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REG

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W. L. Ginkel, Manager
Idaho Operations Office

TRANSMITTAL OF CONFERENCE REPORT

Transmitted herewith is a report of the conference held in Chicago on February 28 at which the ACRS Reactor Safety Research Subcommittee discussed their comments on the Water Reactor Safety Program Plan with representatives of REG, RDT, and PPCo. The formal comments of the ACRS contained in their letter of March 20 are also appended.

Original signed by
Milton Shaw
Milton Shaw, Director
Division of Reactor Development
and Technology

RDT:NS:A088

Attachment:
Conference Report

cc: C. W. Bills, ID, w/o att.
J.
J.
S.
G.

BCC: H.
J.
N.
Me

NRC Job 75 Box 79 Shelf 5116
O&M-7 ACRS-General
1/69 - 4/69

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Conference Report

ACRS Reactor Safety Research Subcommittee
February 28, 1969 (9:00 a.m. to 5:30 p.m.) Chicago, Ill.

Purpose: Review and comment on WRSPO Program Plan

Attendees:

ACRS	REG	RDT
D. Okrent (Chairman)	F. Schroeder	G. M. Kavanagh (ACMR)
H. S. Isbin	J. Levine	M. Shaw
J. M. Hendrie	J. McEwen	A. J. Pressesky
S. H. Bush	R. DeYoung	P. J. Davis
A. A. O'Kelly	B. Grimes	
H. O. Monson	C. Moon	
M. W. Libarkin (Staff)		

PPCo	WRSPO
G. Brockett	G. O. Bright
K. Johnson	

Discussion:

The meeting convened in a conference room at the 7 Continents Restaurant at O'Hare International Airport. After introductory remarks by the Chairman the discussion of ACRS asterisked items began, prefaced by the distribution of a draft status and opinion document prepared by REG. Shaw stated the RDT viewpoint that safety R&D can only overlay the basic technology; R&D should confirm normal operation and concurrently explore abnormal situations; and REG should consider limitations on operation if safety related data is not available in vital areas. Isbin feels that R&D should provide basic understanding of technology as well as confirming adequacy of design and safety limits. Okrent and Levine pointed out that reasonable safety limits are difficult to establish if basic data is lacking; and analytical techniques are of little value in assessing safety margins if they have not been confirmed by conclusive experiments. The discussion of the asterisked items continued in the context of the WRSPO Program Plan, both before lunch and following the discussion described in the next paragraph.

After lunch there was a general discussion of R&D problems. Pressesky summarized the current funding levels, stressing the large proportion of the budget which is involved in the construction of facilities such as LOFT and PBF compared with the funding of work which is actually producing usable safety related design data. Okrent and Shaw discussed the flexibility of the safety R&D program in relation to the more advanced water reactor designs. Shaw pointed out that a substantial part of the current program is directed toward obtaining information on problems that are essentially independent of size, power density, metropolitan siting, etc. Kavanagh mentioned the continuing effort by REG and RDT to keep in touch with the reactor manufacturers to obtain as much advance notice as they are willing to give concerning significant changes that may involve the R&D program. Isbin and Kavanagh discussed the nature of the safety R&D effort. Isbin feels that emphasis should be on obtaining a better understanding of the basic technology. Kavanagh agreed that this would be ideal, but that due to budget restrictions, expenditures must be justified on the basis of resolving real safety problems (applied research), not theoretical, general-technology ones. Kavanagh disagreed with Isbin that there was "excessive overseeing" of the R&D work. Isbin expressed general agreement with the program plan and discussed several aspects of R&D philosophy in regard to implementing this plan.

The discussion of the Program Plan is best summarized by the attached letter from the ACRS to the General Manager dated 3/20/69. Both the general and particular comments made by the members of the ACRS research subcommittee during this meeting are included in this letter. Okrent agreed that the Program Plan was generally good enough to be submitted to industry for comment as it now stands, as far as the ACRS is concerned.

The remainder of the discussion is summarized under the major headings of the Program Plan as follows:

1. Accident Prevention - Shaw and Levine agreed that REG should be represented on the HSST Program Review Committee and that he should be empowered to speak for REG. Bush emphasized that he should be a strong participant. Okrent pointed out the need for better information about the time scale of a piping break. Isbin, Levine, and Shaw discussed industry cooperation in the preparation of standards and codes. Hendrie and O'Kelly discussed the priority

rating for reliability studies. Shaw emphasized the need for better incident reporting as a means for providing feedback to the reactor designers. Bush mentioned that the industry programs on materials properties is more extensive than the Program Plan indicates.

