PDR 8/30/82

ACRS-1993

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ACRS ADVANCED REACTORS SUBCOMMITTEE MEETING
MEETING MINUTES
MAY 26, 1982
WASHINGTON, DC

PURPOSE: The Advanced Reactors Subcommitteee met on May 26, 1982 at 1717 H St., N.W., in Washington, D.C., to discuss the status of NRC research programs in the areas of LMFBR and gas-cooled reactor research as well as to consider the proposed advanced reactors budget for FY 1984-85.

ATTENDEES: Principle attendees of the meeting include:

ACRS	NRC
M. Carbon, Chairman	R. Curtis
C. Mark, Member	P. Wood
W. Kastenberg, Consultant	S. Burson
G. Quittschreiber, Staff*	R. Wright
A. Bice, Fellow	J. Glynn

A complete list of attendees is attached to the office copy of these minutes.

MEETING HIGHLIGHTS, AGREEMENTS, AND REQUESTS

1. In Open Executive Session the Subcommittee received presentations from the NRC Staff concerning the Advanced Reactors budget for FY 1984-85. Mr. R. Curtis (NRC/RES) briefly discussed the current CRBR licensing schedule through the issuance of the CP (targeted for 6/1/84) and he presented an overview of the fast reactor research budget for FY 1983, 84 and 85. It was noted that the FY 1983 fast reactor research budget expected (Figure 1) totals $10.5 million compared to the originally proposed CRBR specific budget requests totalling $5.2 million. Mr. Curtis stated that it is expected that the FY 1983 fast reactor research will be funded at the $10.5 million level (as indicated by recent Congressional action on the President's budget).

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DESIGNATED ORIGINAL

Certified By B & R

The projected Nuclear Regulatory research budget for FY 1984-85 was presented (see Figure 2). The budget submitted to EDO shows funding for the fast reactor program at $8 million and $6.5 million for FY 1984 and FY 1985, respectively. The associated gas-cooled reactor research budget is projected at an even $2.5 million for FY 1984 and FY 1985.

- Mr. Curtis stated (in response to a question of Dr. Mark) that he he did not know whether or not DOE will resubmit their application for a CRBR LWA exemption. Since DOE is starting over on a procedural basis this situation would have no effect on the present CRBR licensing schedule for at least 90 days. If a request for an excemption were submitted and if it were granted than the current budget proposals would have to be reconsidered.

- In response to a question of Dr. Mark, it was stated by Mr. Curtis that these levels of funding would be adequate if the only LMFBR effort was the licensing of the CRBR. If, however, there was a national initiative to undertake another effort this level of funding would not be sufficient for such an activity.

- It was noted that the scope and content of the HTGR safety research is essentially undefined beyond 1983 and will have to be evaluated in FY 1983. The present gas-cooled reactor program is almost completely dedicated to performing a site suitability study (with no specific site in mind).

- In response to a question from Dr. Carbon, it was noted that the budget trend after 1985 would be toward much smaller funding unless a national program was initiated which caused NRC to respond.

- In response to a question from Dr. Mark, it was noted by Mr. Curtis that there really is nothing in these proposed budgets which allows for the review of a pool-type versus a loop-type LMFBR. However, if specific designs were submitted (for instance by DOE) the NRC would have to respond and a correspondingly larger budget would be necessary.

2. Mr. P. Wood (NRC/RES) presented an overview of the proposed LMFBR analytical program for FY 1983, '84 and '85. In particular, the development, verification and application of the code SIMMER were briefly discussed. In FY 1983 the SIMMER program will be dedicated entirely to supporting the CRBR licensing activities. In FY 1984 this support will continue, as well as making model refinements and interfacing SASA 4A to the SIMMER code. In FY 1985 there will continue to be CRBR licensing support. In addition, a small scale effort will be initiated to consider the feasibility of more advanced versions of the SIMMER code as applied to large commercial reactors.

