REACTOR SAFETY RESEARCH SUBCOMMITTEE MEETING

O'HARE FIELD, CHICAGO, ILLINOIS

MAY 27, 1971

The Reactor Safety Research Subcommittee met at O'Hare Field on May 27, 1971 to discuss the AEC water reactor safety research program. Present at this meeting were the following:

ACRS

D. Okrent
J. M. Hendrie
H. G. Mangelsdorf
H. O. Monson
A. A. O'Kelly
M. C. Gaske, ACRS Staff

Regulatory Staff

B. Grimes
S. H. Hanauer
R. S. Minogue
J. A. Norberg
M. Rosen

DRD&T

G. Bright
G. M. Kavanagh
W. H. Layman
J. E. McEwen
J. L. Mershon
A. J. Pressesky
S. A. Szawlewicz
G. F. Brockett, INC
W. A. Carbiener, BMI
L. Ybarrondo, INC

Meeting with Regulatory Staff Representatives

Mr. Minogue said that some of the areas of safety research relate to reactors to be proposed in the future for difficult sites. Some safety problems can be resolved through use of acceptably conservative design approaches. Dr. O'Kelly inquired regarding the ACRS and Regulatory Staff's influence relative to the priority for reactor safety research by the AEC. Dr. Hanauer stated that the two groups have an influence and are listened to but that the safety research program has a certain amount of momentum and takes some time for changes to be brought about. Dr. Hanauer indicated that the Commission is short of safety research funds and that the situation is going to become worse. He said the Bureau of the Budget sees the large water reactor industry, and they question the need for the AEC to provide funds for water reactor safety research. Dr. Kavanagh stated at a recent Joint Committee Hearing that an additional $30 million/year is needed for reactor safety research. DRD&T has been attempting to obtain industry participation in a joint reactor safety research effort.



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Dr. Hanauer thought that some difficult decisions may have to be made regarding water reactor safety research. He felt that people will really have to mean what they say if industry is to be told that research is necessary for the licensing of reactors. He said that he did not know how industry could be told that certain research is necessary if it is not necessary for reactor licensing. He said that the situation is considerably different from that where it is suggested that the AEC perform research to provide assurance regarding reactor safety. Dr. Hanauer stated that there was recently a need for $100,000 of safety research money to be redirected, and he found that DRD&T was not fully responsive, although when it became apparent that the money was absolutely needed it became available. Dr. Okrent suggested that considerably less money than would be ideal is available for reactor safety research.

Mr. Norberg stated that, in the major areas flagged by the Regulatory Staff in 1967, effort has been expended, that the LOFT emphasis has been shifted, and the semi-scale tests are giving results. He thought that the reactor safety research program has been responsive in the Heavy Section Steel Technology area. Environmental testing of equipment was stated to be more of a concern for industry than the AEC, although some such testing has been carried out in connection with LOFT. Containment response testing was performed as a result of concerns by the Regulatory Staff. Pipe whipping will be analyzed using analytical tools like the INC STRAP Code. In the area of reliability analysis, industry is carrying out an effort under the EEI program. Dr. Okrent said that items like work on pipe whipping do not appear to be the usual types of reactor safety research.

Dr. Okrent inquired regarding where the reactor safety research program is deficient. Mr. Minogue said that work regarding the ECCS has not progressed fast enough. Dr. Rosen stated that a real test of a reactor safety research program is how it reacts in a crisis. There is a difference among persons of the Regulatory Staff regarding how much of a crisis there is regarding ECCS. Dr. Rosen thought that new systems are needed as part of the ECCS. Defects became apparent approximately six months to a year ago. He indicated that, if he could have his say, he would direct DRD&T to expand effort in developing new design concepts relative to ECCS. Dr. Hanauer said he believes LOFT is needed and that LOFT should be a bigger and more expensive experiment that would produce results sooner and with fewer frills. Mr. Minogue pointed out the problem of scaling the LOFT results to 1000 MWe reactors. Dr. Okrent said that some of the best people at INC have indicated that computer codes presently available are not adequate for the big reactor systems for which calculations are necessary. Dr. Rosen pointed out the problem of prototype tests and that he does not believe that scaling safety problems is an easy matter.



