



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

September 10, 2008

SECRETARY

COMMISSION VOTING RECORD

DECISION ITEM: SECY-08-0029

TITLE: STATE-OF-THE-ART REACTOR CONSEQUENCE  
ANALYSIS -- REPORTING OFFSITE HEALTH  
CONSEQUENCES

The Commission (with all Commissioners agreeing) approved the subject paper as recorded in the Staff Requirements Memorandum (SRM) of September 10, 2008.

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

A handwritten signature in black ink, appearing to read "Annette Vietti-Cook".

Annette L. Vietti-Cook  
Secretary of the Commission

Attachments:

1. Voting Summary
2. Commissioner Vote Sheets

cc: Chairman Klein  
Commissioner Jaczko  
Commissioner Lyons  
Commissioner Svinicki  
OGC  
EDO  
PDR

VOTING SUMMARY - SECY-08-0029

RECORDED VOTES

	APRVD	DISAPRVD	ABSTAIN	NOT PARTICIP	COMMENTS	DATE
CHRM. KLEIN	X				X	6/6/08
COMR. JACZKO	X				X	3/26/08
COMR. LYONS	X				X	4/7/08
COMR. SVINICKI	X				X	6/6/08

COMMENT RESOLUTION

In their vote sheets, all Commissioners approved the staff's recommendation and provided some additional comments. Subsequently, the comments of the Commission were incorporated into the guidance to staff as reflected in the SRM issued on September 10, 2008.

**NOTATION VOTE**


**RESPONSE SHEET**

**TO:** Annette Vietti-Cook, Secretary  
**FROM:** CHAIRMAN KLEIN  
**SUBJECT:** SECY-08-0029 – STATE-OF-THE-ART REACTOR  
CONSEQUENCE ANALYSES—REPORTING  
OFFSITE HEALTH CONSEQUENCES

Approved XX Disapproved \_\_\_\_\_ Abstain \_\_\_\_\_

Not Participating \_\_\_\_\_

COMMENTS: Below \_\_\_\_\_ Attached XX None \_\_\_\_\_



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SIGNATURE

6/6/08

\_\_\_\_\_  
DATE

Entered on "STARS" Yes  No \_\_\_\_\_

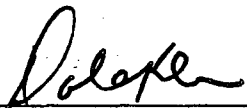
Chairman Klein's Comments on SECY-08-0029

I approve staff's Recommendation 6 for assessing and reporting offsite health consequences in the state-of-the-art reactor consequence analyses (SOARCA) project.

I also approve the staff's recommendation to seek external peer review of the methodologies and approaches employed in the SOARCA assessment of Peach Bottom and Surry.

I do not support performing level-3 PRAs for the pilot plants at this time. Alternatively, I propose that the staff complete the work on the Peach Bottom and Surry pilot plants pursuant to the direction in Staff Requirements-SECY-05-0233-PLAN FOR DEVELOPING STATE-OF-THE-ART REACTOR CONSEQUENCE ANALYSES and submit the methodology and approaches for peer review as recommended in SECY-08-0029. The peer review should address, in part, the credibility of the underlying assumptions and engineering judgment employed by the staff in the performance of these consequence analyses and whether it is necessary to perform level-3 PRAs to corroborate the integrity of the SOARCA Project.

In Staff Requirements Memorandum (SRM)-SECY-05-0233, the Commission approved the staff's plan to (1) evaluate and update, as appropriate, analytical methods and models for realistic evaluation of severe accident progression and offsite consequences; (2) develop state-of-the-art reactor consequence assessments; and (3) develop an integrated, predictive, computer-based tool to assist decision-making in the event of a severe reactor accident. I believe that the staff's efforts thus far have been in keeping with the direction of the SRM. I believe that the logical progression would be to employ the results of a well developed SOARCA methodology to inform and support the performance of level-3 PRAs, if desired.