2. Emergency Core Cooling - Isbin questioned whether LOFT integral test will produce the needed data. Brockett stressed that the LOFT integral test is the only means for observing the interaction of the many variables, which currently can only be analyzed separately. Bush suggested another one day meeting to discuss the LOFT integral test. Isbin suggested that more emphasis should be placed on DRL assistance. Isbin, Levine, and Brockett discussed the various industry computer codes and the difficulty of obtaining proprietary data from industry to confirm the validity of these codes. This results in PPCo duplicating industry work in some areas. Okrent discussed fuel behavior and fuel failure propagation.

3. Containment - Hendrie commented that this area seems to be in better shape than the others. Hendrie, O'Kelly, and Levine discussed hydrogen evolution resulting from an accident. Okrent, O'Kelly, Isbin, Levine, and McEwen discussed the molten fuel problem. Okrent suggested that this part of the Plan should be revised before it is sent to industry for comment and it was agreed that this would be done.

4. Behavior and Control of Fission Products - There was a general discussion of fission product release and behavior in the containment. Okrent discussed the basis for the presently accepted operating limits relating to fuel failure and operating with failed fuel. Isbin and Okrent discussed basic versus applied research on this problem. Shaw, Levine, and Grimes discussed blowdown in relation to the time that fission product release may occur.

5. Power Excursion Accidents - Okrent and Johnson discussed analytical techniques and their confirmation by experiments for predicting the behavior of the larger cores now being designed. Okrent and Levine discussed the present limits on core design and the applicability of these limits to the safety margins of the larger cores, especially the effect of higher fuel burnup. Johnson mentioned the fuel heat-up tests now underway and their relation to the damage potential of an

excursion. He suggested that if energy conversion can be demonstrated to be insufficient to breach the primary system, more information on excursions will not be needed.

6. Miscellaneous - Okrent discussed the problem of a steam explosion and questioned whether the safety research program would be able to resolve it.

This report prepared by P. J. Davis (X-3668), 4/7/69.

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MINUTES OF PBF/LOFT EXPERIMENTAL PROGRAMS
SEPTEMBER 26-27, 1969
CHICAGO, ILLINOIS

Purpose

The purpose of this meeting was to review the Division of Reactor Development and Technology's experimental programs at the Power Burst Facility (PBF) and the Loss of Fluid Test (LOFT) facility.

Attendees

ACRS

D. Okrent, Chairman
H. Etherington

DRD&T

A. J. Pressesky
W. H. Layman

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Fri. only)

C
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W
G
E. reinauer
D. Walker

C. Allen (Fri. only)
E. Case (Sat. only)
J. McEwen
P. E. Norian (Sat. only)

APPA

R. Reder, Consumers Pub. Pwr. Dist.
(Sat. only)

AIF

J. McAdoo, Westinghouse (Sat. only)
R. Wascher, B&W (Sat. only)

General Electric

D. Fisher (and AIF)

EEI

W. Behnke, Com. Ed. (Sat. only)
P. Van Nort, Com. Ed. (Sat. only)

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ACRS

D. Okrent, Chairman
H. Etherington
S. H. Hanauer (Fri. P.M. and Sat.)
J. M. Hendrie (Fri. P.M. and Sat.)
H. M. Hill
H. S. Isbin
H. G. Mangelsdorf
H. O. Monson
A. A. O'Kelly
C. P. Siess
W. R. Stratton (Fri. only)
M. C. Gaske, Staff
J. C. Rodgers, Staff

Idaho Nuclear Corporation

G. O. Bright
S. O. Johnson
W. E. Nyer
G. Brockett
E. Feinauer
D. Walker

APPA

R. Reder, Consumers Pub. Pwr. Dist. (Sat. only)

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DRD&T

A. J. Pressesky
W. H. Layman
W. W. Wendell

Idaho Operations Office

J. F. Kaufmann
R. E. Swanson

DRL

F. Schroeder
S. Levine (Fri. only)
M. Rosen
B. Grimes
L. N. Rib (Fri. only)
H. J. Richings (Fri. only)

DRS

C. Allen (Fri. only)
E. Case (Sat. only)
J. McEwen
P. E. Norian (Sat. only)

AIF

J. McAdoo, Westinghouse (Sat. only)
R. Wascher, B&W (Sat. only)

Summary

A review of the PBF and LOFT programs was presented by representatives of RDT and Idaho Nuclear Corporation (INC). They addressed the questions provided in the meeting agenda.

PBF - INC concluded that the PBF program can provide a flexible study of the effects of power density increases on both LWR and LMFBR fuels. This is due, in part, to the ability of the PBF to generate steady state power transients as well as natural and shaped bursts. The test hole can be used for either LWR fuel pins or clusters. A sodium loop can also be attached to the test hole for use with LMFBR fuel pins or clusters.

LOFT - INC reviewed their work to date on the analysis of a LOCA. They conclude that, with the exception of the area related to subcooling, none of the items analyzed are "sufficiently resolved" at this time. INC believes, however, that the results of the proposed series of LOFT experiments will provide significantly to answering the majority of these unresolved items.

