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Dear Professor Okrent:

This letter is in response to your request for comments following the 5/31-6/1 meeting of your Subcommittee on the TMI-2 accident implications. There are many detailed points that I would like to make at some later time. However, for the purpose of emphasis and to avoid dilution I would like to concentrate, in this letter, in the major point of philosophy of approach in responding to TMI-2.

According to the office of Nuclear Regulatory Research the TMI-2 accident has brought up the need to better study the area between design basis accidents and core melt accidents. Based on this an extensive but rather diffuse list of task areas ranging from "accelerating development of transient and small LOCA codes" to "containment integrity under fuel melt conditions," was prepared with a total price tag of ∿ 30 million dollars. Although I still believe, as I did in a 1974 letter to the ACRS, that better understanding ("probability of occurrence and consequences") of this intermediate area ("partially degraded conditions") is warranted I think it will be wrong to make it the <u>initial</u> focal point of our response to TMI. Instead, I believe, we need to look (in a more generic fashion) for safety deficiencies primarily responsible for TMI. In my opinion the answer to this question is lack of sufficient understanding of accident sequences (of not only small LOCAs but of the whole spectrum of sizes) including the whole breadth of physical phenomena associated with LOCAs and system/human interactions. This is *like* constructing event trees except with the emphasis in mechanistic details of accident progression (as determined from physically grounded analysis tools) *together* with the usual probalistic oriented aspects of component/human behavior.

A major and diligent effort would be required to produce useful results in this area. On the other hand such results would be instrumental in a number of areas: (a) indicating areas where further fundamental research and/or empirical information would have the greatest impact on safety; (b) providing a background against which operator training may be made substantially complete, including better elucidation of the type and kind of instrumentation crucial for correct operator responses; (c) provide the necessary basis for a realistic approach to the advanced code verification (assessment) efforts that is about to commence, and finally; (d) such studies will provide us with a better basis (than that available today) for a realistic approach to striking the appropriate balance between *prevention*, *mitigation*, *intervention*, and *estimation of consequences* for reactor accidents. Along these various lines of

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defense verification of projections becomes increasingly more difficult. Unscheduled complications may always arise, hence major uncertainties in the projected behavior develop. Clearly, therefore, the research emphasis should be in the above order. However the demarcation lines and the absolute degree of emphasis need better definition.

I would also like to take issue with the attitude, expressed by many these days, that the main licensing thrust has been on "conservative" analysis while TMI points to the need of "realistic" evaluations. I think, in a more appropriate view of this situation, we should recognize that unless one knows the true phenomenology and sequence of events one is hard pressed, in many situations, to make "conservative" choices in the analysis. This has been well known in the past. The ECCS hearings and Appendix K implementation have many times pointed to this fact. This is precisely the reason that such large efforts have, and are continuing to be devoted to the development of best estimate Computer Codes for LOCA (and transients). Further it should be obvious that as the size of the break decreases and the time sequence of the accident increases, there is more opportunity for phase separation and large degrees of nonequilibrium (i.e. injecting cold water etc.) both being complicating and ill-characterized factors affecting the thermal-hydraulic response of the system. Also there is more opportunity for human and system interactions (i.e., actuating/deactuating systems and random systems failures) further complicating the sequence. I do not think we have failed to recognize the importance of all these things in the past. We failed instead in carrying out the relevant analysis, thinking and scrutinizing the results, to better understand the system response and identify weak links in systems and troublesome areas in human interactions. Such endeavors are difficult and not precisely definable in detail at the outset. The response of the system can be very complicated indeed. There has been a "natural" hesitation, therefore, to undertake major efforts in this direction in favor of a plug-and-chug approach with code computations carried out primarily for the purpose of obtaining a peak clad temperature. The excuse has been, at least given in response to my asking for such applications, that the analytical tools have not been adequately developed as yet. This may have been true five years ago, but it has become less true during the past 1-2 years. If we wait until the tools are completely perfected it will take forever. I believe that it is now urgent that any further analysis tools and code development be guided by appropriate "synthesis" of accident sequence studies. Like I mentioned in a 1977 letter to the ACRS we need to put major emphasis in scrutinizing "code results and accident sequences to provide the basis for an iterative synthesis-analysis process converging *to the actual phenomenology of interest to safety.*"

One can think of situations where operator intervention would be essential during the course of an accident. This will be particularly true for small breaks. Hence as the break size decreases the accident sequence becomes more complicated. Hence it is less clear what represents a conservative analysis choice and most importantly it becomes more difficult formulating a reasonably compact set of recommended operator actions. For this latter task, in any case, it is absolutely necessary that the operator have the appropriate diagnostic tools and to relate, through analysis, the indication of these tools to the physically occurring processes. Hence the need for predicting actual (vs. conservative) system response increases as break size decreases. The difficulties of modeling and computations also increase. Incidentally I find the current B&W effort to provide a "plausible" explanation for the TMI events a step consistent with their capabilities but rather inadequate. Finally it will prove, I think, rather difficult to find appropriate facilities for assessing (or verifying) the adequacy of such computations. This is because the scaling problems become more severe. There are reasons to doubt, for example, that we can expect to learn much about small breaks from Semi-scale. Since such experimental programs need long lead times, I suggest that this issue also receive concentrated attention in conjunction with the accident sequence studies mentioned above.

Due to the time available between our subcommittee and the full ACRS meeting I am afraid this write-up is not as well organized or as clear as I would have liked. Please call me if you have any questions, and I will do my best to attend the meeting of 6/14-6/16.

Sincerely,

T. Theofanous

T. G. Theofanous
Professor

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