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Results of the semi-scale tests raise questions regarding such codes as FRUST and FLECHT. Dr. Rosen said that such codes cannot predict what will happen in the case of a large cold leg break. Gross assumptions are made in the computer calculations, and a number of persons who are familiar with the codes say the results of the computer calculations cannot be believed. Dr. Rosen thought that this matter cannot be solved within the next year. Dr. O'Kelly indicated he believed that Dr. Morris was talking about items for which Westinghouse and not DRD&T should have the prime burden of proof. Dr. Hanauer indicated that he had discussed this matter with some of the vendors, and they say that they are trying to make an input to the DRD&T program.

Dr. Okrent said that he had a small complaint to register regarding the Regulatory Staff not arranging for the Committee to receive copies of the CREST report, "Water Cooled Reactor Safety", dated May 1970. This report raises questions regarding BWRs as well as PWRs relative to core cooling. Dr. Okrent referenced page 14 of the report which indicates that work is needed on how spray distribution is affected by the rise of steam and regarding the effect of the geometry of the system. Dr. Okrent asked the Regulatory Staff if it is reasonable to request that they answer the questions proposed in the CREST document. Mr. Norberg said he believed that the FLECHT program using fuel bundles is a direct outcome of the Regulatory Staff recommendation in 1967. Dr. Rosen stated that the use of sprays helps the situation relative to BWRs. He felt that, if steam had been used instead of air in the spray tests, the results would have been even more favorable. He indicated he feels comfortable regarding the capability of the BWR ECCS. Dr. Okrent said that the CREST document which was dated May 1970 and references 1969 reports states that the use of bottom flooding with a top spray is a complicated system. Dr. Okrent also indicated that the CREST document suggests injection of water directly into the higher power density areas.

Dr. Rosen said that the more that has been learned about ECCS's the worse things appear. Mr. Mangelsdorf stated that Dr. Rosen had raised two questions, i.e., whether there will be turmoil if changes in design are required as a result of information gained from the LOFT tests and whether accidents with serious consequences may occur before the tests are completed and any necessary changes in system design made. Mr. Mangelsdorf asked which of these two items is of the greater concern. Dr. Rosen replied that he was more concerned about the turmoil that would be involved. He stated he believes it is an acceptable risk for reactors to continue to operate until the LOFT results are obtained. Dr. Rosen believes that LOFT may raise questions that will result in a decision being made that changes in the ECCS are required. He believes, however, that separate effects tests would be preferable to the LOFT tests and that LOFT may not provide the necessary answers for questions being raised regarding ECCS's. Mr. Mangelsdorf inquired as to whether Dr. Rosen was predicting a catastrophic accident by 1974. Dr. Rosen replied that he was not but that the safety history of reactors has not been good. He indicated that the possibility of injection of water directly into the core by the ECCS should be investigated. Dr. Rosen





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stated that PWR venders say that spray systems cannot be used in PWRs because of the presence of control rod system equipment above the core. He thought it is not obvious, however, that spray systems cannot be used in PWRs. Dr. Hanauer said it was clear from the present discussions among members of the Regulatory Staff that what they are searching for is what to do about licensing. He stated he believes licensing needs to be based on a series of tests, with LOFT being one of these.