   Mr. Wood also presented an overview of the proposed development and application of the SAS 4A, BIFLO, SSC and COMMIX codes for FY 1983, '84 and '85. These codes and associated programs will be dedicated in part to support of the CRBR licensing activities for the fiscal years discussed. Presently the SAS 4A code is operational and some calculations are being done with it. The BIFLO code is still being utilized to develop a better sodium boiling model. The SSC program is doing both confirmatory calculations (of the DHRS) and calculations of certain accident sequences (like complete station blackout or a large break accident) of relevance to the CRBR. The COMMIX code is being modified to perform a full in-vessel calculation of the CRBR to investigate the decay heat removal system and to provide a series of benchmark calculations for the SSC upper plenum model.

   The short discussion at the end of this presentation concerned whether the money requested was sufficient to implement these programs. Mr. Wood indicated that the EDO budget figures given earlier are sufficient for proper implementation of these programs including numerous SIMMER calculations.

3. Mr. S. Burson (NRC/RES) provided a review of the NRC containment integrity research. Brief overviews of the CONTAIN code, the CORCON code and their associated development/application programs were given.

The code CONTAIN is designed to model all physical phenomena expected to accompany hypothetical severe reactor accidents (it surpasses the capabilities of the MARCH and CACECO codes). This code has been operational for testing for about one year and the CRBR containment analysis (as well as LWR modeling) have been initiated. It was indicated that the code CORCON simulates the interactions between concrete and molten reactor-core debris in a state-of-the-art fashion. A second version of this code which includes freezing and crusting effects will be available later this year. Mr. Burson indicated that the CORCON code will be developed about as much as it can by mid-1983, and this program should be completed by mid-1984.

Mr. Burson also presented a brief overview of a combined experimental and model development project on sodium-concrete interactions. Of interest is understanding the abalation and the attack rate on the concrete and the gas evolution. (Presently there is some conflict betwen HEDL experiments and Sandia experiments and most of the data available has not been on concretes of interest to the CRBR). It was indicated that a mechanistic modeling of sodium-concrete interactions should be completed by mid-1983. The experimental sodium-concrete research effort is to focus on licensing concerns for the CRBR reactor containment system.

4. Mr. R. Wright (NRC/RES) presented an overview of the anticipated work in the areas of CDA energetics and core debris coolability - both threats to the primary system. The CDA analysis will conceptually be broken into investigating three accident phases; the initiation, the transition and the disassembly phases. The structural integrity of the vessel will not be investigated, only the work potential source. It was noted that a data base is needed for the NRR review of the project safety case, and for aiding in the development and verification of models addressing threats to the primary system.

In the CDA analyses the initiation phase studies will include investigating the reactivity rates from fuel clad and sodium motion during an LOF or TOP condition. The transition phase studies will address areas of both CRBR and generic interest; molten fuel and clad streaming and freezing, fuel and clad removal and bottle formation. The question of energetic recriticality and the dynamics of critical boiling pools of fuel and steel is not budgeted for in FY 1983-85. The disassembly phase work will address the issue of whether the work potential is low or not. This work will impact directly on the CRBR licensing procedure. (See Figures 3-7 for a brief overview of this program.)

In the area of CDA debris coolability, Mr. Wright noted that at the end of FY 1983 a joint 4-year program with EURATOM and Japan will end. A synopsis of this program is given in Figure 8. The main focus of the program is understanding the formation of the debris and debris bed dry-out limit as well as the post-dry-out behavior. Currently no budget proposals show continued work in this area in FY 1984 and '85. Mr. Wright noted that if the national position was against breeder reactor development he would recommend against continuing this joint program although it is an important area with some outstanding questions. (Japan has expressed interest in continuing this joint program although EURATOM will be funding other projects and therefore could not be involved.)

- Following this presentation, Dr. Kastenberg commented that one area of research does not seem to be receiving adequate attention, i.e., little work is addressing the possible vessel melt-through phase of a CDA.

5. Mr. J. Glynn (NRC/RES) presented a brief overview of the proposed FY 1982 to FY 1985 CRBR risk analysis program. Mr. Glynn noted that presently the division of risk analysis does not have any funded research with respect to reliability or risk analysis for the CRBR or LMFBRs in general. A program summary has been developed and presently is being reviewed by NRR. This program includes a FY 1982, $300,000 IREP-type analysis of the CRBR plant and a $1 million effort in FY 1983 to

complete that analysis. The proposed FY 1984 and '85 CRBR risk analysis program budget would include performing a complete PRA of the CRBR.