Industry Comments

Representatives of GE, AIF, APPA, and EEI presented comments on the LWR research program.

GE stated they would like to have a portion on two phase flow capability incorporated into the PBF and LOFT programs. GE would like more tests related to coolant blockage and flow to power mismatches.

AIF, APPA, and EEI generally believe the LOFT program will help acceptance of urban sites for nuclear plants. They do believe the LOFT integral test should be performed as soon as possible.

WRSPO - RDT presented a summary on how the Water Safety Program Plan had considered the ACRS and Regulatory Staff comments on the RDT Safety Program Plan.

Executive Session

The Subcommittee made no decisions to recommend writing reports on the PBF and LOFT programs. The Committee is tentatively scheduled to discuss the programs at the October (114th) ACRS meeting.

Discussion

A. Power Burst Facility (PBF)-LWR (See Attachment 1)

The RDT Staff briefly reviewed the construction and test schedules for the PBF. Construction is to be completed by May 1970; this will be followed by one year of testing and calibration of the systems before experimental work commences. An arbitrary two year test program has been prepared. RDT will be reviewing the program over the next year and will be asking the Regulatory Staff, ACRS, and industry for comments during this time. DRD&T has been reorganized to have a project management division, with W. W. Wendell as the PBF project manager.

Representatives of Idaho Nuclear Corporation (INC), contractor for PBF, presented a description of the PBF proposed program and capabilities. Attachment 1 is the information displayed by INC during the discussion. The following information summarizes the INC presentation regarding the LWR safety questions which can be addressed meaningfully in PBF, which of these problems appears to be most in need of safety research and why.

1. The PBF was compared with the capsule driver core (CDC) facility. The PBF will provide more flexible tests than CDC. The PBF should provide a large amount of information in a limited amount of time.

2. Fuel failure phenomena can be studied to determine the threshold at which fuel failures occur, e.g., energy densities at which cladding melts for different enrichments. It is expected that observation of a threshold will be limited due to a step-function or steep ramp occurrence when the fuel cladding fails. The consequences of such failures can be studied to determine whether they are negligible. The mechanisms by which fuel fails will also be studied. The fuel failure threshold, consequences of failure, and mechanisms to cause failure are functions of initial plant conditions, fuel design, fuel conditions, and initiating causes. Investigation of the consequences of fuel failure should include determining whether the failure propagates, whether a non-coolable geometry results, what is the thermal to mechanical energy conversion, to what extent metal-water reactions take place, and the magnitude of pressure pulses.

3. INC representatives noted that it may be difficult to record the thermodynamic changes during tests.

4. The objective of the PBF tests is to provide measured information to the Regulatory Staff who can then set, for example, fuel damage limits in the licensing criteria.

5. The PBF will have a larger test space hole than is available in the CDC facility (8½" vs 3.4" diameter). The PBF will use a decoupler (approximately .95" thick-phase hardened SS) between the active core and the test space. The PBF reactor period will be shorter (1.3 msec) vs 3 msec for the CDC. The PBF can accommodate 8+ times (76 vs 9) as many PWR fuel pins and 11 times (44 vs 4) as many BWR fuel pins than can the CDC. A 4 to 5 times greater enthalpy increase can be obtained in a PBF power burst than a CDC power burst with 7% enriched fuel.

6. The PBF can provide natural (msec) bursts, shaped (up to a few seconds) bursts, and steady state transients (up to a few minutes). The designed steady state limit is 20 MWt.

7. INC reported that more recent experiments show that fuel melting might occur between 250 and 300 cal/g UO_2 (vs 264-331 cal/g) and fuel vaporization might occur between 360 and 700-800 cal/g UO_2 (vs 456-820 cal/g). A chart showed that most of the utility PSAR's indicate that the predicted energy densities expected during a power transient would place the fuel just below the 250 cal/g energy level. However the Indian Point 1 and Calvert Cliffs PSAR's provide values which place the fuel within the newly observed fuel melting region. (It was suggested this might be reviewed with the Regulatory Staff.)

8. PBF tests can be performed at cold start-up, hot standby, or power conditions.

9. The philosophy of the test schedule is to begin with scoping tests and follow-up with appropriate detailed tests reflecting the findings of the scoping tests. INC believes that the first PBF tests should be directed to finding out where fuel fails, i.e., where the threshold is, and then determine if the threshold changes with different parameters.

Comments and questions on the use of PBF for LWR safety research included the following:

1. Dr. Stratton asked whether the power density would be adversely affected by the use of the decouplers. INC believes that there will be an adequate quantity of thermal neutrons to provide the needed power densities for the tests.

2. Mr. Levine noted that the PBF uses a PWR loop and asked if BWR conditions can be simulated. INC replied that some of the mechanical effects expected in BWR's might be simulated.