DRD&T Representatives

Mr. Pressesky presented the information regarding the DRD&T reactor safety research program shown in Attachment 1. He said that DRD&T has requested an extra $2 million for FY 72 which is not shown. The decreased funding indicated for the Power Burst Facility is due to ending the expenditures for capital equipment for the Capsule Driver experiments. The money indicated for the Power Burst Facility does not include that for purchase of irradiated fuel. It is hoped that such fuel can be obtained from fuel manufacturers. In reference to the fast reactor safety budget, Mr. Pressesky said that DRD&T is trying to anticipate LMFBR problems ahead of time. The money budgeted under chemical reactions is being spent for investigation of failure of cladding under heat up transients and in support of the waste solidification program. The thermal effects tests are being terminated, but the waste solidification program is being continued. Some problems have been encountered relative to the Lyons, Kansas waste storage site. Research regarding waste management has not been completed relative to the handling of noble gases and water containing tritium. Relative to the budget for reactor safety analysis and evaluations, Dr. Okrent inquired whether the decrease in funding between FY 71 and FY 72 is due to closing of the HTGR Program office, and Mr. Pressesky indicated that it is. In regard to the engineered safety features study, Mr. Pressesky indicated that the BMI pipe rupture study will be terminated within the next fiscal year. The work under Mr. George Brockett of INC was budgeted for 3.7 million dollars in FY 71 and 2.9 million dollars in FY 72.

Mr. Pressesky stated that DRD&T has met with representatives of architect-engineers, UF, KEI, etc. They have recently begun to hear from the Atomic Safety and Licensing Boards. The Reactor Safety Research Steering Committee has not met for a year now. This Committee was established to assure adequate coordination between DRD&T and the Regulatory Staff. Dr. Okrent inquired whether, in the process of determining what money it recommends be spent, DRD&T considers the reactor safety research needs of the country and attempts to see that the AEC program is sufficient to meet these needs. Mr. Pressesky stated that DRD&T makes such an analysis to a certain extent but that there are differences in opinion between DRD&T and others relative to priority, and DRD&T does not feel obligated to maintain an AEC program which is "sufficient". The Water Reactor Safety Program Office originates the DRD&T budget request.





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This is modified by Mr. Pressesky and then Mr. Shaw. Mr. Pressesky stated that support of a specific applications is the responsibility of applicants. Work is performed in carrying out DRD&T programmatic responsibilities in assuring that there is adequate information available that nuclear power become a part of the electrical power economy of the country. DRD&T has responded to questions of the Bureau of the Budget by saying that they believe the reactor safety research budget should be decreased with time but that DRD&T should insure that its own interests are served and that the persons who have to decide regarding reactor safety have an adequate basis for decision. Mr. Pressesky indicated that the cost to the reactor safety research program of inflation is approximately 10%/year. He presented a chart entitled "Reactor Safety Program Budget Cycle", which is included as Attachment 2. Mr. Pressesky indicated that the amount of money to be spent on seismic matters will be less in FY 72 than in FY 71 because DRD&T supported USGS work for the Regulatory Staff in FY 71 for individual reactor cases. The amount of money spent on the water reactor safety research program is fairly constant, and it is believed that it will eventually decrease to approximately 5 million dollars/year. It is hoped that this will be supplemented by an arrangement by which industry will provide approximately 5 million dollars a year in addition. Mr. Pressesky stated he believed that this would be a reasonable value, since, in his opinion, the number of changes in water reactors will peak and there will only be a small number of changes from year to year. One problem that has not been adequately faced was reported to be the transportation of radioactive wastes. The General Manager has established a working group to consider the problems of shipment of liquid waste.

In response to a question by Mr. Mangeledorf, Mr. Pressesky indicated that he believes that a serious question does exist regarding ECCS. A $2 million supplemental appropriation has been sought for research in this area. Mr. Pressesky said that he does not believe that the design basis accident can be precluded but that it can be made sufficiently unlikely. He indicated that more is being spent regarding ECCS safety research than on research regarding system integrity. Mr. Mangeledorf inquired whether, if the $2 million is not obtained, there is something less urgent from which funds could be diverted. Mr. Pressesky replied that there are probably areas from which the money can be obtained. He said that it would help, if funds must be diverted, if there were pressure from industry to do this. Dr. Okrent inquired, if money is available for a joint AEC-industry safety research program, whether work will be carried out in accordance with what the Regulatory Staff thinks has the highest priority, the AEC General Manager, or industry. Dr. Okrent pointed out that research regarding ECCS has an A priority. Mr. Pressesky stated that safety research work is presently being performed mostly on A priority items. He stated that DRD&T had not had a strong recommendation from anyone regarding the need for research relative to blowdown heat transfer. Mr. Norberg indicated that the Regulatory Staff has provided considerable guidance regarding the reactor safety research program. Mr. Pressesky stated that this was true but that the ECCS has not been highlighted as needing research until the recent discovery that water may not enter the core when the ECCS is actuated. The problem was not identified until October or

