PDR

JUN 12 1985

MEMORANDUM FOR: William J. Dircks
Executive Director for Operations

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

SUBJECT: SAFETY GOAL EVALUATION REPORT

As you requested on May 3, 1985, I have personally reviewed the Safety Goal Evaluation Report and draft policy statement. The report reflects, in my opinion, a thoughtful and well-written approach to this difficult and controversial issue. The one serious difficulty I have with the proposed policy statement is in the value selected for the plant performance guideline. In addition, my comments on the details of certain other issues are attached. With appropriate consideration of these comments, I believe that the report and policy statement should be forwarded to the Commission.

As highlighted by our recent answer to a question from the Congress, the probability of a core-melt accident, even if the proposed guideline were met, is high. The proposed guideline is 10^{-4}/ry for a large-scale core melt. If just met, in the median by all plants, this would result in an approximate 50% probability of one or more serious reactor accidents in the next 20 years in a population of 100 plants. Also, there would be about a 10% probability of two or more such accidents. Calculations of public risk from these accidents rely heavily on a knowledge of fission product behavior and containment performance beyond conditions for which mitigation systems and structures have been designed or tested. Computer simulations and limited small-scale test data need to be applied with caution. The accident prevention guideline is a quantitative corollary of our defense-in-depth concept and should include a margin to allow for the imperfection in the current methods of predicting core melts, fission product behavior and containment performance. I propose the following alternate guideline:

> The likelihood of a nuclear reactor accident that results in a large scale release of fuel and fission products from the reactor coolant system should normally be less than one in 100,000 per year of reactor operation.

The restatement in terms of vessel melt-through introduces a margin for the uncertainty in current methods and focuses on the event which challenges containment integrity and public safety. While current methods have not distinguished between core damage, core melt or vessel melt-through, the guideline would allow for such discrimination. Analyses done today usually only assess "loss of adequate core cooling," which would usually be compared to the 10^{-5}/ry guideline, since loss of cooling, core-melt and vessel

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melt-through are not differentiated. This discrimination between degrees of core damage could be made, recognizing the additional large uncertainties, in those cases where it would be important. Also, such an approach would serve to guide the design of new standardized plants toward increased safety.

I would be happy to discuss these comments with you at your convenience.

/s/

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosure:
Suggested Improvements in the
Safety Goal Evaluation Report

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PDR per Doris Mossburg 7/9/85

*See previous concurrence.
**Oral /c/ rec'd by FRowsome 5/28/85.
***Concurred w/comments which for the most part have been incorporated.
****Concurred w/comments that have been incorporated.

DL
HThompson**
(FMiraglia /c/ for DL.)
5/28/85

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ENCLOSURE

SUGGESTED IMPROVEMENTS IN THE SAFETY GOAL EVALUATION REPORT

I. Errors

A. Fig 4.1 of Volume 2 depicts how some operating reactors stack up against the early fatality guideline. One plant appears to be unambiguously over the acceptable risk level. This plant we understand to be Crystal River 3, based upon the IREP study. This is not correct. The IREP study is not consistent with so high an early fatality risk. This Figure entry, and perhaps others, should be corrected along with the corresponding text. RES should revise these figures.

B. Mean vs median in benefit-cost analysis.

NRR agrees that it is rarely possible to identify means and medians, and agrees that when they can be identified, both should be displayed as an aid to the judgment of uncertainty for all QDOs. However, Volume II, pp. 2-13 and 3-7, suggests that median values rather than mean values should be used in assessing risks against the safety goals. For the three QDOs, this choice is a policy matter subject only to the constraint that the decision logic must be made consistent with the choice of the statistical measure. However, for benefit-cost analysis, it is an error to employ the median. Mean values must be used for logical consistency.

In Volume II, p. 2-13, middle paragraph, the first line should be changed from, "In summary, the staff recommends using median values, ..." to, "In summary, the staff recommends using mean values for benefit-cost analysis for logical consistency, ..."

In Volume II, p. 3-7, top paragraph, lines from the bottom, should be changed from, "..., but the medians will be used as the principal measure against the safety goals" to ", but the mean values will be used as the principal measure in benefit cost analysis." See also the related suggested "Improvement 'E'" below.

