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

January 16, 1992

MEMORANDUM FOR: Commissioner Rogers

FROM: James M. Taylor
Executive Director for Operations

SUBJECT: STAFF REVIEW OF RECENT STATEMENTS ON SAFETY GOALS

In a memorandum from G. H. Marcus to James L. Blaha, dated November 27, 1991, the staff was asked to review a recent analysis of safety goals by Mr. Steven Sholly. As requested in that memorandum, the staff has focused its review on point A.1 of Mr. Sholly's analysis and the associated Appendix A. In this appendix, Mr. Sholly concludes that a 3400 Mwth reactor without a containment could have a core damage frequency of roughly 3 x 10^{-4} per reactor year and still meet the Commission's quantitative health objectives (QHO).

Mr. Sholly makes other assumptions and assertions in his analysis (e.g., average core damage frequency across industry is 3 x 10^{-4} per reactor year) which the staff has not addressed in this memorandum.

The staff's explanation and observations are provided in the enclosure and the main points are summarized here.

o His choice of population dose consequences for poorly mitigated core meltdown accidents (and his resulting core damage frequency) is at the high end of present consequence estimates, is not based on a 10 mile population distance calculation in accord with the safety goal policy, and is not clear regarding the use of mean values and consistent assumptions;

o The Commission's individual early fatality quantitative health objective can be more constraining than the Commission's individual latent cancer fatality objective and, apparently, Mr. Sholly's related goal, by approximately an order of magnitude or more; and

o Possible subordinate goals, such as the large release guideline, could be more constraining than either of the quantitative health objectives or Mr. Sholly's goal. Since the exact definition of this goal has not yet been approved, the staff is unable to address how much more constraining such a subordinate goal might be. However, NUREG-1150 information, using one proposed definition of "large," indicates that such a goal could be more constraining by one to several orders of magnitude. The Commission in its June 15, 1990, SRM on safety goal

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implementation acknowledged that in the large release guideline an inherent order of magnitude constraint could exist relative to the quantitative health objectives.

It must be noted, however, that existing risk analyses indicate that there is considerable margin between plant internal event risks and the individual early fatality objective, and therefore, it is possible that plant designs could in concept, have significantly higher risks (for example, a factor of thirty greater than that shown for the Surry internal events risk in NUREG-1150) and still meet the quantitative health objectives.

It is also important to reiterate here that it is the body of NRC regulations and NRC's regulatory oversight that act to define and maintain acceptable design and operational practices in commercial reactors. It is these practices that have served to constrain the frequency of core damage accidents and the containment integrity requirements against large releases of radioactive material, not safety goals per se. If the NUREG-1150 plant and site-specific risk assessment is assumed as a representative snapshot of the levels of safety achieved by our regulations and oversight, then the quantitative health objectives in the safety goal policy are being attained with a wide margin.

James M. Taylor
Executive Director
for Operations

Enclosure:
As stated

cc: The Chairman
Commissioner Curtiss
Commissioner Remick
Commissioner de Planque
SECY
OGC

Enclosure

Evaluation of SafetY Goal Analysis by Mr. S. ShollY

In his analysis, Mr. Sholly has created a safety goal based on collective population dose within 50 miles of the site. This measure is related to, but not identical to, one of the Commission's two quantitative health objectives, the average individual latent cancer fatality risk within 10 miles. He has used the "acceptable" risk increment of the Commission's quantitative health objectives, 0.1 percent. Using the 50-mile average population around active commercial nuclear power plant sites and the average latent cancer fatality death rate in the United States, as well as the BIER V dose response information, Mr. Sholly calculates that his goal is equivalent to approximately 7000 person-rem per year in the 50-mile population.

Mr. Sholly then assumes an estimate of population dose consequences (20 million person-rem, citing NUREG-1150) for a poorly mitigated core meltdown accident (i.e., one in which either early containment failure or containment bypass occurs). As Mr. Sholly notes, such a consequence is at the high end of those calculated in NUREG-1150. However, the source of this consequence estimate in NUREG-1150 is not specified. Also in NUREG-1150, population dose calculations are made using site-specific population data; it is not clear which site/population Mr. Sholly used.

With both an "acceptable" risk and assumed consequences defined, Mr. Sholly then calculates the frequency of an accident that would correspond with this risk. This results in his conclusion that such an accident could have a frequency as high as 3×10^{-4} per year. The validity of this value is not clear from the analysis presented since the average population value used in determining the 7000 person-rem number may not be the same as that corresponding to the 20 million person-rem number and the 20 million person - rem may not be a mean value (which are to be used in safety goal comparisons).

Since the staff does not normally deal with a safety goal such as that defined by Mr. Sholly, it is difficult to quickly assess all of its implications. In particular, some additional effort would be required to analyze the relationship between his goal and the average individual latent cancer fatality objective, although the two do seem closely related.

In lieu of performing such work, the staff has examined NUREG-1150 data to address the question of how much worse a plant could be and still meet the Commission's quantitative health objectives. Figure 1, taken from NUREG-1150, provides comparisons of the accident risks of five plants with the Commission's two quantitative health objectives. As may be seen, Figure 1 shows that, for internally initiated accidents, the plants meet the objectives with considerable margins. This can be interpreted that these plants yield very small risks from internally initiated accidents. This also means, however, that these plants, if otherwise unconstrained, could have significantly higher risks and still meet the objectives.

As you are aware, the staff is assessing the use of (and definition of) a subordinate goal relating to the frequency of a "large" release of radioactive material. An evaluation of such a goal, using one proposed definition of

"large" was also made in NUREG-1150, and is shown in Figure 2. If such a goal were accepted, it would be considerably more constraining than the individual early fatality QHO (by one to several orders of magnitude); the individual latent cancer fatality QHO, and, apparently, Mr. Sholly's goal. The Commission has previously acknowledged (in its June 15, 1990, SRM on safety goal implementation) that a large release goal could be inherently more constraining than the QHOs.

NUREG-1150 information can also be used to assess how much more frequent a specific accident could be and still meet the quantitative health objectives. The Surry plant, the risk of which is dominated by containment bypass accidents with relatively large consequences (the type of accident discussed by Mr. Sholly), can be used as an example. The Surry plant has a somewhat lower power rating than the plant cited by Mr. Sholly (2441 Mwth vs. 3400 Mwth); this difference is not believed to be significant for purposes of this analysis. The mean 50-mile population dose from a containment bypass accident at Surry is estimated to be roughly one million person-rem. This is considerably less than that assumed by Mr. Sholly. For Surry the 10-mile population is approximately 100,000, which would translate to 240 person-rem per year, using an "acceptable" risk increment 0.1 percent. Using Mr. Sholly's method of calculating a frequency this would result in 2×10^{-3} per year. However, the staff considers this population dose more appropriate for use, since safety goal assessments are focused on mean values. This difference in population dose, however, does not have a major impact on the staff's conclusions.

As Figure 1 indicates, the Surry plant mean risk is roughly a factor of thirty below the individual early fatality QHO, and roughly a factor of one thousand below the individual latent cancer fatality QHO. With this margin, and if unconstrained by regulations, a containment bypass accident at Surry could have a mean frequency of roughly 1×10^{-4} per reactor year (vs. the NUREG-1150 estimate of roughly 3×10^{-6} per reactor year) and just meet the individual early fatality QHO, while meeting the individual latent cancer fatality QHO with some margin.

If unconstrained by regulations <u>or</u> the individual early fatality objective, a containment bypass accident at Surry could have a mean frequency of roughly 6×10^{-3} per reactor year and just meet the individual latent cancer fatality objective using the information in Figure 1. Since the population dose goal defined by Mr. Sholly is more closely related to the individual latent cancer fatality quantitative health objective than the individual early fatality objective, this example appears to be more directly comparable to his analysis.

In summary, Mr. Sholly's analysis of safety goals may be pessimistic, because:

o His choice of population dose consequences for poorly mitigated core meltdown accidents (and his resulting core damage frequency) is at the high end of present consequence estimates, is not based on a 10 mile population distance calculation in accord with the safety goal policy, and is not clear regarding the use of mean values and consistent assumptions;

- o The Commission's individual early fatality quantitative health objective can be more constraining than the Commission's individual latent cancer fatality objective and, apparently, Mr. Sholly's related goal, by approximately an order of magnitude or more; and

- o Possible subordinate goals, such as the large release guideline, could be more constraining than either of the quantitative health objectives or Mr. Sholly's goal. Since the exact definition of this goal has not yet been approved, the staff is unable to address how much more constraining such a subordinate goal might be. However, NUREG-1150 information, using one proposed definition of "large," indicates that such a goal could be more constraining by one to several orders of magnitude. The Commission in its June 15, 1990, SRM on safety goal implementation acknowledged that in the large release guideline an inherent order of magnitude constraint could exist relative to the quantitative health objectives.

It must be noted, however, that existing risk analyses indicate that there is considerable margin between plant internal event risks and the individual early fatality objective, and, therefore, it is possible that plant designs could in concept, have significantly higher risks (for example, a factor of thirty greater than that shown for the Surry internal events risk in NUREG-1150) and still meet the quantitative health objectives.

It is also important to reiterate here that it is the body of NRC regulations and NRC's regulatory oversight that act to define and maintain acceptable design and operational practices in commercial reactors. It is these practices that have served to constrain the frequency of core damage accidents and the containment integrity requirements against large releases of radioactive material, not safety goals per se. If the NUREG-1150 plant and site-specific risk assessment is assumed as a representative snapshot of the levels of safety achieved by our regulations and oversight, then the quantitative health objectives in the safety goal policy are being already attained with a wide margin.

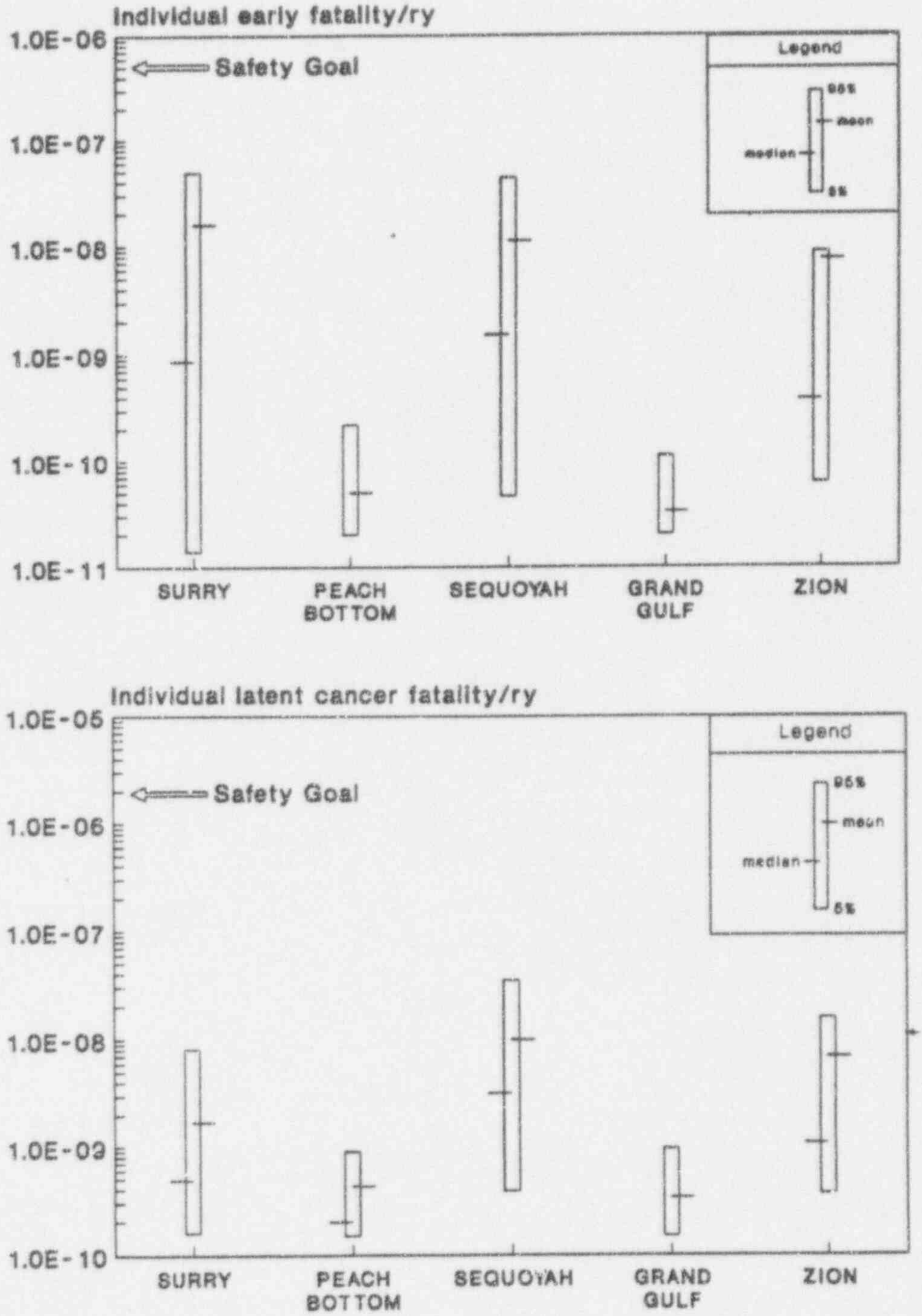

Figure 1 Comparisons of NUREG-1150 results to safety goals

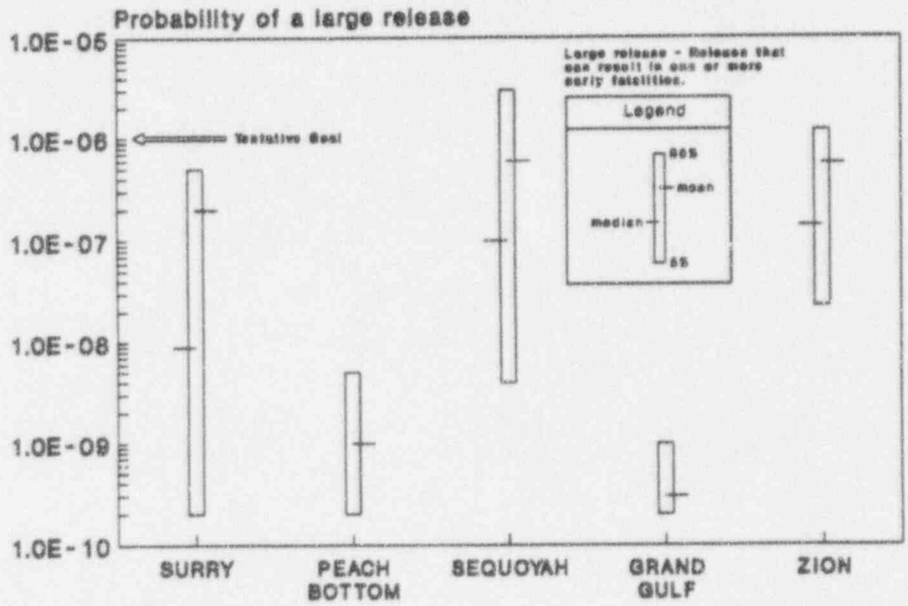

Figure 2 NUREG-1150 large release comparisons

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