 4/16/08  
Dale E. Klein      Date

**NOTATION VOTE**

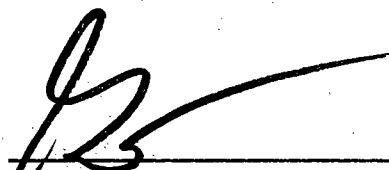
**RESPONSE SHEET**

**TO:** Annette Vietti-Cook, Secretary  
**FROM:** COMMISSIONER JACZKO  
**SUBJECT:** SECY-08-0029 – STATE-OF-THE-ART REACTOR  
CONSEQUENCE ANALYSES—REPORTING  
OFFSITE HEALTH CONSEQUENCES

Approved  X  Disapproved   Abstain

Not Participating

COMMENTS: Below   Attached  X  None

  
\_\_\_\_\_  
SIGNATURE

3/26/08   
DATE

Entered on "STARS" Yes  x  No

**Commissioner Jaczko's Vote on SECY-08-0029**  
**State-of-the-Art Reactor Consequence Analyses – Reporting Offsite Health**  
**Consequences**

I approve of the staff recommendation for providing information on offsite consequences in the state of the art reactor consequence analysis subject to the following comments. The staff has worked diligently on this complex project and I applaud the work that has been done so far. I encourage the staff to continue to refine and improve an extremely important project. My comments are intended to reflect areas in which I believe the work of the staff will only be enhanced.

I believe that the reporting of offsite health consequences should be as broad and comprehensive as possible. The results should be comprehensive to provide sufficient opportunity for the public to understand the outcomes and for the public to perform their own evaluation of the results. Consistent with my previous vote on SECY-05-0233, "Plan for Developing State-of-the-Art Consequence Analysis," the NRC should not quantitatively restrict the results to preclude individuals or groups from drawing inappropriate conclusions. It should also not preclude physically possible consequences. Furthermore, the results should provide the statistical distributions, as well as potential land contamination.

In addition, I believe the use of collective dose to develop consequences for low dose exposure is, as the staff indicated, a misleading methodology to determine the potential consequences from stochastic effects of radiation exposure. Irrespective of the particular model used to determine the individual health effects from a low dose exposure, the use of collective dose provides misleading information about the effects to the population. For example, using a linear dose effect relationship, a year dose of 1 rem applied to a population of 100,000 produces the same postulated health effect as a 10 mrem dose applied to a population of 10 million. As a result, these situations would appear to present the same offsite consequences. In fact, they are quite different. In one case an individual would be exposed to doses 100 times larger. This information is not readily apparent, however, if the consequences are expressed in terms of the collective effects to the entire affected population.

This problem, however, is not restricted to the use of the linear-no-threshold dose model. Collective dose could be used with equally questionable results with a dose model employing a threshold. The fundamental problem is not the dose model, but the summation of low doses to a large population in situations for which the health effects are not promptly manifested directly from the radiation exposure. Rather, the health effects are potential long term effects that may manifest themselves over much longer time frames. In my view, the better way to characterize these effects is to talk about the elevated risk to an individual of becoming afflicted by these latent health effects. The use of collective dose does not provide, in my view, meaningful results for understanding the real consequences to the public.

As a result, as recommended by the staff, consequence results should be communicated in terms of an individual risk. Because the Nuclear Regulatory Commission continues to use the linear-no-threshold model as the basis for regulatory decisions, the primary dose model should utilize the linear-no-threshold model to determine the individual risk. In using individual risk, the staff should ensure that differences in risk of cancer incidence and mortality in unique population subgroups are

considered where there may be statistically significant differences in risk. The staff should adopt this approach rather than using a single average individual risk where differences may exist

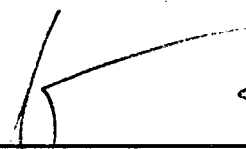
Also, the staff should develop a methodology to determine economic consequences from land contamination as a result of a postulated accident. As Commissioner Lyons indicated in a recent Commission meeting, this issue is very closely related to efforts the agency and other federal agencies are engaged with regard to analysis of potential consequences of the misuse of radiological materials. This type of analysis will provide additional useful information about the consequences of a radiological release. The methodology will likely require consideration of a number of different standards for decontamination and other remediation activities.

The staff should also incorporate the first two recommendations of the Advisory Committee for Reactor Safeguards (ACRS) on the State-of-the-Art Reactor Consequence Analyses project in their letter to the Chairman dated February 22, 2008. In particular, I have advocated a more sophisticated methodology comparable to the methodology endorsed by the ACRS in which virtually all calculable accident sequences are considered through the entire analysis, eliminating the use of a probability cut-off for core damage frequency. As the ACRS aptly stated,

“Thus, application of *a priori* CDF screening criteria can inappropriately overlook many risk-significant scenarios. Such an approach also does not provide a fully integrated evaluation of risk in terms of frequency and consequences. With current computational capabilities, virtually all sequences can be considered through the complete Level-1, Level-2, and Level-3 analyses. This type of fully integrated evaluation removes the need for intermediate screening and scenario dumping. It allows for clear identification of the most important scenarios for offsite consequences and facilitates an integrated evaluation of important physical and functional dependencies that affect core damage, severe accident progression, and offsite emergency responses.”