3. Dr. Stratton believes the more meaningful tests are those which generate energy density increases over periods which more closely resemble power reactor periods. He believes power reactors should not be designed which can experience a 3 msec reactivity period. He asked whether the PBF could generate energy densities at the periods which would occur in a power reactor. INC replied that the PBF, depending on fuel enrichment, could provide realistic periods for the desired energy densities. RDT commented that they are now considering tests using longer periods. INC noted, however, that they have detected very little change in the effects on the fuel if the period is changed. To this Dr. Okrent noted that he feels the time for the energy increase to take place in the fuel could vary the effects if the fuel were highly irradiated and contained fission product gases.

4. Dr. Okrent was not satisfied that RDT had answered the question "what LWR safety questions can be addressed meaningfully in PBF?" He thought RDT would provide the specific tests which PBF could perform to answer important questions related to the regulatory review, i.e., RDT should have identified the important needs, justified the needs, and explained whether PBF could provide definitive answers to these needs. INC stated that they hoped to build a base on the CDC tests. Their emphasis is on reactivity accidents. They can, however, perform power mismatches with the PBF at steady state conditions. RDT added that they are trying to decide what specific tests should be performed with the PBF. They believe that studies of fuel near end-of-life need to be made and that propagation of fuel failure warrants high priority in the PBF tests.

5. Dr. Stratton thinks experiments should be performed which determine the effects on the entire core of improper enrichment of some fuel pins, crud buildup, over-power transients, etc. INC stated that their first priority is to study the effects of reaching the threshold of significant mechanical energy generation and determining if propagation occurs as a result of overpower, under-cooling, or blockage of virgin and irradiated fuels. Mr. Levine suggested that a balanced program is required; a scoping program should be performed first to determine which of the more probable and less probable events need further study.

6. DRS reported that seven TREAT irradiated fuel pins swelled and made contact at 1750°F.

F. Capsule Driver Core (CDC) Tests Reviewed (See Attachment 2)

INC representatives also reviewed results from some fuel failure tests performed at the CDC facility. The bursts lasted from 3 to 4.5 msec. The estimated accuracy of the enthalpy rise for virgin fuel is 12% and for used fuel 15%. The repeatability of the test results is, however, within 2% of the original test. Investigation for fuel failure is primarily made to detect fission products having fairly short half-lives (few days). Pressure pulses are monitored during the tests. Values from a few psi to about 500 psi have been recorded. The motion of the water head is measured to determine the amount of nuclear energy that is converted to thermal energy.

GE rods tested at the CDC facility had a hole melted in the cladding at 257 cal/g, gross clad melting at 342 cal/g, and wholesale disintegration at 414 cal/g. A chart showed that fuel clad melting occurred at lower energy densities for irradiated (3000 MWD/T) fuel than for virgin fuel.

Several ACRS members and Regulatory Staff members indicated a desire to include much more highly irradiated fuel in the PBF program than the 3000 MWD/T fuel used in CDC's. INC replied that it is difficult to obtain highly irradiated fuel pins. They have considered designing some fuel pins which can be made of sections screwed together. The fuel could be used in power reactors and then disconnected after removal to reduce the length for use in the PBF reactor. The fuel would be highly irradiated and not lose the fission product gases as would be the case if the fuel pin were cut.

C. General Electric Presentation

The GE representative, Mr. Fisher, briefly presented what GE believes the power burst program has done to date, what the PBF program should include, and identified tests other safety research programs should perform. A review of the presentation follows:

1. Present Power Burst Program - The tests of single pins have been valuable to help identify failure thresholds. GE is still interested in tests with mixed oxide fuels. GE would like an examination of the effects on the primary plant when fuel experiences energy densities of 300 cal/g. GE would like to have tests which provide information as to the amount of mechanical damage which occurs in the plant from the thermal energy released to the water during power excursions.

2. PBF Program - GE believes the PBF program does not simulate the coolant flow for BWR's. GE would like to extend the program to provide a two phase (water/steam) flow for steady state tests. GE believes there may be some tests planned that need not be done since the tests are covered by other programs.

3. Other Safety Research Tests - GE would like to have LOFT information if the conditions of the test simulated BWR's, i.e., two phase flow conditions. For example, GE is interested in tests that mismatch the power to flow ratio by having the flow reduced more rapidly than would occur due to pump trips. GE would like tests which study the effects of depressurization. Also, GE would like tests where the critical heat flux is exceeded. GE is also more interested in tests dealing with blockage of coolant flow than in power bursts. Overall GE is satisfied that RDT test programs have provided valuable and timely data.

Dr. Okrent asked Mr. Fisher to more specifically define what information the use of two phase flow will provide to answer questions related to the regulatory (licensing) process. Mr. Fisher replied that GE is being asked by the AEC what the effects would be if GE's fuel experiences higher energy densities during transients than is presently predicted, e.g., 400 cal/g vs 250 cal/g. GE is concerned that tests using a single phase plant (PWR) would not provide the same results as would be seen in a two phase plant. GE does not believe they would have the pressure peaks seen in a solid plant, due to the open area in the dome of the boiling water reactor vessel. GE does not intend to increase their damage limit, however, if the test results were to show that higher energy densities, than presently used for design calculations, did not cause fuel damage.

