TUFTS UNIVERSITY

Department of Mechanical Engineering

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Mr. L.G. Hulman
Chief, Accident Evaluation Branch
Division of Systems Intergration, NRR
U.S. Nuclear Regulatory Commission
1717 "H" Street, NW
Washington, D.C. 20555

Dear Mr. Hulman:

I have had the opportunity to review the comments submitted to you by Stone and Webster Engineering Corporation relative to the Draft Report of NUREG/CR-2629 entitled "Interim Source Term Assumptions for Emergency Planning and Equipment Qualification" and am taking this opportunity to strongly support those comments and the recommendations they contain.

Of singular importance is the recommendation that an interim source term be issued in the short term. As noted there, it is hoped that such an interim action might be taken by June 30, 1982 and that it address the airborne radioiodine and waterborne cesium portions of the source term.

Furthermore, I also strongly urge that both the interim and eventual revised source term incorporate the recommendations of a separate and distinct radioiodine component, and that the radioiodine term not be grouped with other radioisotopes or be put forth as a surrogate for other radioisotopes.

Thank you for consideration of this issue. I appreciate the opportunity to comment and look foreward to an effective, timely decision on the issue of an interim source term.

Sincerely,

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COMMENTS ON DRAFT REPORT - NUREG/CR-2629

"INTERIM SOURCE TERM ASSUMPTIONS FOR EMERGENCY PLANNING AND EQUIPMENT QUALIFICATION" AND ASSOCIATED PEER REVIEW MEETING ON MARCH 18, 1982

Prepared By
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Scope of Comments

The following comments are not limited to the Draft Report of NUREG/CR-2629, hereafter referred to as the Draft Report. Comments of a more general nature are provided on the broader subject of establishing interim source terms. A recommended approach to be taken in establishing interim source terms is discussed herein.

Summary Comments on Draft Report

The report does not provide explicit recommendations for interim source term assumptions coupled with technical justifications for each recommendation. It does not propose an approach for estimating source terms. Nor does it develop criteria and assumptions to be used for estimating source terms for equipment qualification calculations and emergency planning.

What the report does do is essentially rehash the Reactor Safety Study (RSS) and Reactor Safety Study Methodology Application Program (RSSMAP) efforts in the source term area. This rehash is accompanied by some relatively minor improvements over the RSSMAP activities. There is absolutely no new ground broken in this study. It therefore adds very little to the solution of the interim source term issue.

A fundamental problem with this study is that it simply represents still another analysis with the MARCH and CORRAL computer programs. As was stated in the Peer Review Meeting on March 18, by Dr. W. Stratton ' "If you turn the same crank, you're going to get the same answers." Admittedly there were some changes in these analyses as compared with previous similar analyses.

However, these changes were not substantive and did not address the real issues which make all such analyses suspect (see later comments).

The old adage of "Garbage in - - garbage out" as applied to computer codes can be modified to read "Reasonable assumptions in - garbage out" if the processing of the input by the code results in unrealistic output no matter how good the input is. The MARCH code has been described by the ACRS and others as being so fundamentally flawed as to be virtually unuseable. The track record for the CORRAL code isn't much better. Therefore it should be kept in mind that a "new" analysis using these same codes is essentially no change at all from the RSS and RSSMAP studies. It is not surprising, therefore, that the results in this Draft Report agree well with the RSS. This close agreement is a direct measure of how inappropriate these answers are.

As indicated by Dr. R. Vogel of EPRI, at the Peer Review Meeting, the original MARCH code was found to contain 100 fundamental flaws. A recent meeting to review a more improved version of MARCH identified 43 fundamental flaws. As reported by Mendoza, etal., in the May 1981 issue of Nuclear Technology, the CORRAL code overpredicted the radioiodine released to the atmosphere at the SL1 accident by a factor of 215. Such codes do not provide "best estimate" results.

To rely on the use of such codes, as was done in this study, reflects a mindset that is apparently based on the thought process that argues that unless an analysis is performed with computer codes it is not an appropriate analysis - irrespective of how accurately the computer codes emulate reality. A series of hand calculations based on first principals and sound engineering judgement is far better than a lot of numbers from questionable computer codes.

The point to be made is that these codes do not adequately treat the most important physical, chemical and natural phenomena. In the case of MARCH, the code does not adequately treat the thermal-hydraulics. The draft report merely lists all of the important things that were not included. However it leaves the uninformed reader with the impression that these are merely uncertainties. The fact that virtually all of the ignored effects act to reduce the source term is not discussed.

General Comments

The Reactor Safety Study (RSS) as reported in WASH-1400 should not be viewed as the standard against which other source term investigations are measured. The value of the RSS is in the establishment of a baseline estimate of accident sequences and their associated probability of occurance. The consequence analyses in the RSS, including the source terms, should be recognized for what they are - that is overestimates in an attempt to define upper bounds of radiological consequences.

In judging whether a postulated source term is adequate - the measure should not be how it compares with the RSS or the more recent slight modifications of the RSS contained in the Reactor Safety Study Methodology Application Program (RSSMAP). The source terms used in those studies in themselves represent interim source terms for Probabilistic Risk Assessment (PRA). These are *defacto* interim source terms for PRA work. They have no direct applicability in establishing interim source terms for emergency planning and equipment qualification.

