NUS
CORPORATION
4 RESEARCH PLACE
ROCKVILLE, MARYLAND 20850
301 948-7010

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Mr. M. Silberberg, Chairman
Peer Review
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Comments on draft report on Technical Bases For Estimating Fission Product Behavior During LWR Accidents

Dear Mel:

Attached for your information are comments on NUREG 0772. I think you are to be congratulated on such a fine comprehensive report, and our comments in no way are meant to detract from your good feelings about your report. The comments are meant to be constructive in nature.

Sincerely,

Saul

Saul Levine
Vice President and
General Manager
Consulting Division

SL/m

001202

COMMENTS ON NUREG-0772

"Technical Bases for Estimating Fission Product Behavior During LWR Accidents"

(Compiled by W. Arcieri, H. Firstenberg and G.D. Kaiser, NUS Corporation.)

GENERAL COMMENTS

1. The authors of the report deserve to be congratulated for having put together such an impressive document in such a short time.

2. It is strongly felt, however, that the publication of NUREG-0772 is being pushed ahead too quickly. This can have repercussions in two ways:

   (i) The authors of the various sections have clearly not had time properly to interface with each other. A good example is to be found in Chapters 6 and 7. Chapter 6 is devoted to fission product transport in the primary system and Chapter 7 to fission product transport through the containment. In Chapter 7, paragraph 7.4, there is a statement to the effect that "no credit is taken for attenuation in the primary system." Yet the source term in the containment is cruially dependent on what takes place in the primary system, not only for determining the quantity of radioactivity present but also for determining important aerosol characteristics such as the particle size distribution.

(ii) The lessons to be learned from the great mass of material presented in the report have not been properly digested. This is not surprising since the correlation of such a large amount of information and the understanding of the subtle impact of the many uncertainties requires time for considered reflection. In particular, the abstract is not an adequate summary of what is contained in the report. For example, the conclusion on p. (i) that cesium iodide is the expected predominant iodine form is stronger than the conclusions in Paragraph 4.5, which states that the results of several experiments are inconclusive or even contradictory while, in the experiments of Lorenz et al, which provide the best available evidence for the presence of CsI, "in tests using steam, the percent of iodine identified as cesium iodide ranged from 4 to 90% with the balance as the molecular specie and on particulates. Several reasons for low cesium iodide release fractions in some of the steam runs are speculated but not proven."

Similarly, the conclusion in item (3) on p. (ii) that "the results of this study do not support the contention that the predicted consequences for the risk dominant accidents have been overpredicted by orders of magnitude" is premature since the study is incomplete. It was apparent at the peer review meeting on March 17/18, for example, that the study of the transport of aerosols in the primary containment is in its infancy and, as has already been noted, the effect of aerosol processes in the primary system on transport in the secondary was not considered. The answer to question (3) of the abstract is essentially that more work must be done before the answer can be determined.

It is therefore strongly urged that publication of NUREG-0772 be delayed. There also appears to be a need for a more considered overview, explaining the key parameters that influence the calculations.

3. In general, the assumptions that are made in each section of the report are not clearly stated, nor is it always clear how well the various codes used have been validated by comparison with experiment. This is particularly true of the TRAP-MELT code (Chapter 7, with its review of aerosol codes and the accompanying appendix E, is much more satisfactory). Similarly, the assumptions and simplifications that go into defining flowpaths are not clear to the reader.

IMPORTANT TECHNICAL POINTS

1. The report concentrates on iodine and, to a lesser extent, cesium. There is only a limited examination of the possibility that other fission products could affect the stable compounds of iodine, for example, or that volatile compounds such as $Sr(OH)_2$ can influence the source term. In general, fission products other than iodide and cesium should be examined. It is true that the authors do provide a means of estimating the fission product realease of other radioactive materials, but they do not relate these release rates to the chemistry.

   Fractional release rate coefficients are given in Fig 4.3 and the authors claim that there is an associated order of magnitude uncertainty. Since the timing of the release during an accident sequence is important for an assessment of the fate of the fission products, it is considered worthwhile to perform sensitivity studies to quantify the effects of this uncertainty during representative accident sequences

2. Flowpaths: one of the key elements of this sort of analysis is the definition of the flowpath into the containment and out of it into the atmosphere or ground water. We are concerned that flowpath diagrams such as Fig. D7 and D8 conceal a host of assumptions and simplifications. This is related to the point made above that the assumptions used are not always clearly stated.

   In general, the report appears to underestimate the difficulty of defining flowpaths, particularly where containment failure due to overpressure, hydrogen burn or steam explosion is concerned. There is great uncertainly in the definition of the nature of the pathways that are thereby created and existing methods of structural response are not adequate for the job - i.e. further research is required.

3. As has already been mentioned, in the general comments, it is felt that aerosol behavior, particularly in the primary system, is a major source of uncertainty.

4. In order for the natural processes that attenuate the fission product source term to act efficiently, it is desirable that the confinement time should be as long as possible. This confinement time depends on time to containment failure and on subsequent leak rates. It would seem that this should be given more prominence as a key parameter, and that the physical processes which determine its value deserve special study. This means that research into the sequence of events during a core melt should be emphasised and that efforts should be devoted to improving codes such as MARCH. In this context, as in some of the comments above, we emphasize again the need for further examination of the ways in which the containment can fail and of the leakage pathways that are subsequently

opened up to the atmosphere or to ground water.

5. Returning to the question, already touched upon in the general comments, of the chemical form and release of iodine and cesium, the basic arguments for support of the existence of cesium iodide are made from thermodynamic considerations. The application of these results to the conditions likely to prevail during an accident would presume a quasi-steady-state in the fuel chemistry, since thermodynamics is involved with chemical equilibria and not reaction kinetics. The actual state of the system cannot be estiablished without consideration of the reaction kinetics. In this context, the effect of the radiation environment needs some consideration, since the photochemical reactions may favour the dissociation reactions.

As has already been mentioned in the foregoing, it is felt that the experimental evidence given in Table 4.3 for the existence of CsI as the dominant form of the iodine species is inconclusive. Interestingly enough, however, there appears to be a strong correlation between the fractional release 'presumably as CsI' and the test duration, when steam was used. The attached table presents a resummary of tests to illustrate this point. There also seems to be a tendency for the fraction released 'presumably as CsI' to increase with increasing test temperature. These general effects remain to be adequately explained, as well as their implications with respect to the ultimate fate of radioiodine during an accident sequence.

Temperature °C	Duration (min)	% in Presumed Form		
		CsI	I_2	Particulates
850	1	79	0.1	21
900	1	71	4	25
950	1	67	0.4	33
960	1	67	0.4	33
1000	10	6	88	6
1050	11	26	53	20
900	61	4	88	8
900	120	14	73	13
700	300	18	72	10

Effects of Temperature

1000	10	6	88	6
1050	11	26	53	20
1300	10	70	10	20
1445	7	90	0.1	9.9
1200	25	44	0.7	56
1200	27	34	8	58