Dr. Okrent asked several questions related to the use of plutonium (mixed oxide) fuels. GE indicated that they are planning to start using plutonium fuels in refuelings starting in 1973. Some plutonium enriched fuel pins have been provided to the CDC facility by GE. GE has detected a greater doppler feedback in Pu-240 fuels than in currently used fuels. (Details of this effect were given at ANS meeting in Seattle in June.)

D. PBF- LMFBR (See Attachment 3)

INC replied to the question, "What LMFBR safety problems can be addressed meaningfully in PBF? How?" (INC noted that the PBF will not be able to filter out all thermal neutrons. They do hope to obtain a reduction by a factor of ten, however. The fuel pin enrichment will be 15% or greater. The LMFBR program will be able to commence as soon as the PBF is ready for experimental tests.) The PBF can perform natural and shaped bursts, and steady state power tests to study the effects on LMFBR fuel pins. The following presentation was given to answer the above questions:

1. Natural burst tests - Tests of single pins can be performed to determine the nuclear to thermal energy exchange, the damage threshold, and the failure mode. Tests of fuel pin clusters can be performed to study damage propagation.

2. Shaped burst tests - Single pin and cluster tests can be performed to study decay heat with or without coolant. The PBF can be pushed to 40 MWt for an 8 minute duration to provide a more severe test.

3. Steady state power tests - Single pin and cluster tests can be performed to study power mismatch, degradation of fuel, fission product releases, fuel failure thresholds and modes, and damage propagation.

4. INC described three ways to connect an LMFBR loop to the PBF test hole. They recommended a capsule loop which permits an easy means to connect and remove the LMFBR loop from the PBF. The turn-around time to go from a LWR to a LMFBR test and vice versa should be relatively fast.

Questions and comments related to the above presentation included the following:

Dr. Okrent asked INC if experiments were planned to study the effects of a core that has lost its original geometry. INC has not considered this type of test.

Dr. Okrent asked if the PBF program was going to study the problem of containing a core within the vessel when no cooling is available. INC stated a study could be done with a limited sized core.

Dr. Okrent asked what power density was available for LMFBR fuel pins. INC replied that 500 cal/g could be reached. A higher power density would be available if thermal neutron filtering and fast flux convertors were available.

INC indicated that obtaining highly irradiated fuel with 15-25% enrichment may be difficult.

Dr. Stratton suggested that some consideration should be given to simulate the Fermi 1 reactor accident in order to learn better how to protect against such an accident.

ACRS members asked several questions about the actual use of PBF, the experiments to be performed, when and what funding will be provided, etc. RDT replied that they will decide during fiscal year 1970 what the actual use of PBF will be. They would like to identify now what LMFBR experiments should be performed during the first few years. They will have no funding alloted to a sodium loop design for PBF unless the need for one is identified.

Dr. Okrent commented that the ACRS and Regulatory Staff have offered recommendations for RDT safety research programs but have not found RDT willing to accept the recommendations. He added that the ACRS and Regulatory Staff benefit the most from safety research programs which provide timely information. Therefore, it might be better to perform only certain key experiments and waive others. Dr. O'Kelly added that R&D programs should be flexible and not be locked in by too many details. Dr. Hanauer concurred and stated that applicants are now paying for possible overconservatism due to lack of safety research information. This is an expensive trade-off.

RDT was puzzled by the above comments. They commented that the ACRS is saying on the one hand that too much planning is undesirable, and on the other hand that planning is needed. RDT believes they have modified safety research programs to provide more meaningful information on a timely scale. Dr. Okrent took exception to this statement by noting the long delay time in getting answers to ACRS questions (some made as long ago as 1966).

Mr. Mangelsdorf asked if closer working relationships are developing among RDT, industry, and the Regulatory Staff. (The Internal Study Group recommended that some informal communication take place between working level members of RDT, industry, and the Regulatory Staff.) RDT replied that industry has been reticent to communicate. This problem will be aired at the October AIF meeting.

E. PBF - HTGR

INC reported that they have not studied use of the PBF to answer the question, "What HTGR safety problems can be addressed in PBF?" INC believes that there are HTGR applications, however.

Dr. Okrent asked INC if they think the HTGR is immune to blockage which would affect the matching of flow to power. INC replied that GGA believes that a power-flow mismatch is the major HTGR problem.

F WRSPO (See Attachment 4)

RDT presented a summary of how the ACRS comments in its March 20, 1969 report and the February 18, 1969 REC: RSR-34 memo to DRD&T were considered in the May 1969 issue of the Water Safety Program Plan.