II. Suggested Improvements

A. Inclusion of averted on-site losses for core melt accidents among the benefits in Benefit-Cost Analysis [I.11, II.1-7].

NRR agrees with the proposed position of including averted on-site losses, and endorses the arguments put forward. However, we think this controversial proposal needs better documentation. The Commission is intensely interested in this question and has questioned the staff about it in many meetings such as those on severe accident policy, standardization policy, advanced reactors, briefings on the Indian Point hearings, and others. The Commissioners can be expected to want to know the statutory basis for benefit-cost analysis, whether the staff proposal constitutes economic regulation, whether the staff proposal could lead to over-regulation, the disadvantages as well as the advantages of the staff proposal, and the pros and cons of the Commission's versions in NUREG-0880, 1982, and Rev. 1, 1983. It is unwise to face the Commission with a "take it or leave it" option.

To avoid rewriting the package extensively, we suggest that a Commission paper be added to the package specifically on the issue of benefit-cost analysis. The paper would contain pros and cons of both the Commission and staff proposals and perhaps others, such as treating averted on-site losses as a consideration but with lesser weight in decision making than averted radiological exposure. We might recommend treating averted on-site losses as favorable cost impacts, subtracting them from the adverse cost impacts of a proposed NRC requirement in arriving at the action's net cost impact. Safety-cost trade-offs would then compare net safety benefits with net cost.

In addition, we should anticipate that the Commission may well not endorse the proposal to include on-site losses in benefit-cost analysis. In that event, the other safety goals and/or implementation guidance would need alteration, lest the goals severely undercut defense-in-depth. It is desirable to inform the Commission of this need, and may be wise to offer them viable alternatives now.

B. Societal risk and the leniency of the cancer risk guideline.

Nowhere does the report discuss the intrinsic leniency of the cancer risk guideline. Latent casualties are so dilute among exposed populations that a plant might satisfy the cancer risk guideline in the year it has an accident accompanied by a substantial release of radiation. This is true even in the report's version of the guideline that shrinks the radius to be considered from 50 to 10 miles. This is not to say the guideline is not reasonable as a statement of acceptable individual risk. However, it is too lenient as a surrogate for societal risk, as the name

of the guideline, "Societal Risk Quantitative Design Objective," implies that it is.

For example, suppose one of the Indian Point units were to operate for thirty years and then suffer a severe accident. Suppose, further, that the radiological outcome were to be:[1]

Early fatalities:	None
Early injuries:	16
Cancer fatalities:	500
Person-rem:	7 Million
Off-site property damage	$300 Million
Land area requiring long-term interdiction	1 Square Mile
Genetic effects:	1,800
Non-fatal cancers	1,500
Non-cancerous thyroid nodules	1,000

Despite these substantial off-site consequences, the rate of arrival of excess cancer fatalities among those people located within ten miles of the reactor, due both to acute and chronic exposure, would average only one-tenth-of-one-percent of the non-nuclear rate of occurrence in each of the following thirty years. Thus, by some ways of reckoning, it could be said that the plant actually satisfied - on a plant-lifetime average - the societal risk quantitative design objective. Thus, this plant history would not violate either of the mortality risk guidelines, evaluated retrospectively.

Even if one stipulates that all latent cancer fatalities must be treated as though they occurred in the year of the accident, one can show that the mortality-based quantitative design objectives would treat as acceptable a release each year of plant operation that would cause several tens of cancer fatalities, property damage up to roughly $40 million, and long-term interdiction of 100,000 square meters offsite.

It should be noted that the Indian Point site has an unusually high surrounding population density. For a site with median

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[1]These consequences were obtained from Indian Point hearing testimony by interpolating among release categories whose average outcome most closely approximates the level of risk suggested by the cancer QDO. The tabulated consequences are agregated consequences without limitation of distance.

surrounding population density, the consequences would be approximately ten times lower.