The establishment of interim source terms for emergency planning and equipment qualification should have as its foundation all of the available pertinent technical knowledge - published in the technical literature and made available to the NRC in peer review meetings and comment correspondence. The RSS and RSSMAP documents are only two parts of the mosaic.

Among the more important information which is useful in addressing the establishment of an interim source term is the experience gained from all previous reactor accidents, especially those involving complete or partial core melting. Those accidents, such as SL1 with little or not containment or in which containment barrier was breached should be awarded special attention and relatively high weight in the scientific judgement process. After all, these represent hard empirical observations. Also of great importance are the many large and small scale experiments.

In assessing the information from these and other sources, particular attention must be given to the physical and chemical characteristics of the released fission products, the time at which they were available for escape to the environs, the natural phenomena which were operative in each instance, and the effects of engineered safety features (including containment).

Above all else, the evaluation of these data must be realistic. There is no excuse for applying what is thought to be conservative judgements in assessing the scientific merit of these data. The entire source term issue has been plagued with the use of the word "conservative" for what in fact was "wrong" judgement. The place for conservatism is at the end of the scientific judgement process - where a "safety factor" should be applied to cover reasonably expected uncertainties. This factor should not be some unsubstantiated "umbrella" which is based on convoluted logic such as a highly improbable dry accident scenario in a light water reactor plant. Rather, this "safety factor" should be based on best engineering judgement - a practice which is widely followed in other industries (such as the elevator industry in which public health and safety is assured by the use of such factors).

Before addressing a new interim source term, it would be instructive to address the question: "What are the scientific bases for the present source term?" Subsets of this question should address such issues as: "What are the scientific bases for the assumption that the radioiodine postulated to be airborne in the containment is primarily in the elemental (I_2) form? What are the bases for assuming the iodine consists of 91% elemtal, 4 % organic, and 5% particulate material? There are many other subsets to the above general question. However the public safety would not be well served by a protracted investigation of the answers to these questions. Simple straight forward answers, with all their attendant qualifications are in order. The regulatory staff should not be pre-occupied with the uncertainties to the extent that it precludes answering the questions. Clear headed scientific judgement should replace the mindset which is so concerned about uncertainties as to lose sight of the facts of the situation.

The four most important factors which influence the establishment of the source term are:

- o The physical and chemical characteristics of the fission products which are postulated to be airborne in the containment building.
- o The natural phenomena which are operative-independent of mitigating actions.
- o The temporal effects as a function of time after initiation of the accident events.
- o The effects of engineered safety features.

The paramount importance of radioiodine in assessing the radiological consequences of postulated accidents requires that a separate and distinct radioiodine portion of the source term be established. It should not be grouped with other radioisotopes. Nor should it be put forth as a surrogate for other radioisotopes.

Recommendations

A. Short Term (i.e., by June 30, 1982)

Enough is now known to permit establishment of an interim source term for emergency planning and equipment qualification by:

1) Reducing the present airborne radioiodine source term by at least a factor of 20.

2) Modifying the postulated chemical form of the airborne radioiodine to be more nearly consistent with the chemical and physical properties of airborne radioiodine observed in actual accidents and small and large scale experiments.

3) Increasing the amount of Cesium from 1% to 50% for waterborne sources used in equipment qualification calculations.

B. Long Term (i.e., by January 1, 1984)

Based on the intermediate results available from ongoing research and development efforts, establish a revised source term to be applicable after January 1, 1984, unless further ammended by the Commission at the conclusion of the ongoing research programs.

The approach that should be taken in establishing such an a revised source term is outlined below:

Step 1

Prepare a matrix style listing of the postulated accidents (e.g., the TMLB'δ sequence from WASH-1400). This listing should include a very brief description of the features of the postulated accidents which directly affect the source term.

Step 2

Prepare a matrix style listing of the most realistic assumptions of the fraction of the available fission product inventories which are postulated to escape from the core, the pressure vessel, the primary coolant system, and the containment. These fractions should be multiplicative. They should also be specific to individual fission products and fission product groups (e.g., Xenon, Krypton, Iodine, Cesium and groups of other fission products).

Step 3

Prepare a listing describing the postulated chemical and physical form of these fission products at each step in the process (i.e., in the core, the pressure vessel, the primary coolant system, and the containment).

Step 4

Provide the best estimate as to the time sequence for the transport of the specific fission products and fission product groups in going from the core through the pressure vessel, the primary coolant system, and through leakage paths in the containment.

Step 5

Provide the best estimate of the effects of engineered safety features (such as containment sprays in the case of a PWR and the suppression pool scrubbing in the case of a BWR).

Step 6

Combine all of the information from the above steps and postulate the most realistic source term for each class of accident.

Step 7

Only after completing step 6, should the questions of uncertainty and the conservatism be addressed. The range of uncertainties for each of the "bottom line" realistic source term components should be explicity established. This of course will require engineering and scientific judgement.

Step 8

Having established the most realistic source term components and the engineering and scientific judgement of their attendant uncertainties, the question of the probability of the scenarios should be addressed. In particular, a rough estimate should be made of the probability associated with the upper range of the uncertainties for each fission product or fission product group for each accident scenario. In a word, the upper range of uncertainty must have associated with it a probability that uncertainty would become a real situation.

Step 9

Armed with the information from steps 1 through 8 - safety factors could be developed. An appropriate safety factor should be developed for each fission product and fission product group for each class of accident. An overall safety factor approach should be avoided.