Comments and questions related to the summary included:

1. .1.3.2 (other component response) - Dr. Okrent suggested that "structural integrity" might be a real, not just a potential, problem as the WRSPO summary indicates.

2. 3.1.1 (energy sources) - Dr. Okrent asked WRSPO if they believe no further R&D is required by them to study the hydrogen energy sources resulting from a LOCA. WRSPO noted that ORNL is conducting a series of hydrogen generation experiments (later confirmed to be contracted for by GE). WRSPO believes that a literature research will satisfy them there is adequate knowledge about the hydrogen problem. Dr. Okrent added a note of caution should be made in accepting the hydrogen data in available literature.

3. 3.5.2 (leak tightness at DBA conditions) - Mr. Levine stated that DRL has asked RDT for help in resolving the main steam isolation valve leakage rate problem. Dr. Okrent noted that there are a number of questions related to containment integrity which need answers.

4. 3.6 (containment of molten core) - RDT replied to Dr. Stratton's question that two man-years are planned to study this subject. Dr. Okrent disagreed with the technical judgment to have a scoping study. He thinks someone might say this was a delaying tactic to avoid an important problem.

G. Meeting with Regulatory Staff

1. DRS reported that a formal letter is to be sent to the ACRS on their recommendations for the PBF program (first week of October).

2. DRL reported that a good working level communication exchange is taking place between the Staff and RDT. DRS added that they have sent a number of comments to RDT regarding the safety research program. DRS will forward to Dr. Okrent a set of those reports already sent to RDT and will place the ACRS on the Distribution List. (Copies were forwarded on October 3, 1969) DRS also reported that they now attend RDT briefing meetings, and that the management levels of RDT and Regulatory Division have a better working relationship.

3. Dr. Rosen reported there has been a marked improvement in the rapid dissemination of DRD&T safety research results. This improvement has occurred within the last year. Dr. Okrent suggested that, perhaps, a brief note could be sent to the ACRS office regarding significant safety research test results. Dr. Monson suggested that, alternatively, the item might be reported during the "cats and dogs" session.

H. LOFT Integral Experimental Program (See Attachment 5)

RDT and its contractors reviewed the LOFT program. Included in the review was a brief description of the LOFT integral test facility, a summary of the planned experimental program, and comments on the questions:

1. What are the important specific gaps in our knowledge of large water reactor safety which these experiments will help fill? To what extent?

2. How will the experimental program accomplish this?

3. What are the uncertainties in achieving success in these LOFT measurements?

4. How can the information from LOFT be extrapolated to large reactors?

The review included the following:

1. INC representatives identified the objective of the LOFT program to be an examination of engineered safety systems using a 50 MWt PWR. The facility is 38% complete. The systems are to be constructed to the same standards required of power reactors, i.e., the systems should have a [illegible] year useful life, but RDT later indicated it was not certain that the facility would be used for that duration.

2. INC indicated that one objective of LOFT will be to close the loop between criteria, predictions, and experiments.

3. INC identified items in the AEC general design criteria which they find difficult to address in the LOFT program, e.g., words like "adverse after effects", "cope", "unacceptable", in the CDC are difficult to interpret and solve by pragmatic experiments. In other words, INC stated that it is difficult to say what is adequate performance if the requirements are not well defined by the Regulatory groups.

4. INC discussed the results of their analysis of the events and action related to a LOCA. They compared the response of the containment, the primary system, and the mechanical and thermal aspects of the core relative to time at the results of a LOCA. They displayed the interaction which the emergency core cooling and engineered safety systems should have on the event. The INC analysis concluded that, with the exception of subcooling, none of the events or actions which might take place are considered "substantially resolved". INC categorized these unresolved items as "under control", has had "limited study", or required "integral investigation".

INC indicated which of the items to be studied required a general understanding, a boundary analysis, or a precise analysis. INC provided a prediction chart which indicated that the information obtained, as a result of performing a progressive series of LOFT experiments, would shift the majority of the "unresolved" items to the "sufficiently resolved" column.

5. INC briefly described the LOFT integral test. The test requires nuclear generated heat to be meaningful. Blowdown will be accomplished by rupturing discs in an auxiliary loop. INC displayed a matrix to demonstrate what tests are to be performed to determine the effectiveness of ECCS for cold and/or hot leg breaks of small to large sizes.

6. INC replied to the question, "How will the experimental program accomplish ... filling specific gaps in our knowledge of large water reactor safety?" INC stated that each LOFT test, single or integrated, will be evaluated to determine what happens at each event. Active measurements will be taken of dimensional changes, etc.

7. INC replied to the question, "What are the uncertainties in achieving success in these LOFT measurements?" The major concern is whether a one dimension analysis is adequate to state three dimensional effects. It is important to identify those items which are sensitive to scaling.