November of last year during the semi-scale tests. Mr. Mangelsdorf inquired whether DRD&T believes that identification of problems is part of their job. Mr. Pressesky stated that, in developing requests for funding or the transfer of funds, it is helpful if industry has delineated a problem. Mr. McEwen has been visiting reactor vendors for DRD&T to determine what they are doing regarding the ECCS situation. They have a problem regarding customer relations and are probably desirous of a cooperative program for resolution of the ECCS problem. Dr. Hanauer indicated that one way that the vendors can be depended upon to be responsive in resolving the ECCS problem is not to issue licenses.

Mr. Bright of the Water Reactor Safety Program Office presented information regarding the "Water Reactor Safety Program Plan", dated February 1970. He reported that there has been a partial de-emphasis regarding the study of piping integrity. Mr. Bright said that he believed the reactor design should be capable of coping with the hydrogen problems. During testing of the CVTR containment, there was some liner deformation but no problem due to liner leakage. It was suggested that the containment liner design does not need safety research, but the designer of the liner needs to do an adequate job. Almost all of the work regarding behavior and control of fission products is being de-emphasized. Dr. Okrent inquired as to whether there are questions regarding the stability of any of the chemical sprays being used. Dr. Hanauer replied that there are problems but that these are believed to be fairly well understood. DRD&T indicated that they feel there is adequate basic information available. It was reported that concern is not being expressed regarding need for safety research relative to reactivity insertion accidents. Studies of reactor kinetics are being de-emphasized.

Dr. Okrent inquired regarding the reason that studies relative to large core kinetics are being de-emphasized. Mr. Bright stated that there do not appear to be any industry or Regulatory Staff concerns regarding this problem. Dr. Okrent stated that the CREST document indicated two areas of concern regarding reactivity excursions. There is a question regarding the behavior of large cores under sub-prompt critical transients, e.g., the peak power present during xenon transients. Dr. Okrent indicated that this uncertainty is highlighted when a vendor says that a maximum of only 5% uncertainty in maximum flux values is acceptable. There are also questions regarding the super-prompt critical situation. Dr. Okrent indicated that questions have been raised regarding whether the power limits for reactors are being pushed too far. Mr. Pressesky said that operation of the FBF power-coolant mismatch experiments should provide some information on this subject.

A question was raised regarding those areas where more work is needed than DRD&T can fund. It was stated that the primary areas are regarding decompression and heat-up prior to ECCS initiation and regarding core cooling phenomena during ECCS operation. DRD&T indicated that perhaps more emphasis needs to be placed on the possibility of by-pass flow. Both Mr. Pressesky and Dr. Rosen agreed that design changes should be considered relative to the ECCS problem.





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Mr. Prassesky stated he believed that the Germans recognize the potential for back pressure in the core preventing water from entering the core region. He thought that part or all of the Germans' water reactor designs incorporate a system to introduce coolant into the upper plenum of the reactor pressure vessel. Dr. Okrent asked if Mr. Prassesky could obtain information on the German ECCS designs.

DRD&T indicated that another area they believe has inadequate funding is that of coolant starvation. They thought that this is an important area and that it would be worthwhile to accelerate the program of obtaining information.