The Safety Goal Evaluation Steering Committee believes that this is not a serious problem with the safety goals because the plant performance guideline or engineering judgment would prevent abuses. However, we believe that the policy statement on safety goals, as they directly address off-site radiological risk, should not contain a serious loophole as a matter of principle. Then, too, regulatory issues will arise involving fuel handling accidents, rad waste releases, or core damage that stops short of "large scale core melt." In such cases, the safety goals, as now written, would accept unduly large risks.

The report indicates that an aggregate societal risk guideline is unnecessary [Vol. I, pp. 8, A-9; Vol. II, pp. 2-9, 10]. The examples above show that even with WASH-1400 source terms, high levels of societal risk can still satisfy the mortality risk guidelines. However, when the source terms are reduced, the mortality risk guidelines, as proposed, would treat a broader class of accidents with quite large latent casualty and off-site property damage risks as acceptable. The problem is heightened by the proposed implementation guidance [Vol. I, pp. 21,22; Vol. II, pp. 3-8, 9] which would not consider enforcement of the plant performance guideline if the radiological risk QDOs are satisfied. The net effect would be to treat as acceptable plants with high core melt frequency (up to 10^{-3}) and high aggregate societal risks of latent casualties and property damage.

We recommend that an aggregate societal risk goal be proposed, and the text altered to reflect the need. We see two possible ways it might be formulated. One is to accept the ACRS or AIF proposals for a societal, aggregate mortality quantitative design objective. The other is to adopt a limitation on the expected off-site radiological property damage risk. The first option has the advantage that it is cast in terms of health effects and carries the stature of the mortality-based QDOs. The first option has the disadvantage that it lends itself to body counts. The NRC could not be accused of identifying an acceptable number of casualties if it employs property damage in the aggregate societal risk goal. Then, too, it is widely recognized that off-site radiological property damage is likely to be a larger societal problem than health effects in the event of a severe release of fission products. Thus, there is considerable merit in a quantitative design guideline based upon off-site radiological property damage.

Some in NRR believe that in applying the cancer guideline, the population to be considered should extend only to one mile, not ten miles, from the site boundary. The principal benefit would be

better fulfillment of the first qualitative safety goal for those living near the site boundary. Making this change would also simplify the calculations (the same reference population and consequence calculations would be used for both early and latent fatalities) and would diminish, but not eliminate, the need for a truly aggregate societal risk QDO. It would have the effect of making the cancer test more stringent by a factor of 3 to 5. All PRAs we have seen to date would still satisfy such a QDO.

NRR could edit or add to the text of the Safety Goal Evaluation Report and proposed policy statement to reflect such a goal if this proposal is accepted.

C. Provisional implementation guidance
[Vol. I, pp. 21, 22; Vol. II, pp. 3-8, 9].

These guidelines have two explicit problems. First, as proposed, they would exclude consideration of regulatory actions to lower risk for plants with a core melt frequency between 3×10^{-5} and 10^{-3}, unless a mortality-based QDO is not met with reasonable assurance or an individual sequence is above 10^{-5}. One can envision situations, particularly as analyzed with reduced source terms, where such consideration is warranted. In effect, this alters the plant performance guideline from 10^{-4} to 10^{-3}. Second, part D sets a standard for "individual core melt accident sequence[s]." This is meaningless without a definition of how finely divided an "individual" sequence should be. Where one analyst sees one sequence, another may see thousands of sequences, each of very much lower frequency.

> These core-melt frequency numbers all relate to the 10^{-4} per year figure constituting the basis of the Steering Group's report. With adoption of our recommendation of a 10^{-5} frequency instead, these figures would be divided by 10.

In addition, the guideline fails to mention many of the practical problems that will arise in its use. How, for example, does the decision maker allow for known biases or omissions in the PRA? Is no weight to be given to the margin by which the estimates differ from the guidelines? We think it too simplistic in its current form. We recommend that it be fleshed out more carefully or deleted, to be refined later.

In Part A (Vol. I, p. 21), a core melt frequency above 10^{-5}, rather than 10^{-3}, should allow the staff to "consider" safety improvements, even if the mortality QDOs are satisfied.