8. INC replied to the question, "How can the information from LOFT be extrapolated to large reactors?" INC is exploring those items which are scaling sensitive, e.g., surface to volume ratio, loop location, etc., and is performing a parametric sensitivity analysis.

Comments and questions related to the LOFT program included the following:

1. Mr. Mangeldorf asked what the status is regarding the core catcher design. INC replied that the core catcher is still included in the overall plant design but a detailed design has not been completed. INC decided not to fabricate or install a core catcher on the basis that an analysis showed that a core meltdown could be contained by the reactor vessel. Dr. Okrent asked if a core catcher would be helpful in a plant which sustained greater than 20% fuel melt. INC agrees that one would. INC has confidence a suitable core catcher could be built, but doesn't want to build one for the LOFT reactor.

2. ACRS members asked questions about the schedule associated with performing the LOFT experiments. RDT stated that the LOFT program was reorganized recently. RDT has a project manager for the LOFT program, Mr. Layman, who reports directly to Mr. Shaw. The prime contract has been removed from Phillips and given to Idaho Nuclear Corporation, a subsidiary of Aerojet. The latest schedule shows the commencement of non-nuclear LOFT experiments to start in the latter half of 1973. The LOCA (Nuclear 4 Test) is now scheduled for 1975. The non-nuclear tests should take about 6 months. The turn-around between each nuclear test is estimated to be about 4 months.

3. Dr. Hanauer asked RDT if they will hold up completion of the facility due to non-existent or unacceptable codes and standards. RDT replied that no delay will be due to lack of codes and standards. If necessary, RDT will write their own codes and standards.

4. Mr. Mangelsdorf commented that one should not consume so much time preparing a facility for recovery when this delays early tests needed for safety, i.e., one should weigh the time saved by abandoning a facility to obtain earlier safety experiments against the time it takes to construct a recoverable facility.

5. The APPA representative asked whether the major delay is due to manufacture time. RDT replied that, until the recent reorganization, the components had been redesigned as much as 5 times. Therefore, not many items have been manufactured. The major items are expected to be through the design stage by August 1970.

6. Mr. Van Nort of Commonwealth Edison asked whether industry believes the items identified by INC as being "unresolved" to be the present situation. INC replied that they do not have all the manufacturers' analyses, reports, etc. INC has based their conclusions on an independent review. The AIF (B&W) representative commented that he believes industry is relying on conservative safety factors in design to preclude fuel meltdown. He, therefore, wonders if LOFT tests will do more than provide added confidence that the design is safe. Dr. Okrent noted that, after having put safety factors into the design, the objective of safety research is to answer the remaining questions.

7. Dr. Isbin suggested that the category "under control" might better be called "good start". He believes that the reactors are safe now, "under control", or nuclear plants wouldn't be licensed.

8. Dr. Okrent felt he couldn't tell what specific uncertainties of large reactors would be resolved by performing a LOCA on the LOFT reactor. He stated it would be hard to tell if the LOFT program will make large contributions to resolving safety "uncertainties". If the uncertainties are very important problems, is it valid to wait until 1975 to obtain the LOFT answers? There are other safety research programs which are making and will make significant contributions.

   INC agreed that the planned first series of tests may be academic. They do not believe that LOFT will provide a "step-function" in information; however, LOFT will tell one there is or isn't a comfortable margin of safety.

9. Mr. Etherington asked how suitable the LOFT tests would be for BWR's. INC stated they are extending the tests to cover parallel PWR/BWR conditions. They do not think a separate LOFT is needed for BWR's since the present LOFT is suited for both PWR's and BWR's for fuel failure tests.

10. Dr. Isbin asked if new separate LOFT tests are being planned which could delay the integral tests. INC stated that no new tests are planned.

I. AIF, APPA, EEI Discussion (See Attachment 6)

Representatives from AIF, EEI, and APPA presented comments and recommendations on the LOFT Integral Experiments, and on safety R&D programs applicable to LWR's which warrant greater emphasis than is currently contemplated in the AEC Program Plan. Each representative read a report prepared by a task group within his organization.

Comments and questions related to the reports included the following:

1. Dr. Hanauer asked the AIF, APPA, and EEI representatives if they thought the LOFT tests had any relationship to urban siting of reactors. The AIF representative stated his report was not intended to indicate that AIF believes a successful LOFT experiment would help support urban sitings. The APPA representative stated that LOFT will tell whether there is adequate assurance that the ECC and engineered safety systems can be depended on. This would help urban siting.

The EEI representative stated that the LOFT test might demonstrate that the ECCS is an adequate second line of defense and thus help support urban sitings. He urged that the ACRS/AEC place requirements into the LOFT program which would help support urban sitings.

2. Dr. Isbin asked the AIF representative to explain why AIF believes there is inadequate exchange of information from AEC to industry. AIF has two concerns: obtaining enough details and obtaining the information in a timely fashion. Mr. Case noted the same problem exists in getting information from industry. Dr. Hanauer inquired if the LOFT contractor could obtain industrial proprietary information. AIF believes such information could be made available.