Mr. McEwen stated that DRD&T has recently attempted to establish an AEC-industry safety research program and is seeking a funding base for such a program. Attachment 3 indicates the meetings that have been scheduled. At the February 1971 meeting, the reactor vendors agreed that they would provide funds if the utilities would do likewise. It was proposed that industry provide $5 million, and the vendors appeared to believe that this was reasonable. Mr. McEwen next presented "Reactor Safety Research Program Industrial Participation Future Plans", Attachment 4. The reactor vendors insist that it is necessary to obta Department of Justice approval for their participation in the proposed joint effort. Mr. Mangelsdorf inquired regarding where the research would be performed, and Mr. McEwen indicated that it would be performed mostly at the National Laboratories. There is some precedent for cooperative programs between the AEC and industry. For example, the Edison Electric Institute provided approximately $500,000 for the HSST program, and ORNL has performed work for industry regarding charcoal filters.

Dr. Okrent inquired regarding where funds would originate for AEC programs to meet regulatory needs in the future. Mr. Prassesky stated that less than $1 million/year is being spent in direct support of the Regulatory Staff. He thought that this might increase to approximately $2 million/year. Mr. McEwen indicated that the DRD&T research money will never all be assigned to the industry participation program. Dr. Okrent inquired whether, when AEC money is involved in the industrial participation program, it will be one step more removed from the Regulatory Staff requirements. Mr. Prassesky replied that he did not think that industry would support the program unless it is responsive to the Regulatory Staff needs. Mr. McEwen stated that the Regulatory Staff has a permanent invitation to attend meetings between DRD&T and industry representatives regarding the cooperative program. It was pointed out that discovery of the potential for clad embrittlement did not originate in an industry sponsored program but in one where investigators were free to pursue their own interest. Dr. Okrent stated that there is a need to consider how much safety research will be free from industrial direction. Mr. Prassesky said that the joint program will be under strong Regulatory Staff and ACRS influence. The Water Reactor Safety Program Office will draft the proposed industry cooperative program plan.

Mr. Pressesky stated he believes that government spending for water reactor safety research should be decreased and industry spending increased. Dr. Okrent inquired whether the total amount being spent will decrease. Mr. Pressesky replied that, if the LOFT and FBF capita costs are neglected, the amount spent should remain about constant. Mr. McEwen stated that DRD&T would have to maintain final control over AEC money spent for reactor safety research. Mr. Mangelsdorf said that, by the same token, DRD&T cannot expect to obtain complete control over all of the money provided by the cooperative program with industry.

Mr. Szawlewicz presented a number of slides, and copies of these are included in Attachment 5. Mr. Mangelsdorf stated that, despite the results to be obtained, there will still be worries about what might occur in the lower plenum of a reactor. It was stated that there appears to be a lack of information regarding basic phenomena and a lack of ability to represent these phenomena in tests. Mr. Szawlewicz presented a slide entitled "FLECHT Tests Variables". Dr. Okrent inquired regarding whether this program was considered to be completed because the scheduled experiments had been finished or the necessary information obtained. Mr. Szawlewicz replied that it was because the necessary information had been obtained. Mr. Pressesky stated that the purpose of the test was to develop the heat transfer correlations for an LOCA. Dr. Okrent inquired how many good clean core spray experiments involving Zircaloy had been performed. Mr. Brockett replied that no clean test had been performed in the sense of obtaining information up to 2200 or 2300° F. Mr. Szawlewicz reported that excessive heater failure occurred above a certain temperature. Dr. Okrent said he believes that persons evaluating the effectiveness of spray systems lack sufficient basic information for such evaluations. Mr. Szawlewicz stated that perhaps additional work is needed regarding heater design in order to obtain information at higher temperatures. Dr. Okrent said that a single experiment with various heaters failing does not provide sufficient information on which to base a decision regarding acceptability of operation of a reactor. It was stated that the GE blowdown heat transfer program will start in early FY 72 and will probably be monitored by INC. This program will take approximately two to three years to complete.

