4/30/82

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNITED STATES DEPARTMENT OF ENERGY	)	Docket No. 50-537
PROJECT MANAGEMENT CORPORATION	)	
TENNESSEE VALLEY AUTHORITY	)	
	)	
(Clinch River Breeder Reactor Plant)	)	

NRC STAFF'S UPDATED ANSWERS TO NATURAL RESOURCES DEFENSE COUNCIL, INC., AND THE SIERRA CLUB FOURTH SET OF INTERROGATORIES TO THE NUCLEAR REGULATORY COMMISSION STAFF

Pursuant to the Licensing Board's Prehearing Conference Order of February 11, 1982, the Nuclear Regulatory Commission Staff (Staff) hereby updates its February 5, 1976, April 7, 1976, June 16, 1976 and December 1, 1976 responses to Intervenors' Natural Resources Defense Council, Inc. and the Sierra Club Fourth Set of Interrogatories to the Nuclear Regulatory Commission Staff filed on January 19, 1976. Attached hereto are the NRC Staff's answers to NRDC's and the Sierra Club's interrogatories together with the affidavit of Mr. Bill M. Morris.[1/]

Respectfully submitted,

Daniel T. Swanson

Daniel T. Swanson
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 30th day of April, 1982

1/ The affidavit of Mr. Morris is unsigned. However, a copy of his signed and notarized affidavit will be filed shortly.

NRC STAFF'S ANSWERS TO NRDC'S
AND THE SIERRA CLUB'S INTERROGATORIES

In previous interrogatories we have requested information concerning four distinct validations relative to the models and computer codes, namely:

(i) validation that the code's output is correct numerical calculation that should result from a given set of input data and the model assumptions;

(ii) validation of the models against actual expertimental data;

(iii) validation that the models can be extended to the CRBR; and

(iv) Validation that the input assumptions for the CRBR case are adequate with respect to the CDA analysis, i.e., are supported by experimental evidence. By "adequate" here and below, we mean that the calculations will not underestimate the CDA work potential (i.e., forces and resulting energetics of a CDA) or overestimate the containment capability of the reactor with respect to a CDA.

With respect to the following requests for information we are concerned primarily with the fourth validation -- validation that the input assumptions for the CRBR case are adequate with respect to the CDA analysis. Here we are not so much concerned with the validity of the model expressions as with the uncertainties in the VENUS work energy calculations due to propagation of uncertainties in a) the parameters used, and b) the model input data and due to any synergisms among these uncertainties and the model assumptions.

I. With respect to each (including coupled-code) disassembly (e.g., SAS/VENUS) calculation considered by the Staff (and consultants to the Staff) in its analysis of CRBR CDA energetics, please provide the following information:

Interrogatory 1

List and identify all model input data (exclusive of coding flags and inputs that specify coding options, criteria, printout formats, etc.)

and all model parameters that come into play in each of the models utilized in the coupled-code accident analysis calculations, e.g., including but not limited to input data and parameters in SAS and VENUS. Exclude parameters not called into use because a subroutine, or part thereof, was not utilized.

Interrogatory 2

Describe in detail the basis for the choice of each input datum and model parameter listed above, and

(i) In each case quantify the uncertainty in the value selected;

(ii) In each case indicate whether the value is based on first principles, experimental measurements, unvalidated hypothesis, output of a coupled model (e.g., VENUS-II input obtained from SAS3A output), etc;

(iii) In each case indicate whether the choice of the input datum or model parameter was selected to represent the "best estimate," or a bounding or "conservative value" where "conservative value" here means a value chosen so as not to underestimate the accident consequences, e.g., work potential.

Interrogatory 3

For each input datum and model parameter with uncertainty listed in 1) above, indicate in quantitative terms the maginitude of the uncertainty introduced into the final calculation of the work energy by the uncertainty in the input datum or model parameter. In addition, discuss in detail any synergistic effects resulting from combinations of uncertainties in the input values, model parameters, and model assumptions. In each case discuss the basis for the estimate of how the uncertainties propagate, e.g., include and discuss all parametric analyses used to test the effect or uncertainties.

Interrogatory 4

Identify by name, affiliation (including organization, division, branch, title, etc.) each Staff member or consultant that has intimate working knowledge of the basis for the selection of the parameter of input datum.