D. ALARA [Vol. I, pp. 14, 15; Vol. II, pp. 2-11, 12].

The dismissal of an ALARA principle in the safety goal report conflicts with the proposed severe accident policy, advanced reactor policy, and standardization policy. In these contexts, the policy statements indicate that we expect applicants to avail themselves of cost-effective risk-reduction opportunities. These policies make it clear that we are setting higher standards for the safety of new or standardized designs than we have for operating reactors. In addition, we need to be more careful lest we leave concerned neighbors of nuclear plants with the impression that we are ignoring ways to lower their risk at less cost than the risk reduction would be worth.

The apparent contradiction can be resolved by distinguishing different meanings of ALARA and different contexts of application:

1. No licensee would be required to make changes of only trivial significance by virtue of ALARA, since any change involves at least certain minimal costs, which would not be justified if the safety improvement is trivial. On the other hand, the analyses required as a foundation for ALARA decisions constitute a useful discipline in efforts to discriminate between improvements that are worth their cost and those that are not.

2. In contexts where the NRC means to set particularly high standards, such as design certification for new standard plants, applicants should be obliged to avail themselves of the lowest cost options for risk reduction until no further significant improvement can be had in a cost-effective manner. The QDOs do not constitute an adequate de minimis standard for this purpose.

3. In the backfit context, a higher threshold of de minimis risk should be used to stabilize the regulatory process, perhaps when all three[2] of the QDOs are satisfied with reasonable confidence.

E. Mean vs median for QDOs [Vol. II, P. 2-13].

The report advocates the use of median values. This conflicts with what we believe to have been the Commission's basis for choosing the plant performance guideline at 10^{-4}. If one intends to achieve a mean time to core melt of 10,000 reactor years, then it is the mean, not the median core melt frequency that must be chosen to be 10^{-4}. Were a median used instead, the mean time between core melt accidents might well remain around our current estimate of 3,300

reactor years. This is within the projected service time of the current population of plants.

The ACRS has recommended using mean values as does NRR. The principal advantage in doing so is that it gives proper weight to the consideration of uncertainties. The report now calls for consideration of uncertainties in decision making but outside the context of safety goal evaluation. By bringing the consideration of uncertainties within goal implementation, and by indicating how much is enough (as the use of the mean could be said to do), the safety goals would be strengthened as a tool to stabilize the regulatory process and better discriminate over- or under-regulation.

F. Commissioner Asselstine's proposed safety goal [Vol. I, p. 17; Vol. II, pp. 2-10, 11].

The proposed goal reads, "It is the Commission's objective that there will be no more accidents as severe as or more severe than that which occurred at Three Mile Island. If there is another such accident, then the Commission's regulatory program has failed."

The report proposes to reject the proposal. We believe that a greater emphasis on preventing future TMI-like accidents is indeed warranted. We believe that the reduction and revised description of the core-melt frequency guideline that we propose is a practical approach to such added emphasis. Nevertheless, we concur that Commissioner Asselstine's proposal should not be adopted as written but for different reasons: The Steering Group's arguments made for its rejection omit the most convincing reason, and may conflict with other parts of the report. We believe that the second sentence in the proposal might have the unintended effect of shifting the primary responsibility for safe design and operation from licensees to the NRC. This is clearly undesirable. This point is not made in the report, but should be.

The report does say that "the current safety goals, particularly the core melt guideline as intended to be implemented, provide adequate objectives for TMI-type accidents." The problems with this statement are these:

1. For accidents that stop short of vessel melt-through, the plant performance guideline is not meant to apply.

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[2]Four if there is an aggregate societal risk guideline.

2. The provisional implementation guidance does not call for even consideration of regulatory action to lower core melt frequencies below 10^{-3} unless a mortality guideline or a high frequency of an individual sequence triggers such action.

Finally, it is worth noting that there is a major policy issue in the extent to which the NRC should act to reduce pronounced vulnerabilities to core melt accidents that are believed to pose little objective off-site radiological risk. This policy question is touched upon in many places in the report but never squarely faced.

We suggest that the dismissal of the Asselstine proposal be rewritten, and that consideration be given to elevating the policy issue of regulating well-contained severe core damage or meltdown accident frequency.