In regard to level swell, Dr. Okrent inquired as to whether INC has performed blowdown calculations to see if they agree quantitatively with GE. It was reported that they have modeled Vermont Yankee but that they have not obtained firm results that they would really believe. It was stated that INC would not like to imply that level swell will not occur. The question was raised as to whether INC intends to perform more calculations regarding this matter, and it was indicated that they do not. The question was raised as to the reason why, and Dr. Hanauer stated that this is a long range problem and that there are questions for which there is a more immediate need for answers. Dr. Okrent indicated that for upcoming projects, like Newbold Island, answers are needed regarding core spray systems and flooding for licensing BWRs. Dr. Hanauer stated that the means for analyzing BWRs are being developed. Dr. Okrent inquired as to whether the BWR LOCA situation is a money or people - limited matter in regard to evaluation. Mr. Pressesky replied that it is perhaps some

of each. He thought, however, that if more money were available it would still be difficult to have more persons available to perform the work at INC. Time would be required to increase the staff. Dr. Okrent stated that pressure was placed on GE to supply information and they did. Mr. Prasseesky stated that DRD&T is applying the resources they have available to analyzing the GE information. When the problem of the ability of the ECCS to supply water to the core was identified, the Regulatory Staff asked for more assistance than had been budgeted. Rearrangements of the funding were made to provide for this. Dr. Okrent inquired as to whether INC has persons who could perform the required work for PWRs and additional personnel who could work on the problems relative to BWRs. Dr. Okrent inquired, in particular, whether there are persons who are not involved in the Regulatory assistance program and not working on the 1-1/2 loop semi-scale program who could pursue work relative to BWRs. Mr. Brockett replied that there are. Personnel could be obtained from the service resources and these services bought.

Dr. Hanauer stated that the money for the regulatory assistance program comes out of the Regulatory Staff budget. For FY 72, there is not enough money in the budget for regulatory assistance. He stated, however, that someone always seems to come up with money when it is needed. Dr. Hanauer said that, if the Subcommittee is interested in the Regulatory Staff budget, they should inform Mr. Price of this. Mr. Mangelsdorf inquired regarding the possible range of effect of plenum swell on cladding temperature. Dr. Rosen replied that this approximately 100° F. Dr. Okrent stated that there are some difficult decisions to be made regarding issuance of construction permits for certain BWRs. Dr. Hanauer said that, if it is decided that independent calculations are needed, this would result in months of delay.

Mr. Szawlewicz reported regarding the LOFT program. He presented two slides, "LOFT Tests Objectives" and "LOFT Test Program" which are included in Attachment 5. Attachment 6 shows the present schedule for LOFT. Mr. Layman stated that DRD&T expects to be ahead of this schedule. The LOFT containment is approximately 60% complete, and the major components have all either been ordered or completed. Modification of the reactor pressure vessel appears to be the critical item, and the vessel is now scheduled for delivery in June 1972. Mr. Szawlewicz showed several slides regarding the PBF, which are included in Attachment 7. Dr. Okrent inquired regarding the maximum Kw/ft value that can be obtained with a small cluster of fuel rods. A 28 Kw/ft value can be obtained in a 9-rod cluster and the experiment run for one hour. A modification is to be made to permit such runs to continue for as long as 48 hours. Dr. Okrent thought that it would be helpful to perform some out-of-pile background experiments with molten fuel and hot water before performing the 9-rod test. The PBF is scheduled to be completed by the end of 1971. Some changes are being made in the facility, but these are not expected to delay operation of the reactor. Dr. Okrent commented that DRD&T appeared to be quite responsive regarding obtaining information relative to the question as to whether a real problem exists if some fuel is melted while a reactor is operating at high power. Mr. McEwen reported that the final safety analysis report for the PBF will not be submitted until October or November. He stated that the report has been revised and this hopefully this will result in a shorter review time.

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Mr. Pressesky said it appeared that questions regarding ECCS might be resolved by injection of water on the top of the core as well as into the bottom of the pressure vessel. Mr. Mangelsdorf inquired how uniformly the distribution of the water needs to be across the top of the core in order for injection of the water to be effective. Mr. Pressesky indicated that he believed a spray ring should be used with several nozzles.