3. Dr. Okrent asked AIF if they believe industry would agree with "unresolved" items identified by INC. If so, how would industry satisfy the Regulatory Staff? B&W and Westinghouse think several of the "unresolved" items could be identified as "resolved".

4. DRS expressed surprise that the APPA recommended that studies of fuel melting be dropped from safety research programs. APPA replied that they are depending on the ECCS to prevent meltdown.

5. The EEI representative, Mr. Behnke, speaking for the utilities, noted that, if core catchers were part of the reactor design, no utility would want to buy nuclear power units. No utility would want a nuclear unit if the core might melt down. He stressed the thought that utilities want "reliability" and believe this is the first line of defense.

6. EEI is interested in fission product release and transport including cleanup techniques. They are also interested in the survivability of systems during post-accident conditions.

7. Dr. Isbin asked if industry believes the LOFT core will adequately represent the same effects which a power reactor would experience during a LOCA. The Westinghouse representative replied that not all effects will be accurately scalable, e.g., DNB and blowdown.

8. Dr. Okrent was surprised that industry did not express interest in R&D programs related to fuel anomalies which might occur during normal plant operation, e.g., local fuel overheating.

J. Meeting with RDT/INC/Regulatory Staff on LOFT

Mr. Layman, RDT, indicated that extensive reorganization had to take place in the LOFT program due to engineering deficiencies and poor direction. The new contractor, INC, has reviewed and revised the LOFT program schedule. The design effort is now under control.

RDT indicated they have a tighter schedule for the construction of the LOFT facility than the real schedule indicates.

The critical path at this time follows the resolution of the tube sheet design in the steam generator. It is not known whether the tube sheets can tolerate one cycle of a severe transient. (Temperature change from 600°F water to 70°F water.)

The LOFT facility construction cost, not including the core, nuclear island, or dolly, is $35M. ($16M has been spent). The yearly expenditures for constructing the nuclear island plus dolly, and buying the core will cost $3M for fiscal year 70 and probably more for succeeding years. Operation, tests, developmental support, etc., will cost about $7-8M/year. RDT added that they do not believe funding is a limiting factor for LOFT.

RDT indicated that the LOFT facility should be built to provide support for safety research programs on a long term basis.

RDT seemed to indicate that they were reluctant to perform experiments at the LOFT facility which resulted in a significant melting of the fuel, i.e., which would prevent the reuse or possible reuse of the facility or components.

Dr. Hanauer asked when RDT will provide a revised LOFT program document. RDT did not provide an estimate.

Dr. Okrent indicated that he was not sure that LOFT will answer the questions regarding current LWR (regulatory) problems. If the LOFT integral tests are conducted in 1975, this makes the tests even less meaningful, e.g., too late, and costly.

Mr. Mangelsdorf indicated that he was not sure what real problems LOFT will attempt to address. He suggested that a list of real problems be correlated to the LOFT program to determine that the program intends to cover every problem it is capable of studying.

Mr. Etherington indicated he is not confident that the engineered core spray systemswill perform as designed. He suggested that, if an ECCS test is to be performed, a core spray system should be included in the LOFT design.

Dr. Monson suggested that RDT give immediate thought to working with industry to determine if there are more "resolved" areas than were indicated by the INC review. He added that industry is apparently concerned with delaying the LOFT tests. He suggested RDT consider accelerating the tests at the cost of sacrificing some presently planned items. He noted that industry is also interested in having highly irradiated fuels used in the test.

K. Executive Session

1. Mr. Pressesky had asked the Subcommittee whether the ACRS desires a formal RDT reply to the ACRS report dated March 20, 1969. This item will be discussed with the full ACRS.

2. Dr. Okrent asked the members if a report should be prepared for the PBF and/or LOFT programs. Dr. Isbin noted he could not attend the 114th ACRS meeting and was interested in contributing to the ACRS decision on LOFT. He also noted that the PBF and LOFT documents issued do not contain all the information presented at the Subcommittee meeting. Dr. Okrent suggested that the Committee might decide the information has been presented orally, or it could ask for additional information before writing a report.

3. Dr. Okrent suggested that comments on the WRSPO document could be made by orally discussing the subject with DRD&T or by mentioning the comments to the Commissioners. No decision was made as to what action should be taken.

4. Dr. Hanauer commented that he does not believe sites with population indexes worse than Indian Point-Zion should be approved until the LOFT integral test is completed.

5. Dr. Isbin raised the question as to whether the ACRS should "prorate" research monies for the different portions of the safety programs. Dr. Okrent noted that the ACRS has recommended priority to specific safety research programs but has never told RDT how to operate the research program.

6. Dr. Hanauer indicated he would include time to discuss the PBF and LOFT programs at the October (114th) ACRS meeting.

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