I also approve the staff's recommendation to submit the Peach Bottom and Surry methodology and approaches for peer review by a cadre of experts who have not participated in the development of the State-of-the-Art Consequence Analysis and who have expertise in one or more areas of the disciplines employed in the State-of-the-Art Consequence Analysis.

Finally, the staff should finally make all previous staff and Commission papers on this project publically available.

  
\_\_\_\_\_  
Gregory B. Jaczko

3/26/08  
\_\_\_\_\_  
Date

**NOTATION VOTE**


**RESPONSE SHEET**

**TO:** Annette Vietti-Cook, Secretary  
**FROM:** COMMISSIONER LYONS  
**SUBJECT:** SECY-08-0029 – STATE-OF-THE-ART REACTOR  
CONSEQUENCE ANALYSES—REPORTING  
OFFSITE HEALTH CONSEQUENCES

Approved  X  Disapproved \_\_\_\_\_ Abstain \_\_\_\_\_

Not Participating \_\_\_\_\_

COMMENTS: Below \_\_\_\_\_ Attached  X  None \_\_\_\_\_

  
Peter B. Lyons  
\_\_\_\_\_  
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4/7/08  
\_\_\_\_\_  
DATE

Entered on "STARS" Yes  X  No \_\_\_\_\_



## Commissioner Lyons' Comments on SECY-08-0029

I approve the staff's Recommendation 6 for assessing and reporting offsite health consequences in the state-of-the-art reactor consequence analyses (SOARCA) subject to the following comments and reservations.

I recently attended the staff's briefing of the Commission Technical Assistants and expressed my strong continued support for this very important project. I very much appreciated the staff's response to my questions with well founded technical assessments. As I noted in that briefing, I strongly support the staff's plan to seek external peer review of the methods and technical issues associated with assessing offsite health consequences. I applaud the staff for its past efforts and its initiative to complete SOARCA. I believe this analysis is a significant step towards enhancing the NRC's emergency planning as well as our decision-making process for reactor safety and security. Furthermore, as I noted in my earlier vote on SOARCA, this new knowledge base will enable the NRC to communicate more effectively with decision-makers at all levels, including Congressional, Federal, State, and local authorities, as well as licensees and the public.

The staff's paper clearly articulates that the relationship between health effects and the distribution of radiation dose to an exposed population is not simple. Historically, NRC and both its domestic and international collegiate bodies have used collective dose and the linear dose response (or linear no-threshold (LNT)) model to predict health consequences and for realization of the "as low as reasonably achievable" (ALARA) conditions (or optimizations, as referenced by the international community). Use of the collective dose concept is a direct result of the LNT model, which simply linearly extrapolates effects from those observed at very high doses. As discussed further in this vote, epidemiological data cannot confirm or refute the LNT model at low doses where the low magnitude of any potential risk can not be documented. New scientific research is directly challenging both the use of LNT at low doses and any use of collective dose for risk determinations.

The National Council on Radiation Protection and Measurements (NCRP), in its Report 121, notes that collective dose should not be used to predict death or injury from low-dose radiation:

"The summation of trivial average risks over very large populations or time periods...has produced a distorted image of risk, completely out of perspective with risks accepted every day, both voluntarily and involuntarily." (page 58)

"...it is recommended that regulatory limits not be set in terms of collective dose...When the uncertainty in the number of individuals is large...collective dose should not be used as a surrogate for risk, even at relatively high levels of individual radiation dose." (page 62)

The International Commission on Radiation Protection (ICRP), in its 2007 recommendations, notes that collective dose "...is not appropriate...to calculate the hypothetical number of cases of cancer or heritable disease that might be associated with very small radiation doses received by large numbers of people over very long periods of time." ICRP further notes that collective dose is "an instrument for optimization."