Mr. Glynn also commented on the present small effort by the Division of Risk Analysis on HTGR plants. Specifically, a small effort will be directed at looking into whether a high-temperature gas-cooled reactor has any significant safety advantages.

After this presentation there was a discussion (initiated by Dr. Kastenberg) as to the motivation for performing a full-blown risk assessment for the CRBR in view of the fact that the Clinch River Breeder Reactor applicant has performed a PRA and now is doing a second iteration on it. Mr. Glynn stated that because of all the ramifications associated with the CRBR an independent PRA is warranted. Mr. G. Burdick (Chief of the Research Division, NRC) added that such a PRA would not necessarily be a duplicate of what the applicant is doing. It would be available before the applicants PRA and thus could be useful to the NRC for its licensing objectives. (Currently NUREG-0718 only requires that the applicant commit to performing a PRA and completing it within two years of the issuance of a CP). Dr. Kastenberg noted that based on experience (with some of the PRAs recently completed) it might be valuable for the NRC to have the capability of doing an independent PRA in some cases.

The meeting was adjourned at 10:55 a.m.

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A transcript of the open portion of the meeting is available in the NRC Public Document Room at 1717 H Street, N.W., Washington, D.C., or can be obtained at cost from Alderson Reporting, 400 Virginia Avenue, S.W., Washington, D.C. 202/554-2345.

FY 1983 FAST REACTOR RESEARCH BUDGET

FIN NO	LAB.	PROGRAM	ASSUMPTION (000)	CRBR REQUEST (000)
A3015	BNL	SSC APPLICATION	$675	$900
A3041	BNL	BALANCE OF PLANT-SSC	360	
A7015	LANL	SIMMER APPL. & VERIF.	1600	1000
A2015	ANL	REACTOR SAFETY MODELING	480	0
A2045	ANL	COMMIX APPLICATION	800	600
B0476	ORNL	CRBR AEROSOL RELEASE AND TRANSPORT	650	400
A1054	SNL	SODIUM CONCRETE INTER.	950	900
A1016	SNL	ACCIDENT ENERGETICS ACRR	1850	1000
A1362	SNL	CONTAIN APPLICATION	450	400
B8117	SNL	LMFBR RISK ANALYSIS	1200	0
A7242	LASL	ACCIDENT INITIATION - DEFECTS	400	0
A1172	SNL	ELEVATED TEMPERATURE DESIGN	300	0
A8246	-	USER REQUESTS *	785	-
			$10500	$5200

* ANTICIPATED SEISMIC ANALYSIS AND RADIOLOGICAL SAFETY PROGRAMS

Figure 1

NUCLEAR REGULATORY RESEARCH
FY 1984-85 BUDGET
(DOLLARS IN MILLIONS)

		FY 83	FY 84		FY 85	
ADVANCED REACTORS	FY 82	CONG.	LRP	EDO	LRP	EDO
FAST REACTORS	$ 5.0	$10.5	$13.0	$ 8.0	$12.0	$ 6.5
GAS-COOLED REACTORS	2.5	2.5	2.5	2.5	2.5	2.5
TOTAL PROG. SUPPORT	$ 7.5	$13.0	$15.5	$10.5	$14.5	$ 9.0

Figure 2

INITIATION PHASE

NEED: o FUEL, CLAD, AND SODIUM REACTIVITY RATES - LOF AND TOP

o FUEL AND CLAD INVENTORY AT START OF TRANSITION PHASE - LOF AND TOP

FY 82/83: o JOINT LOF IRRADIATED FUEL DISRUPTION EXPERIMENTS IN ACRR WITH KFK

- FD-2, CRBR HETEROGENEOUS CORE CONDITIONS (NRC)
- FD-4, SNR-300 HOMOGENEOUS CORE CONDITIONS (KFK)
- CLAD IRRADIATED PIN SECTIONS IN HELIUM FILLED CAPSULE - OPTICAL DIAGNOSTICS
- COMPLETE 10-TEST MATRIX IN FY 82 - RESOLVE ISSUE FOR LOF