G. Language of the quantitative design objectives [A-9; Vol. I, pp. 7, 8].

The report and the policy statement considerations make it clear that the QDOs should be viewed as aiming points, not thresholds of unacceptable risk. However, the QDOs are written, "....should not exceed...."

We recommend consideration be given to rephrasing the QDOs, so that their language agrees with the proposed interpretation.

H. Omissions in safety goal evaluation.

Nowhere does the report evaluate whether the QDOs are calibrated correctly, i.e., whether the standard should be higher or lower. Very little consideration has been given to the overlapping effect or self consistency among the guidelines. No consideration has been given to whether those aspects of risk not explicitly addressed in the guidelines are adequately limited, e.g., early injuries, off-site property damage, genetic effects, non-fatal cancers, non-cancerous thyroid nodules, teratogenic effects, or off-site indirect effects of accidents such as political, economic, environmental, national security, or psychological effects, etc.

As a minimum, we believe that consideration should be given to amending the report to cover how well the other physiological health risks and off-site radiological property damage risks are limited by the proposed goals.

I. "Whether a single monetary value of averted person-rem is appropriate..." [Vol. I, p. 11; Vol. II, pp. 2-6 through 8].

The Commission requested that this question be addressed as part of the evaluation. We concur with the answer in the report as far as it goes. However, we believe the Commission had other aspects of the question in mind. The answers do not treat the question of whether benefit-cost analysis should give a different weight to averted radiological exposure in the form of high individual doses that could yield early injuries or early fatalities, than is given to low doses that can only yield latent casualties. It may be worthwhile to prepare an answer to this question.

J. Containment performance guideline for new standard plants [Vol. I, p. 16].

The first sentence of the last paragraph now reads, "The concept of a containment performance guideline for future nuclear plant design may well prove to be a cost-beneficial means for reducing public risk, and the staff recommends that work continue to study such a guideline for future plants."

NRR does support continued study of (and is working on) containment performance guidelines for nuclear plants in general. Such guidelines might be of particular value in the resolution of severe accident issues on operating plants, though only after the rapid advances in containment performance analysis and source terms have matured and stabilized, and a thorough regulatory analysis is prepared for the proposed guideline.

K. Safety goals vs. regulations.

Some readers see a contradiction between the statements that the regulations are to retain their force and the statements that safety goals can be employed in requests for exemption under Part 50.12 or in the scrubbing of the rules and regulations of requirements of little value, as suggested in the Commission's PPG and EDO Program Guidance. We in NRR agree with what we believe to be the intent, as sketched below, but the issue warrants clarification.

The promulgation of a safety goal policy will in no way diminish the stature or enforceability of the rules and regulations. In requests for exemption under Part 50.12, a thorough, deterministic analysis of the particular safety issue(s) in contention must be supplied by applicants. Probabilistic arguments, including safety goal perspectives are an optional feature of such safety evaluations. A PRA indicating that a plant satisfies the quantitative design objectives is not, by itself, sufficient to justify a request for exemption. In generic standards development, whether in contexts of tightened or loosened requirements, safety goal evaluations will be a factor in the regulatory analysis of the proposed change.

However, the safety goals will be only one of many factors in the decision. Other factors, including defense-in-depth, soundness of legal and regulatory formulation, and engineering judgment will continue to be major considerations in reactor safety standards development. The application of safety goals to technical reform of rules and regulations will be approached in a cautious and judicious manner.

L. Safety goals in regulatory analyses of proposed generic requirements.

Some readers of the safety goal evaluation package are troubled by the role of safety goals in standards development issues that are difficult to associate with quantitative risk estimates. Section 3.3.1 of Volume II (p. 3-6) appears to address this question, but it is very brief. In issues such as sabotage, some human factors issues, external events issues, etc., in which differential risk estimates have little or no pretense to meaningful accuracy, are we to assume that safety goal evaluations are unnecessary? In such cases, it might be useful to calculate the change in risk that would warrant the projected expense and to address, in judgmental terms, whether such a risk reduction is plausible. Beyond that, such standards development issues should be exempt from a safety goal calculations within the regulatory analysis.