The Health Physics Society "strongly recommends that dose limits be applied only to individual members of the public, not to the collective dose to population groups," and notes that collective dose "may aggregate information excessively, for example, a large

dose to a small number of people is not equivalent to a small dose to many people, even if the collective doses are the same."

All of these scientific bodies agree that the use of collective dose to describe risk from low-dose radiation is scientifically indefensible. I strongly agree with the scientific community on this subject and believe that a statement by a past Chairman of the ICRP states my position very clearly: "If the risk of harm to the health of the most exposed individual is trivial, then the total risk is trivial-irrespective of how many people are exposed."

Therefore, I believe that results of the SOARCA require calculations of dose and estimates of risk consequences on a more individual basis, as proposed by the staff in Recommendation 6.

I do not support Commissioner Jaczko's view that staff should use an approach based on doses to unique population groups in which there may be statistically significant differences in risk. I believe that reporting multiple risk values will lead to confusing results. I further believe that NRC's regulatory focus on the risk to the highest exposed individual has and will continue to protect the public and the environment and ensures that no single group has a disproportionate risk. I thus approve the staff's use of a population-weighted average individual to explain risks associated with calculated exposures. Staff's recommended approach will assist in communicating the results of SOARCA.

I am reluctant to support the NRC's use of a linear dose response relationship for low doses of radiation based on the sheer absence of any credible scientific evidence to support use of LNT at low doses. Nevertheless, I recognize that current radiation protection standards are founded on exactly this LNT model, i.e., on the supposition that any radiation dose, no matter how small, contributes to a potential onset of cancer. The reality is that the bulk of our knowledge about human radiation health effects is derived from studies at high doses or dose rates, such as the survivors of the atomic bombs or certain groups of medical patients, simply extrapolated linearly to zero dose and zero effect.

The strict application of the LNT theory at low dose levels continues to be challenged. Controversies over the use of the linear dose response when setting standards and the costs associated with meeting the standards have further fueled discussions about the United States, as well as international, radiation protection standards. In the opinion of some, the strict application of the linear dose response has led to unnecessarily conservative radiation protection standards, particularly for specific purposes such as the decontamination and decommissioning of licensed facilities.

Current epidemiological data on the effects of low-level irradiation are inconclusive and more research in this area is badly needed. The lack of certainty is reflected in the careful wording chosen by the various advisory bodies as they discuss the lack of basis for use of LNT. This fuels considerable debate in the scientific community on this issue. ICRP notes that "adoption of LNT model...provides prudent basis for practical purposes" and the National Academies BEIR VII "concludes...evidence is consistent with hypothesis [of] linear dose-response relationship."

In contrast:

- The Department of Energy (DOE) notes concern that recent studies provide "Inadequate consideration of significance of recent scientific advances." DOE further notes that "Cellular responses to low doses of radiation are very different from responses to high doses of radiation" and that the "LNT model is based on two

assumptions: that any energy deposition can cause DNA damage and that DNA damage alone is the fundamental risk factor for carcinogenesis.... The latter biological assumption is certainly no longer accurate."

- The study of the French Academies of Sciences and Medicine reports that "Recent radiobiological data undermine validity of estimations based on LNT" and "raise doubts on validity of using LNT for evaluating carcinogenic risk;" They further note that "the LNT concept can be a useful pragmatic tool for assessing rules in radioprotection for doses above 10 mSv [1 Rem]" and that "LNT...is not based on valid scientific data."

- The Health Physics Society states that "There is, however, substantial scientific evidence that this model [LNT] is an oversimplification. It can be rejected for a number of specific cancers...heritable genetic damage has not been observed...." and that "...the effect of biological mechanisms such as DNA repair, bystander effect, and adaptive response... are not well understood and are not accounted for by the linear, no-threshold model."

The work by the DOE's Low Dose Radiation Research program and the French Academies has raised doubts about the validity of using a linear dose response relationship to evaluate risk at low doses. Lastly, I would note that the linear dose response will be the focus of two separate scientific meetings, one to be held by the NRC Advisory Committee on Nuclear Waste and Materials, and the other by NCRP, both in April 2008. These meetings bring together experts to discuss this important topic. Staff should continue monitoring such conferences and the DOE program and, at an appropriate time, provide recommendations to the Commission regarding use of the linear dose response relationship.