o VERY HIGH PRECISION DEMONSTRATED WITH ACRR CODED APERATURE IMAGING SYSTEM (CAIS) FOR FUEL MOTION DIAGNOSTICS

- THIS MAKES POSSIBLE THE HIGH PRECISION SANDY LOOP TOP AND LOF FUEL FAILURE AND SWEEPOUT EXPERIMENTS IN ACRR

o CFR LOF CLAD AND FUEL RELOCATION EXPERIMENTS IN ACRR

- CLAD IRRADIATED FEW-PIN BUNDLE IN BUNDLE IN FLOWING ARGON CAPSULE - OPTICAL DIAGNOSTICS
- DEVELOP EQUIPMENT - FIRST 2 OF 6 - TEST MATRIX IN FY 83

o CRBR LICENSING SUPPORT FOR NRR

Figure 3

INITIATION PHASE - II

FY 84/85: o PERFORM CFR LOF CLAD AND FUEL RELOCATION EXPERIMENTS IN ACRR

- CLAD IRRADIATED FEW-PIN BUNDLE IN FLOWING ARGON CAPSULE - OPTICAL DIAGNOSTICS
- PREPARE EQUIPMENT AND PERFORM PLANNED 6-TEST MATRIX
- ANALYZE RESULTS, DEVELOP MODELS, AND ISSUE REPORT
- PERFORM NEEDED FOLLOW-ON EXPERIMENTS AS BUDGET PERMITS

NOT BUDGETED o HIGH PRECISION SANDY TOP AND LOF FUEL FAILURE AND SWEEPOUT EXPERIMENTS

- REQUIRES FLOWING SODIUM LOOP IN ACRR
- REQUIRED CAIS HIGH PRECISION FUEL MOTION DIAGNOSTICS SYSTEM - NOW DEVELOPED

Figure 4

TRANSITION PHASE

NEED:

- o MOLTEN FUEL AND CLAD STREAMING AND FREEZING, FUEL AND CLAD REMOVAL (REACTIVITY), AND BOTTLE FORMATION. THIS IS BOTH A CRBR AND A GENERIC CRITICAL ISSUE.
- o BOILING POOL DYNAMICS FOR RECRITICALITY ENERGETICS

FY 82/83:

- o COMPLETE INITIAL 5-TEST TRAN-1 SERIES OF EXPERIMENTS IN ACRR ON MOLTEN FUEL STREAMING, FREEZING, AND BLOCKAGE FORMATION IN THICK STAINLESS STEEL TUBES
  - A PULSE - MELTED FUEL (OR FUEL/STEEL) PELLET IN ACRR IS PRESSURE-DRIVEN INTO STEEL TUBES OR OTHER CHANNEL GEOMETRIES
- o PERFORM 7-TEST TRAN-2 SERIES OF EXPERIMENTS IN ACRR
  - STREAMING AND FREEZING OF MOLTEN FUEL AND FUEL/STEEL AND BLOCKAGE FORMATION
  - PROVIDE NECESSARY INFORMATION ON UPWARD FUEL REMOVAL
- o PREPARE FOR AND PERFORM INITIAL TWO TRAN-3 INTEGRAL TESTS ON COLD CAN WALL MELT THROUGH AND BETWEEN CAN-WALL FUEL REMOVAL
  - EXPERIMENT GIVES DIRECT INTEGRAL DATA ON KEY QUESTION IN CRBR SAFETY ASSESSMENT
- o FREEZING, STREAMING, AND BLOCKAGE FORMATION MODEL DEVELOPMENT
- o STRONG SUPPORT TO NRR FOR CRBR LICENSING EVALUATION

Figure 5

TRANSITION PHASE - II

FY 84/85:

- o COMPLETE THE 4-TEST MATRIX OF TRAN-3 INTEGRAL FUEL-REMOVAL TEST IN ACRR
  - ANALYZE AND APPLY RESULTS, DEVELOP MODELS
- o PERFORM NEEDED FOLLOW-ON TRAN PHENOMENOLOGICAL EXPERIMENTS AND INTEGRAL TESTS AS INDICATED BY PREVIOUS DATA AND MODELS AND ACCIDENT ANALYSIS

NOT BUDGETED:

- o LABORATORY EXPERIMENTS AND COROLLARY ANALYSIS ON THE STABILITY AND DYNAMICS OF CRITICAL BOILING POOLS OF FUEL AND STEEL
- o ANALYSIS OF NEED FOR AND POSSIBLE ACRR PHENOMENOLOGICAL EXPERIMENTS ON THE STABILITY AND DYNAMICS OF CRITICAL BOILING POOLS OF FUEL AND STEEL