Interrogatory 5

To the extent that any answers to the above questions are based on referenced material, please supply the references.

Interrogatory 6

Explain whether the Staff is presently engaged in or intend to engage in any further research or work which may affect Applicant's answer. Identify such research work.

Interrogatory 7

Identify the expert(s), if any, whom the Staff intend to have testify on the subject matter questioned. State the qualifications of each such expert.

Response to Interrogatories #1 through #7

The Staff defers responding to these questions because the Staff has not yet selected the computer codes and other tools it will use in its audit and evaluation of the Applicant's CDA analyses. The Staff will describe its audit and evaluation in its Safety Evaluation Report (SER) which the Staff plans to issue in the Spring of 1983.

In providing the information above, it is not necessary to duplicate information where the same information has been previously provided with respect to other cases considered, for example, in parametric analyses where only one changes.

II. Request for the following information is based on our concerns with respect to validations (iii) and (iv) above. In the Staff answers to the generic questions (b) - (e) below, the Staff is requested to be responsive to these concerns.

With respect to each statement, assertion or assumption (primarily from Section F6.2 of the PSAR) identified below, please provide the following information (unless noted otherwise) [NOTE: the following numbered Interrogatories are identified in parentheses by the page and/or paragraph number from the PSAR or by a code number identifying an NRC question addressed to the Applicant].

(a) Identify by name and affiliation (including organization, division, branch, title, etc.) each Staff employee or consultant that has the expert knowledge concerning the subject matter of the statement, assertion, or assumption;

(b) Does the Staff agree with the statement, assertion or assumption?;

(c) If not, why not?;

(d) If the Staff agrees with the statement, assertion, or assumption, describe in detail the supporting evidence for it and where appropriate the rationale for the approach taken;

(e) Provide any additional information requested following each statement, assertion, or assumption;

(f) To the extent that any answers to the above questions are based on reference material, please supply the references;

(g) Explain whether NRC Staff are presently engaged in or intend to engage in any further research or work which may affect the Staff's answer. Identify such research or work; and

(h) Identify the expert(s), if any, whom the Staff intend to have testify on the subject matter questioned. State the qualifications of each such expert.

For all the responses to interrogatories in this set the following are the answers to the requested subparts.

(f) All reference material are mentioned in the direct answer to the question unless otherwise noted.

(g) The Staff is not presently engaged in nor intends to engage in any further, on-going research program which may affect Staff's answer unless otherwise noted.

(h) At this time, the Staff has not determined who will testify on the subject matter questioned. Reasonable notice will be given to all parties after the Staff has made this determination. At that time, a statement of professional qualifications will be provided for each witness.

ANALYSIS OF HYDROYNAMIC DISASSEMBLIES INTRODUCTION

Interrogatory 1

(F6.2-105, par. 1) The cases considered in this section, however, are based on assumed phenomenological behavior that is believed to be very unprobable [sic].

Interrogatory 2

(001.497) The Staff states, ". . . four major parameters have been identified which are subject to significant uncertainties, i.e., fuel axial expansion, clad motion, fuel motion and voiding rate due to FCI.

Generic answers (b) through (d) are not required. (e) Please quantify what is meant by "significant." To what extent have other parameters been analyzed to determine whether their uncertainties are "significant?" Are there other parameters, for example, temperature (and ramp reactivity ramp rate) rate switch points when switching from SAS3A to VENUS-II, that may turn out to have "significant" uncertainties that have not been sufficiently analyzed to make a determination of significance at this time? If so, please identify those parameters where additional analysis is required.

Interrogatory 3

(001.497) The Staff states, ". . . disassenbly calculations results will depend on the results of . . . the equation of state for disassembly phase . . . ." For the disassembly phase perhaps the single most important uncertainty is the question of state especially for temperatures and pressures close to the critical point of fuel vapor.

Generic answers (b) through (d) are not required. (e) Please discuss in more detail the basis for this conclusion. Document the uncertainties in the equation of state and indicate the effect these uncertainties could have on the results of the hydrodynamic disassembly analysis.

Interrogatory 4

(F6.2-105, par. 2) Each of these assumptions contradicts present understanding of the phenomena and the combination of all three is highly improbable.

Interrogatory 5

(F6.2-105, par. 4) For EOEC LOF case, pessimistic assumption must be made regarding the effects of fission gas at the peak of the second burst to generate hydrodynamic disassembly.