In approving Staff Recommendation 6, I believe that truncating the dose at any level below a few hundred millirems is defensible and would be consistent with the Commission's and stakeholder's view of risk associated with our 100 millirem public-dose limit. I considered proposing a threshold based on the average annual background to an individual of about 300 millirem. However, I believe that the staff's recommended cutoff level of 10 millirem offers adequate conservatism and will enhance communication about radiation risk. In addition, much as I do not want to encourage use of collective dose, which follows if LNT is strictly applied, I also support report of a single example of average individual risk by the staff without the threshold to document the relatively small difference in risk probability that results from use of either a zero or 10 millirem threshold.

In agreement with Commissioner Jaczko's vote, I also support the development of a methodology and analysis tool that can be used to predict economic consequences of a reactor event and that can also be applied in the analysis of radioactive dispersion devices. During the Commission Technical Assistants' briefing, it was clear that this is also a goal of the staff and that this effort needs considerable work. I strongly agree with staff that the development of such an analysis tool will require interagency coordination and active stakeholder involvement and will be costly in both time and resources. While staff should develop this economic consequences analysis tool; staff should also ensure that this effort does not impact completion of the initial SOARCA results and peer review.

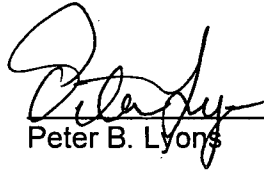
I do not completely agree with Commissioner Jaczko's proposal to incorporate the recommendation of the Advisory Committee for Reactor Safeguards to use only Level-3 PRA (probabilistic risk assessment) analyses for SOARCA. While I agree that a Level-3 PRA could provide useful insights into the screening process, I believe that insight could be gained by

performing a Level-3 PRA for only one plant. Staff discussed this issue at the Commission Technical Assistant Briefing and gave a very well founded rationale for their selection of risk significant events.

Furthermore, a Level-3 PRA analysis, if conducted before proceeding with SOARCA, would have a significant impact on completion of this phase of SOARCA. I thus suggest that staff conduct, in the future and as medium priority, a Level-3 PRA for one plant under a separate Commission-approved and funded program. This Level 3 PRA activity should not impact the ability of staff to complete SOARCA, but can inform future discussion of the accuracy of the current SOARCA approach by comparing the results of the current approach with the PRA-based approach for that single plant.

As staff finalizes the current SOARCA work, I look toward a public briefing for the Commission and solicitation of stakeholder input by the staff.

I believe that SOARCA provides a unique opportunity to develop a more balanced approach to risk communication by engaging stakeholders in the development of a common understanding of how to communicate radiation risk from small doses of radiation. I believe this approach must be clearly articulated as part of a comprehensive communication strategy when the SOARCA project results are released to the public.

  
Peter B. Lyons

4/7/08  
Date


NOTATION VOTE

RESPONSE SHEET

TO: Annette Vietti-Cook, Secretary  
FROM: COMMISSIONER SVINICKI  
SUBJECT: SECY-08-0029 – STATE-OF-THE-ART REACTOR  
CONSEQUENCE ANALYSES—REPORTING  
OFFSITE HEALTH CONSEQUENCES

Approved  X  Disapproved   Abstain    
Not Participating

COMMENTS: Below   Attached  X  None

  
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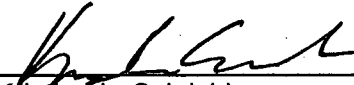
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**Commissioner Svinicki's Comments on SECY-08-0029**

I support the staff's recommendation of alternative 6 as the methodology for assessing and reporting offsite health consequences in the state-of-the-art reactor consequence analyses (SOARCA) project.

I further approve the recommendation of staff to submit the Peach Bottom and Surry methodology and approaches for peer review by a cadre of experts who have not participated in the development of the SOARCA and who have expertise in one or more areas of the disciplines employed in the SOARCA.

I appreciate the thoughtful review and assessment of the SOARCA project conducted by the Advisory Committee on Reactor Safeguards (ACRS), as documented in the ACRS letter report, dated February 25, 2008 and as further elaborated during the Commission meeting with the ACRS held on June 5, 2008; however, at this time, I cannot support the ACRS recommendation to begin immediately a level-3 probabilistic risk assessment for the pilot plants and to suspend further state-of-the-art reactor consequence analyses while doing so.

  
\_\_\_\_\_  
Kristine L. Svinicki

6/6/08