Figure 6

DISASSEMBLY PHASE (WORK POTENTIAL)

NEED:

- o VERIFIED MODELS THAT WORK POTENTIAL IS LOW
  - SODIUM VAPOR WORK AUGMENTATION
- o Pu SOURCE TERM FROM BURST FISSION ENERGY

FY 82/83:

- o PRE-DISPERSED, MOLTEN-UO_2-SODIUM FCI PROPAGATION EXPERIMENTS
  - IF NO PROPAGATION CAN OCCUR IN UO_2-SODIUM SYSTEM, THEN HAVE NO LARGE FCI MASS INVOLVEMENT AND NO FCI SAFETY PROBLEM FROM SODIUM VAPOR WORK AUGMENTATION
  - DEFINITIVE SEPARATE-EFFECTS EXPERIMENTS IN ACRR
- o COMPLETE KFK-FUNDED EOS (VAPOR PRESSURE) EXPERIMENTS WITH FRESH AND IRRADIATED UO_2 AND MO
- o DEVELOP EQUIPMENT AND PERFORM 5-TEST MATRIX IN UO_2-SODIUM PROPAGATION EXPERIMENT
  - DEVELOP FCI PROPAGATION AND ENERGETICS MODEL IF PROPAGATION DOES OCCUR
  - THIS SHOULD RESOLVE ISSUE OF POSSIBLE SODIUM VAPOR WORK AUGMENTATION

FY 84/85:

- o NO FOLLOW-ON FCI PROPAGATION WORK PLANNED

NOT BUDGETED:

- o ANY INTEGRAL EXPERIMENTS ON DISASSEMBLY-PHASE WORK
  - PBE (PROMPT BURST ENERGETICS) EXPERIMENTS IN ACRR WERE DEFERRED UNDER BUDGET PRESSURES BEFORE THE DEFINITIVE EXPERIMENTS WERE PERFORMED

Figure 7

(JOINT 4-YEAR PROGRAM OF ACRR EXPERIMENTS WITH EURATOM AND JAPAN - GENERIC WORK)

NEED:
- o DEBRIS FORMATION AND CHARACTERIZATION
- o DEBRIS BED DRY-OUT LIMITS, INCLUDING BED DYNAMICS
- o POST-DRY-OUT BEHAVIOR AND MELT PROGRESSION
- o EX-VESSEL CONDITIONS

PREVIOUS WORK:
- o RESULTS OF SIX D-SERIES EXPERIMENTS IN ACRR AND OTHER LAB WORK
- o VERIFIED DRY-OUT MODEL (LIPINSKI) FOR UNCHANNELED BEDS
- o DATA ON STRONG EFFECTS OF STRATIFICATION, CHANNELING, AND BED DISRUPTION ON COOLABILITY
- o SOME DATA ON DEBRIS FORMATION AND CHARACTERIZATION

FY 82/83:
- o JOINT 4-YEAR PROGRAM WITH EURATOM AND JAPAN TERMINATES AT END OF FY 83
  - FUNDING: NRC (45%), EURATOM (35%), PNC (20%)
- o COMPLETE D-SERIES CAPSULE EXPERIMENTS ON DEBRIS COOLABILITY LIMITS IN SODIUM WITH SIX TESTS, INCLUDING: EFFECTS OF BED STRATIFICATION, FINES, BOTTOM COOLING, AND EXTENDED DRY OUT
- o COMPLETE TWO DRY-CAPSULE EXPERIMENTS ON EXTENDED DRY OUT TO FUEL AND STEEL MELTING
- o MODEL DEVELOPMENT FOR BED STRATIFICATION, CHANNELING, DISRUPTION, AND POST DRY-OUT BEHAVIOR

FY 84/85:
- o CONTINUED WORK NOT CURRENTLY BUDGETED. DEPENDS ON U.S. CONTINUATION OF LMFBR DEVELOPMENT
  - JAPAN WANTS TO CONTINUE JOINT PROGRAM
  - EURATOM WILL CHANGE TO "EUROPEAN PAHR PROGRAM"

Figure 5