Interrogatory 6

(F6.2-105, par. 5) For TOP events, unrealistic assumptions to force mid-plane cladding failures must be made to attain hydrodynamic disassembly.

Interrogatory 7

(F6.2-106, par. 2) In comments on the PFES LMFBR (with references to p.4.2.-148), the NRC Staff stated:

> ". . . the bases for concluding that the total energy generated in a series of small power bursts will be no greater than that generated in a single, large, perma-

> nently-dispersive burst requies further study. Further, the safety significance of such a conclusion, even if justified, is not clear at this time. For example, further work is required to evaluate the effective mechanical damage from repeated pulses if they do occur."

Generic answers (b) through (d) are not required. (e) How are these considerations treated in CRBR CDA disassembly analyses? Is it not possible that a series of small power bursts could occur in such a fashion that they would lead to a large reactivity insertion at or near prompt critical and lead to a sustained superprompt critical burst? Is it not possible that the small power bursts could be due to phenomena having space, as well as time, assymetries, in other words, in such a fashion that axial symmetry, for example, as assumed in VENUS, would be inappropriate for modeling the phenomena? Discuss in detail the basis for the answers to the above.

<u>Interrogatory 8</u>

(F6.2-106, par. 2) In all cases, care was taken to begin the disassembly calculation early enough to ensure that conservative estimates of the energy generated were made in VENUS-II.

Generic answers (b) through (d) are not required. (e) Is it not true that SAS3A may predict a disassembly ramp rate which either is unreasonable in sign or in magnitude at a specified core fuel temperature (<u>See</u>, Bleiweis, <u>et al</u>., Proc. of the Fast Reactor Safety Meeting, Beverly Hills, California, CONF 740401-P3, p.1324). How is this consideration taken into account in modeling the transition from termination of SAS3A and/or the "transition phase" to VENUS-II? Describe how the VENUS ramp rate is or should be formulated in light of the above.

<u>Interrogatory 9</u>

(001.480) The NRC Staff States:

> "It has been shown by S.J. Board <u>et al</u>., (Nature 254, 319-321, 1975) that mixed molten fuel and sodium could result into a vapor explosion, or detonation, if subjected to a strong shock wave or pressure pulse. Examine if such conditions could potentially exist in the CRBRP."

In the FES LMFBR on pp. V.55-283-284, the ERDA responded to one of NRDC's comments on the PFEIS LMFBR as follows:

> [NRDC Comment page 22)]:
> "At the top of P.4.2.-153, we find:

'All experimental evidence to date illustrates that these energetic interactions will not occur in an LMFBR environment."

Again, this view is not universally held. S. J. Board, R. W. Hall and G. E. Brown (CEGB Report, RD/B/N-3007, June 1975) reject Fauske's model. A more recent publication by S. J. Board, R. W. Hall and R. S. Hall (Nature, 254, March 27, 1975, pp. 319-320) concludes:

'Fuel melting could also arise in fast reactors under fault conditions, and our calculations (Ref: Report RD/B/N 3249 (CEGB, 1974) show that pressures of the order of 12 kbar could be produced from large such events involving sodium and molten uranium dioxide.'

We do not know of any LMFBR design that can withstand the shock pressures referred to here."

ERDA Response:

The Statement quoted from the PFES is valid. The S. J. Board, et al., statement is based on a calculation which is based on a calculation which is based on model which is not intended to represent a realistic representation of an LMFBR environment. The Board, et al., references quoted here are not specifically commenting on Fauske's model, although in other publications Board and Hall have presented alternate hypotheses as to the physical mechanism which inhibits energetic heat transfer in LMFBR accident situations. The quotation here discusses shock propagation phenomena in situations which are generally acknowledged as being inappropriate to reactor situations.

Generic answers (b) through (d) are not required. (e) Does the NRC Staff agree with the last sentence of the ERDA response: If so, why did NRC ask "if such conditions could potentially exist in the CRBRP?

Interrogatory 10

(F6.2-109, par. 3) First, the pressure from vapor generation in the boiling material in the core would tend to leviate the blockage.

Interrogatory 12

(F6.2-110, par. 1) A second reason that recriticality is unlikely is that the reactivity of the system, after the early party of the transition phase, would very probably be too low for fuel re-entry to return the system to critical.

