Finally, expert elicitation should use the converged (whenever possible) service-data and PFM results to provide the Commission a comprehensive "LOCA failure analysis and frequency estimation" predictive envelope that is realistically conservative*. Expert elicitation is better when the data and analysis methods have first been screened for that purpose, and I believe that this has not yet been done.

In a related matter, in a briefing of Commission Technical Assistants on April 22, 2002, the staff stated that it is possible for some pipes to fail without a precursor leak (no leak-before-break) and that this contribution to the pipe break probability should be included in the analysis. I believe that leak-before-break is an established technological fact for risk-significant failures and the Commission should be informed and kept up-to-date on the staff's efforts in this area. I prefer to deal with actual probabilities and not with all possibilities.

One final comment on the above recommendations. As a regulator, I want to know, with significant confidence what the failure rate estimates are for next year, and the year after. For both rulemaking and regulatory oversight, 10 year scenarios are very good; furthermore, I know we can do it even better the next time around. Also, for <u>any</u> safety reason, we can and should take any needed action, as the circumstances require. No service-data, no PFM and no expert elicitation can confidently predict beyond 10 years, nor do we need to using a risk-informed approach.

In summary, the re-consideration of the Large Break Loss-of-Coolant Accident has been a long time in the making. I am convinced that we now have the necessary justification to make this fundamental change to the Light-Water Reactor safety regulatory construct now. Therefore, I vote as follows:

1. With regard to the re-definition of the Large Break LOCA:

The staff should prepare a proposed rule change to 10 CFR Part 50 that allows for a risk-informed alternative to the present maximum LOCA break size. I believe the rule should be very specific and leave no doubt that the pertinent risk parameters are addressed and only the non-significant contributions to risk are handled through severe accident risk management. For example, the

modified definition of the LOCA, for use throughout Part 50 and wherever applicable, could read:

> **Loss of coolant accidents (LOCA). Loss of coolant accidents mean those postulated accidents that result from the loss of reactor coolant at a rate in excess of the capability of the reactor coolant makeup system from breaks in the reactor coolant pressure boundary up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the reactor coolant system *or up to an alternate maximum break size determined by including at least XX% [e.g., 95%, 96%...] of the LOCA failure contributors to core damage frequency.***

Thereby, the most significant failures are included. The net effect of this change would not reduce protection or give up risk sequences; rather, the rule will establish a new risk-informed design basis accident. Only those failures smaller than the average by about two orders of magnitude would be removed for severe accident management; i.e., the capability to mitigate the double-ended rupture of the largest pipe in the reactor coolant system will be retained under severe accident management principles and activities.

While I would expect pertinent changes in the design basis and associated analysis to naturally occur, I concur with the staff that changes in hardware and operation "would require that it be demonstrated that the ECCS functional reliability is commensurate with the frequency of accidents in which ECCS success would prevent core damage or a large early release". In other words, I am not supporting changes to functional requirements unless they are fully risk-informed and protective of public health and safety. For example, I would not support actual changes to ECCS coolant flow rates or containment capabilities to mitigate accidents. I would support changes that provide for risk-informed sequencing of equipment with demonstrated functionality and reliability requirements that arise from the alternate criteria.

There is also no doubt that the redefinition of the LBLOCA would also require strict configuration controls, including during Low Power and Shutdown (LPSD) operations. Thus, I support requiring these strict configuration controls and believe that the ROP, the revised Maintenance Rule and Reg. Guide 1.174, are suitable for use in addressing such requirements.

One last point on the alternate break size. The conservative CDF and LERF safety criteria of Option 3, and particularly the capability of Reg. Guide 1.174 to deal both with absolute (CDF) and relative (delta-CDF) changes, are essential to effect an alternative break size with reasonable assurance of adequate protection.

Furthermore, as discussed above in the recommendation for determining LOCA frequency distribution amenable to decision-making, the rulemaking should be supported by a 10 year estimation of LOCA frequencies, to be delivered by December 31, 2003. This should be done in parallel with the rulemaking activities.

2. Regarding the recommendations in SECY-02-0057:

I approve the staff recommendations to proceed with rulemaking changes to 10 CFR 50.46, 10 CFR Part 50, Appendix K, and GDC 35, sooner rather than later, including an option to the Appendix K evaluation model requirement to permit use of a decay heat model based on the 1994 ANS standard. I support the unbundling and pursuing of separate rulemaking for each of the

proposed changes. In order to improve the timeliness, I also approve not preparing a separate rulemaking plan for each rulemaking. However, I strongly believe we should seek early public and stakeholder comments on all of these proposals.

The staff proposed allowing the use of a decay heat model based on the 1994 ANS standard and stated that concerns with uncertainties and conservatism associated with the current standard would be addressed separately from any proposed rulemaking. This is a prudent approach. A similar approach could be used to handle issues separate from the rulemaking when pursuing rule changes associated with the redefinition of the Large Break LOCA.

Risk is measurable and manageable, and risk-informed decision-making is a very good tool to improve safety. It is available now, and I strongly recommend we use it for this particular significant issue in a manner protective of public health and safety.

Commissioner McGaffigan

The issues presented in this paper and its predecessor (SECY-01-0133) are complex. The path forward to making further progress will likely be long and tortuous. The Commission has taken significant time to vote on them, and that has been appropriate.

I will not repeat here my comments on PRA quality from my vote on SECY-02-0176. But they apply here with perhaps even more emphasis. Until we decide to require high-quality all-mode internal- and external-initiating event PRAs as a condition for participation in these risk-informed initiatives, we will make achieving progress all the more difficult.

That having been noted, let me deal with the issues in this paper:

1. Spectrum of Break Sizes - I appreciate Commissioner Diaz' frustration with how long it has taken to reconsider the definition of the large break loss-of-coolant accident (LBLOCA) in view of the low risk associated with such events according to PRAs. He has made a thoughtful proposal for how to amend 50.46(c). He has pointed out that the change he proposes would require several parallel changes for those who wish to take advantage of it, including high-quality PRAs and strict configuration controls in all operating modes. He has made clear that he would not support actual changes to ECCS coolant flow rates or containment capabilities to mitigate accidents in existing plants. The Chairman has suggested one modification to Commissioner Diaz' approach and several considerations for the staff to take into account as their efforts proceed. Commissioner Merrifield and Commissioner Dicus have supported the staff's ongoing evaluation of the technical feasibility of promulgating a LBLOCA design change, taking into account the points raised by Commissioner Diaz and the Chairman.

   I certainly support the staff continuing this effort with particular emphasis on the proposal by Commissioner Diaz. But I fear that developing the technical basis for this proposed rule will take longer than Commissioner Diaz expects, perhaps years. So in parallel with that effort, I support simply granting the NEI petition for rulemaking (PRM-50-75) which would permit the industry to propose, subject to NRC approval, an alternative to the current LBLOCA definition. This rulemaking would not in any way commit NRC to a new LBLOCA definition using a smaller break size. Rather, the change would signify that the NRC is

open to allowing an applicant the chance to make a case for a smaller break size. Reading the votes of my fellow Commissioners, I would say that there is unanimity that we are open to this possibility. If we pursue this parallel course, I think we will energize industry efforts that will in turn help the staff in their technical work. We should take advantage of the synergy of parallel staff and industry efforts.

Before concluding this part of my vote, I want to reiterate one of Commissioner Diaz' points, namely that if we do ultimately approve a smaller break size for use in ECCS accident analysis, I too would not support actual changes in ECCS coolant flow rates or containment capabilities to mitigate accidents. I would want to maintain those margins because doing so is relevant to potential terrorist-induced accidents which are not modeled in PRAs and in my view cannot be usefully modeled in PRAs because any discussion of initiating-event frequencies would be entirely speculative. In my interactions with the public since September 11, 2001, the fact that these plants have been designed to cope with a 36" pipe break engenders public confidence. We should also maintain similar margins in future plant design certifications, even if we ultimately adopt a revised LBLOCA definition.

2. ECCS Acceptance Criteria - I approve the staff's recommendation to proceed with modifications to 10 CFR 50.46 and General Design Criterion (GDC) 35 to provide a more performance-based approach to meeting ECCS acceptance criteria. I agree with the Chairman that this approach should not relieve licensees of the need to provide an adequate technical basis to demonstrate that cladding material, other than Zircaloy and ZIRLO, can meet performance-based criteria.