Mr. Brockett drew a curve showing the mass of fluid flowing through the core, fuel temperature, and pressure in the vessel as a function of time following an LOCA. He stated that there is only approximately a 16-foot head of water to force water through the core following an LOCA. Dr. Okrent asked Mr. Brockett's opinion relative to the effectiveness of insertion of cold water into the upper plenum. Mr. Brockett replied he believed that this would be effective.

Dr. Okrent inquired regarding how Mr. Brockett would design a PWR so that no further safety research would be required regarding the ECCS. He said that there is no simple solution but that it must be assured that the stagnation point is in the lower plenum. Mr. Brockett indicated that a good top core spray system would be valuable in removing back pressure which might prevent the flooding of water from the bottom of the core. He reported that in-core sprays have been used in reactors in England.

Dr. Ybarrondo stated that the heat transfer correlations used for the ECCS calculations are of an empirical nature. He said that the correlations are for tubes or annuli and that almost no bundle data are available. Dr. Rosen said he believed that a quantitative treatment of fluid flow and heat transfer for the period before the ECCS is actuated for an LOCA is not forthcoming in the near future for the cold leg break accident. Mr. Brockett thought that the situation was relatively good regarding eventually predicting the course of an LOCA during the first few seconds. Dr. Okrent inquired regarding the possibility of designing a core cooling system that has a 999 out of a 1000 chance of functioning adequately. Mr. Carbiener stated that, for PWRs, there are three systems of importance, the low pressure and high pressure safety injection systems and the accumulators. He thought that the pressure capability and capacities of all three might be varied and that increasing the capacity of the high pressure safety injection system should have the first priority. He believed that the capacity of the low pressure system should also be increased but that he would tend to maintain the accumulator pressure low. Dr. Rosen inquired as to how steam generator ruptures might be handled. Mr. Carbiener stated that, if a design is necessary for this, he would suggest placing a valve in the upper plenum.

Mr. Rosen indicated that an applicant had reported the previous week that his computer code for the loss-of-coolant accident requires 20 hours to run. Dr. Rosen said he believes the vendors are wasting their time in developing a code for the occurrences during the first ten seconds of a blowdown event.





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He stated that, if it were up to him, he would make gross assumptions regarding the events during the first ten seconds.

Dr. Okrent asked whether, if the steam binding problem is solved, one can be sure that enough water will reach the core region fast enough. Dr. Okrent inquired regarding how the design of the PWR might be changed so that safety research would not be required to prove the adequacy of the ECCS. Dr. Ybarrondo stated that water could be injected directly into the core if one is not concerned about neutron economy. Mr. Brockett indicated he believes the ECCS for BWRs is more reliable than that of PWRs because of the use of core spray systems. Dr. Okrent pointed out that the CREST document mentioned previously states that the use of a core spray and bottom flooding are difficult to analyze. Dr. Okrent suggested that Dr. Ybarrondo might review the statements in the CREST document regarding ECCS. Dr. Ybarrondo said that a review of BWRs might indicate that an increase in rates or capacities would be desirable. He thought, however, that BWRs are in a much more favorable position relative to the ECCS than are PWRs. Mr. Carbiener said he believes that reliance should be placed more on flooding than on spray systems and that, perhaps, it is academic whether spray systems are present. Dr. Rosen stated that GE calculates their flooding and spray systems are both equally capable of cooling the core.