Interrogatory 13

(F6.2-110, par. 1) The assumption that the remaining inner and outer core fuel is homogenized.

(e) What are the implications in terms of possible ramp rates if it is assumed that the fuel is not homogenized?

EOEC LOF Immediate Re-entry Case

Interrogatory 14

(F6.2-110, par. 4) The assumption that the re-entry can be adequately modeled by limiting the coherent re-entry considerations to the 36 subassemblies in the innermost ring of the outer enrichment zone.

(e) How should the control rods be modeled in the EOEC LOF Immediate Re-entry Case?

Interrogatory 15

(F6.2-110, par. 5) Assume that, in 75% of the subassemblies in the innermost ring of the outer core zone, blockages form in the lower portion of the upper blanket.

Generic answers (b) through (d) are not required. (e) What should be the basis for the choice of the location of the blockage in the upper blanket?

Interrogatory 16

(F6.2-110, par. 2) No means of obtaining large values of V_0 can be identified for this case.

Interrgatory 17

(F6.2-111, par. 3) . . . the inner and outer core fuels are homogenized.

Interrogatory 18

(F6.2-111, par. 3) Some 17% of the core fuel is located in the blanket.

Interrogatory 19

(F6.2-111, par. 4) The fuel and steel which has been ejected is then postulated to fall out of the blanket in rings two and three.

Generic answers (b) through (d) are not required. (e) What should be the basis for selecting the sub-assemblies?

Interrogatory 20

(F6.2-111, par. 4) . . . it was felt that this amount of fuel would form a conservative upper bound for re-entry reactivity ramp rates.

Summary and Conclusions on Hydrodynamic Disassembly

(F6.2-113, Section F6.2.6.5 continuing through the next page) each of the following sentences:

Interrogatory 21

Based on the pessimism involved in the assumptions related to phenomenology or initiating faults, hydrodynamic disassembly is a highly improvable termination path for core disruptive accidents.

Interrogatory 22

Within the framework of hydrodynamic disassembly analyses, attaining ramp rates greater than 50$/sec requies combinations of pessimistic assumptions for the hydrodynamic disassembly processes that are physically unrealistic.

Interrogatory 23

The BOEC LOF event was judged to be the most likely to lead into core disassembly, although such is not expected to happen.

Interrogatory 24

The consequences of such a disassembly are not serious, since sodium is largely still within the core.

Interrogatory 25

Disassemblies resulting from early fuel reentry in the LOF transition phase are judged to be very mild, i.e., average core temperatures should not exeed 4200°K.

Interrogatory 26

Only when unreasonable assumptions are made about initial re-entry velocity do more severe consequences result.

Interrogatory 27

Since all of the cases presented yielded average core temperatures of less than 4800°K, and all but one (which was considered overly pessimistic) predicted values of work-energy at sodium-slug impact of less than 101.4MJ, it is concluded that direct disassemblies in the CRBR would lead to consequences which are enveloped by the structural design loads.

Interrogatory 28

Only when unreasonbly pessimistic assumptions are made about fuel behavior under fuel-collant interaction conditions in the BOEC LOF event, can sufficiently high ramp rates be attained to approach energetic consequences comparable to the structural design bases.

Response to Interrogatories #1 through #28

The Staff considers these questions to be inappropriate because they refer to PSAR Appendix F, which the Applicant has withdrawn (Amendment 60, February 13, 1981), and to the former homogeneous core design which has been superseded by the present heterogeneous core design. The Staff believes that answers to many of these questions, if rewritten in light of present design and documentation, will be found in the Staff's Safety Evaluation Report (SER), which the Staff plans to issue in the Spring of 1983.

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AFFIDAVIT OF BILL M. MORRIS

I, Bill M. Morris, being duly sworn, state as follows:

1. I am employed by the U.S. Nuclear Regulatory Commission as a Section Leader of the Technical Review Section, Clinch River Breeder Reactor Program Office, Office of Nuclear Reactor Regulation.

2. I am duly authorized to participate in answering Interrogatories #1 through #7 of Section I and #1 through #28 of the 4th Set and I hereby certify that the answers given are true to the best of my knowledge.

Bill M. Morris

Subscribed and sworn to before me
this day of April, 1982.

Notary Public

My Commission expires: