R. Tharani

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

April 18, 1978

MEMORANDUM FOR: Miller B. Spangler, Special Assistant for Policy Analysis, Environmental Technology
Division of Site Safety and Environmental Analysis, NRR

FROM: Roger J. Mattson, Director
Division of Systems Safety, NRR

SUBJECT: RISK AVERSION AND PSYCHIC COSTS

This is in response to your thoughtful and illucidating memorandum of April 12 on the subject of risk aversion and psychic costs. Unfortunately I did not receive it until late in the afternoon on April 17 as an attachment to your April 17 memo to the Chairman. I understand that others on the distribution list also did not receive their copies until late on April 17.

Your memo of April 12 asks me to include your proposed treatment of risk aversion and psychic costs as an appendix to the value impact analysis in the ATWS report (NUREG-0460, Volume 2, Appendix XII). You state that I had previously agreed to this approach. I'm afraid there must have been some misunderstanding in our meeting of April 11 on this point. What I meant to offer, and thought I did, was to add a brief summary of your concern in Appendix XIII of the report. In any event, that is water under the bridge since I did not hear back from you last week. The report is now in final reproduction at a contractor's facility outside NRC in order to be available for the April 20 ACRS subcommittee meeting.

The picture is not all bleak, however. In our meeting of April 11 I decided to adopt, with editing, Hal Peterson's summary of the risk aversion concept for use in section 7.2 of Appendix XII in lieu of your writeup. Subsequently, your management (Mr. Ernst and Mr. Denton) appealed that decision on your and their behalf. As a result, I met with them on April 14 and agreed to include in section 7.2 an edited version of your writeup that they had provided for my consideration. The final version of section 7.2 was agreed to in my April 14 meeting with your management. It is provided here as enclosure 1.

Admittedly, the final version of section 7.2 is considerably shorter than your original writeup. It does, in my estimation, speak to the principal elements of the risk aversion concept, and it provides sufficient basis for decision makers to understand the potential role of risk aversion factors in the ATWS decision. That is, if risk aversion

were to be accounted for in the process, it would act to increase, in some unquantifiable fashion, the value of the staff's proposed safety objective and regulatory criteria for ATWS.

At this point I believe we should proceed in the following manner. You should review the final version of section 7.2 of Appendix XII to see if it satisfies your concern for providing the decision makers with sufficient information on risk aversion and psychic costs for purposes of the ATWS decision process I described on April 11. If not, you should recommend to your DSE management what further action you consider necessary. There remain several opportunities to improve the technical basis for the ATWS decision, if that proves to be necessary. This could be either in the course of RRRC review or in the Director of NRR's recommendations to the Commission.

My judgment today is that the final version of section 7.2 provides sufficient information for the RRRC, the NRR Director, and the Commission in making their decisions. The information provided in your memos and initial writeup have been most helpful at Mr. Denton's and my level in developing and defending the final version of section 7.2.

I will wait to hear from Mr. Denton as to whether he feels more is necessary.

Roger J. Mattson

Roger J. Mattson, Director
Division of Systems Safety
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc: (w/encl)
Chairman Hendrie
E. G. Case, NRR
H. Denton, DSE
M. Ernst, DSE
H. Peterson, SD
K. Goller, SD
D. Ross, DSS
A. Thadani, DSS

probability because of reduced reserve margins. Informed judgment suggests that the adverse societal impact of loss of system reliability consistent with the scenario assumptions will likely be significant for a substantial range of utility situations prevailing at the time. However, if the site on which the ATWS core melt took place had as many as three or four units instead of the two assumed, then the social significance of reduced system reliability would be greatly expanded because of the increased difficulty of finding acceptable options sufficient to make up for such a large reduction in reserve margins.

7.2 Psychic Costs and Benefits

"Psychic values" expressed as costs or benefits may be defined as personal perceptions of value associated with certain activities, transactions and real or potential events which are external to marketplace values. At times, psychic values may interact with marketplace values.

However, direct marketplace interactions with psychic values are not a prerequisite for the validation and use of psychic values in decision making. The dysphoria of various unpleasant aspects of living conditions in urban areas, referred to as "psychic costs" in a CEQ - sponsored study on The Costs of Urban Sprawl, is an example of costs not measured in dollar units of the market place nor necessarily affecting marketplace costs.[1]

Regarding health and safety matters, it is observed from the behavior and expressions of concern of individuals that anxieties or fears concerning the prospect of sickness or death can and does have a negative experience or dysphoria quite apart from the negative values associated with the loss of life or illness as realized events. It is the prospective concern for health and safety associated with an ATWS modification decision or its alternative on which the present discussion of psychic costs and benefits will focus. For discussion purposes, a psychic cost will be promoted if the decision and its supporting analyses and public debate lead to a significant increase in the concerns, anxieties, or fears of an appreciable segment of the public and a psychic benefit would result if there is a significant reduction of such concerns, anxieties, or fears for an appreciable segment of the public.

It should be noted that "risk aversion" tendencies in an individual do not necessarily mean that he or she will not engage in certain activities that involve a distasteful element of risk, but rather that in many cases an extra premium must be present in the reward or benefit functions to compensate for these psychic costs of risk-taking.[1] On the other hand, certain other individuals may get a psychic benefit from "risk acceptance" tendencies out of a spirit of adventure or excitement, or the reinforcement of image of the individual as being courageous in the

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[1] This concept of risk aversion as defined by Friedman and Savage contrasts sharply with the definition of risk aversion by Rowe as "the act of reducing risk." Cf., William D. Rowe, An Anatomy of Risk (New York: John Wiley & Sons, 1977), p. 464, and Milton Friedman and L. J. Savage, "Utility Analysis of Choices Involving Risks," Journal of Political Economy, 1948.

face of danger. For many, and perhaps a large majority of persons, a normal tendnecy is to adopt a "satisficing" function rather than a "minimizing" function in their decisions to engage in risk-taking activities (even involvng the possibility of loss of life) provided that the risks are believed to be substantially less than some ill-defined level that is personal to the individual.[1]

Even if one were able to determine the balance of psychic costs and benefits in advance of the decisional process, it is difficult to perceive how such information would or should be used. It is clear today that such an analysis would likely be biased significantly towards risk aversion, but it is not clear that such a bias could be converted into the percise degree of additional conservatism that the NRC should factor into its impact-value analyses.

The $1000 per man-rem value used in Section 1.4.3 is based, in part, upon estimated monetary values for the worth assigned by society for preventing a loss of life or upon compensation payments for a life already lost. These estimates do not account for potential differences

[1] Herbert A. Simon, "Theories of Decision Making on Economics," American Economic Review, vol. xxvi, no. 4, June 1959, pp. 243-283.

in the willingness to pay for avoiding a risk to health or the risk of death depending upon the cause and nature of the injury.

The issue of risk perception could influence the willingness of the public to pay. For example, a recent report[1] indicated numerous factors which affect perception of such risk. This aspect has not been incorporated into the dollar per man-rem values used since it seems more appropriate for public health and safety decisions to be based upon estimates for actual health risks and costs rather than upon perceived risks or psychic costs, as these effects are described in the literature. Not accounting for this potentially increased willingness to pay leads to lower estimates of the value of improving protection against ATWS events than would our accounting of this effect, if such accounting could be accomplished.

7.3 Shutdown of Reactors at Other Sites

Another important consideration in the decision over ATWS modifications is the desirability of reducing the probability of a core melt because, if an ATWS core melt actually occurred at an unmodified reactor, it could lead to a decision in the protection of public safety interests

[1] Licthenstein, Slovic, Fischhiff, Layman, and Combs, "Perceived frequency of Lethal Events," Decision Research Inc., Report 76-2, January 1978.

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April 22, 1977

NOTE TO: Mel Levine

FROM: Ashok Thadani

SUBJECT: CALCULATIONS

Attached are more details on the set of calculations we discussed this morning. Please acknowledge receipt.

A. Thadani

Ashok Thadani

DUPE

8104170120

Run	% Power A	°F Tave B	PCM MTC C	Δk/k Doppler D	Δk/k Gap E	lbm SGI F	Sec AFW G	ft³ RCS H	% P.L. I
1	-	-	-	-	-	-	-	0	0
2	-	-	-	+	+	+	+	0	0
3	-	+	+	-	-	+	+	0	0
4	-	+	+	+	+	-	-	0	0
5	+	-	+	-	+	-	+	0	0
6	+	-	+	+	-	+	-	0	0
7	+	+	-	-	+	+	-	0	0
8	+	+	-	+	-	-	+	0	0
9	0	0	0	0	0	0	0	+	0
10	0	0	0	0	0	0	0	0	+

Levels	Power	Tave	MTC	Doppler	Gap	SGI	AFW	RCS	P.L.
+	96%	Nom-4	-15	1.65×10^{-5}	0.8	Nom. (1.05)	15	X	X
-	104%	Nom+4	-7.0	$.99 \times 10^{-5}$	2.2	Nom. (.95)	40	Nom. (1.05)	Nom. (1.04)
0	100%	Nom	-11.1	1.32×10^{-5}	1.5 mil	Nom.	25 sec.	Nom.	Nom.

0 - Nominal Value (Nom.)

Reference Case: a) Four Additional Safety Valves

b) 10% Relief & Safety Valve Accumulation

c) All other Parameters are at 0 level

Attachment 3

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301-492-7000

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