3. ECCS Reliability - I agree that based on a safety-focused PRA-informed analysis, the staff has developed an adequate technical basis to move forward to relax the GDC 35 requirement for considering the loss of offsite power (LOOP) coincident with a LOCA. This change could bring the safety benefits discussed by the Chairman. However, I believe that we need to be sure that in modifying GDC 35 we do not reduce the capability of a plant to cope with a terrorist-induced event. While possible terrorism was not a consideration in establishing GDC 35, the current redundancy called for in GDC 35 provides significant security benefits that should not be lost in the current generation or future generations of reactors.

4. ECCS Evaluation Model - I join Commissioner Diaz in approving the staff's proposal to provide a voluntary alternative to Appendix K which would replace the 1971 American Nuclear Society (ANS) decay heat standard with the 1994 ANS standard. There is so much conservatism in Appendix K that the fact that there may also be some non-conservatism should not prevent this modest change, proposed by NEI in their petition for rulemaking (PRM 50-74). I would note that we modified Appendix K a couple of years ago to take into account the more accurate flowmeter technology available today (which has in turn allowed numerous small power up-rates to go forward). While I agree with Chairman Meserve and Commissioner Merrifield that licensees should be encouraged to use the more realistic "best estimate" tools, the staff recommendation retains the support of the ACRS. The reasoning behind ACRS's support for this small, focused change was well laid out in their letter to the Commission, dated July 25, 2001. Accordingly, I support the staff's proposal to allow applicants to take credit and improve their calculations based on the newer ANS standard, which reflects more than twenty years of additional data and

experience.

5. I approve the staff proposal to pursue separate rulemakings for each of the proposed changes, and not to submit a rulemaking plan for each one.

Commissioner Merrifield

I appreciate the staff's continued effort to advance the risk-informed philosophy into our regulatory structure. The changes being considered in SECY-02-0057 focus on providing (1) performance-based ECCS acceptance criteria as alternatives to the existing prescriptive criteria, (2) an Appendix K model using the 1994 American Nuclear Society (ANS) decay heat standard as an alternative to the 1971 ANS standard, (3) alternative ECCS reliability requirements that are more consistent with the frequency of challenges to the system's safety function, and (4) the ECCS spectrum of pipe break sizes. I shall address them in that order.

(1) I approve the staff's recommendation to proceed with rulemaking to allow an option to change the current prescriptive ECCS acceptance criteria in §50.46 to make it more performance-based. This option includes criteria for allowing the use of cladding materials other than Zircaloy or ZIRLO without requiring a licensee to submit and the staff review an exemption request. This will improve the efficiency of our regulatory process.

(2) I disapprove the staff's proposal to provide a voluntary alternative to Appendix K which would replace the 1971 ANS decay heat standard with the 1994 ANS standard. As Chairman Meserve points out, the modeling outlined in Appendix K is based on work done in the early 1970's with conservatism based on known phenomena and does not reflect the extensive knowledge gained since then. As known conservatism is removed by incorporation of an updated model such as the 1994 ANS standard, one must clearly understand the potential impact on the overall results and account for potential non-conservatism. One alternative already available in §50.46 and in use by licensees is "best-estimate" analysis of reactor coolant system behavior during LOCAs. This approach provides licensees with a more accurate determination of their plants response to a LOCA, while allowing additional operational flexibility. Therefore, I do not consider it appropriate to rely on obsolete methods when making risk-informed decisions when more realistic approaches are available. Our efforts are better spent focusing on areas to improve our analysis techniques rather than modifying the old. Thus, I agree with Chairman Meserve that licensees who seek to apply the benefits from proposed changes to break size redefinition and ECCS equipment reliability assumptions should be required to use best-estimate codes and methods.

Since Appendix K was devised with conventional light water reactors in mind, there is little assurance that the Appendix K guidelines are adequate when considering new designs such as the ACR-700, General Atomics Gas Turbine Modular Helium Reactor or Pebble Bed Modular Reactor. Thus, for this reason and those stated above for the current fleet who choose to redefine the break size, I agree with Chairman Meserve that §50.46 should be modified to require the use of best-estimate codes for LOCA analyses by future applicants for design certification or construction.

(3) I agree with the staff's recommendation to proceed with rulemaking as an option to risk-inform the ECCS functional reliability requirements in General Design Criterion 35, and thus relax the current requirements for consideration of a large-break loss of coolant accident (LBLOCA) coincident with a loss of offsite power (LOOP) and a single failure. One of the potential benefits from adopting this change is increased availability and reliability of diesel-generators by reducing requirements for fast starts and load sequencing.

I understand the industry is working on a generic topical report that could be used by reference for individual licensee LOCA-LOOP exemption submittals. While I am not a proponent of "multi-plant" exemptions, I believe that a review of this topical report in parallel with the staff's effort to pursue updated LOCA frequencies and a methodology for quantifying the conditional probability of LOOP given a LOCA will ultimately further our understanding of the issues and lead to developing a technically sound basis for eventual rulemaking. I encourage the staff to continue their dialogue with industry and other external stakeholders in this area.

As with the implementation of the new proposed §50.69, clearly the changes being pursued here would also require a licensee's PRA to be of sufficient quality and level of detail to support this initiative. So once again, I encourage the staff to proceed in a timely manner with finalizing draft Regulatory Guide 1122 (DG-1122) to address PRA quality.

(4) I agree with Chairman Meserve and Commissioner Diaz that the Commission should consider redefining the LBLOCA instead of continuing to require analysis of the full spectrum of break sizes, up to and including the double-ended guillotine break of the largest pipe in the reactor coolant system, within the design basis. There is significant potential for safety benefits and reduction of unnecessary burden because considerable improvement in analytic margin could accrue from the elimination of some or all LBLOCAs as design basis accidents (DBAs). Similar to previously discussed changes, if LBLOCA redefinition were to facilitate lengthened diesel-generator start times, this could lessen challenges to diesel-generator reliability and availability. In addition, safety benefits could also accrue from lengthening valve operation times, increasing peaking factors, and by permitting licensees and NRC to shift resources from LBLOCA analyses toward more risk significant accidents. Of course, plant operating changes should not significantly erode the technical basis supporting the break size redefinition and should follow risk-informed policy. I believe that it is more appropriate to provide a voluntary option for a licensee to revise its design and licensing bases to better focus on the more probable events that have safety significance rather than disproportionately focus our resources on such highly unlikely events.

Commissioner Diaz makes a good point regarding our need for both understanding the LBLOCA contribution to total plant risk and better characterizing the low initiating event frequency of these size breaks. As operating experience history shows, there hasn't been a LBLOCA in the nuclear industry. However, this alone does not alleviate the need for the technical work to develop a better understanding of the frequency of the spectrum of LOCA sizes in order to focus on the most risk-significant breaks. I therefore join Chairman Meserve and Commissioner Diaz in supporting the staff in their ongoing evaluation on the technical feasibility of promulgating a LBLOCA design basis change.

Consistent with the votes of Chairman Meserve and Commissioner Diaz, I support unbundling and

pursuing separate rulemakings for each of the proposed changes as an option. However, the staff should ensure that this these changes are viewed in totality for identification of any potential cross-cutting impacts. In addition, I also approve the staff's recommendation for not preparing a separate rulemaking plan for each rulemaking.

Risk-informing 10 C.F.R. 50.46 is a significant initiative and I believe our most challenging effort to date. As I have previously stated, §50.46 is the backbone of our emergency core cooling system (ECCS) regulations for loss-of-coolant accidents (LOCAs) and changes are not to be taken lightly. Clearly a sound technical basis backed by solid research is needed to ensure that safety is maintained and thus public confidence. Public confidence will not only be based on a sound technical basis, but through honest and open communication with our stakeholders on our risk-informed initiatives.

I believe it is time to move forward and build upon the increased technical knowledge we have obtained over the past 30 years of plant operating experience and insights from probabilistic risk assessments. I support the research that is being conducted in these areas and I encourage the staff to proceed expeditiously to further our risk-informed efforts. The staff should continue to seek stakeholder input throughout this effort and keep the Commission informed of the progress. These changes and the Commission's decision must send a clear message that we continue to embrace regulatory reform through these risk-informed initiatives.