Attachments 8 and 9 provide information regarding the HSST program. Dr. Okrent inquired whether there are ways in which the HSST program is inadequately funded. Mr. Marshon stated that the Regulatory Staff and ACRS letters during the last year and a half have resulted in an expansion of the scope of the program without there being a corresponding increase in funding. The program had been scheduled to be completed FY 73 but will now continue into FY 74. Mr. Marshon stated that DRD&T would like to discuss pneumatic testing with the ACRS but probably not until after they have completed hydraulic testing. DRD&T is reviewing the possibility of obtaining vessels made from plate material but probably will not be able to obtain such vessels of the desired diameter. Dr. Okrent inquired regarding how much is known of the nature of the failure if the pressure vessel material is in the ductile range and a crack occurs completely through the vessel wall. Mr. Marshon said that hydraulic tests will not tell how far such failures would go in a pneumatic situation. DRD&T is performing work regarding limit load capacity, etc., for piping, but that they are relying on industry for this type of work on pumps and valves. It was reported that there has recently been significant progress regarding finite element analysis. DRD&T believes that it is necessary to design by finite element analysis for LMFBRs in order to be able to include the effects of thermal stresses. An elastic analysis can be performed for almost any kind of primary system component. There is a problem, however, in obtaining test data. There has been a problem regarding leakage of Naval Reactor valves. A crude finite element analysis would have indicated that a problem should have been expected. Mr. Norberg said that a good analysis regarding pumps and valves is needed but that industry is unwilling to provide such analysis because it





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is too expensive. Mr. Mangelsdorf inquired as to whether it really is believed that pumps and valves can be adequately analyzed. Mr. Mershon replied that he thought that they can although there needs to be a comparison between analysis and test data. Mr. Mangelsdorf said that frequently the minimum thickness for pump and valve body walls is determined by casting requirements. He thought that unnecessary effort might be expended in determining how much margin there is rather than whether there is enough margin. Mr. Mershon said that there is a problem in that, if a valve is tested, there are not analytical tools to extrapolate the data to another valve. Analysis is particularly important regarding liquid metal systems because of the thermal stresses that might be present if thick walls are used. DRD&T standards for valves are being developed. Dr. Okrent inquired whether the Regulatory Staff believes the program regarding pumps is adequate. It was reported that Mr. Maccary is reasonably well satisfied regarding the situation. A slide entitled "Seismic Research Program Major Elements", Attachment 10, was presented as was "Reactor Safety Program Status of RDT Programs on Geologic-Seismic Aspects", Attachment 11. It was reported that much of the work being performed is for the California region. CVTR and the EGCR have been given shaker tests. It has been found that higher amplitude testing is needed. A chart entitled "Reactor Safety Program Status of RDT Programs on Geologic-Seismic Aspects" is included as Attachment 12. Results have been obtained which confirm the Environmental Research Corporation contention that weak seismic data can be extrapolated to strong seismic situations. A geological and environmental map of the California coast at Los Angeles and to the south of the city is being planned. A seismo-tectonic map is being made for the eastern part of the United States. Zones of equal seismic potential will be shown. An initial report is to be issued in the near future to determine if the work that is being carried out will be useful. Work has been performed regarding oil removal and resulting subsidence. This work may be continued for the Gulf Coast. Mr. Mangelsdorf questioned whether the work along the Gulf Coast is of sufficiently general interest. A crustal strain study of the San Andreas fault is essentially complete, and a report is in preparation. As part of the California offshore geologic and geophysics program, surveys are being made from ships along the coast south of Los Angeles. It is intended that next year such surveys will be carried out in the area north of Los Angeles. In the past, DRD&T has been able to use ships that have been traversing the area for other reasons. Information has been obtained out to approximately 15 miles offshore. Attachment 13 regarding the seismic research program indicates areas being de-emphasized and those where increased emphasis would be desirable.

Mr. Layman stated that the LMFC personnel that may be available to investigate the situation regarding BWR ECCS's are those who work on the NRTS test reactors. Dr. Okrent inquired whether the persons that might be used for the BWR analysis are assigned to items of higher priority than reactors awaiting licensing. Mr. Layman indicated that they are working on problems like is it safe to continue operation of an NRTS reactor with a certain amount of crud on the fuel. Dr. Okrent inquired as to whether DRD&T might provide a statement regarding those

items having a higher priority than solving the problems relative to the ECCS for power reactors. Mr. Pressesky indicated that DRD&T needs to make sure that all of their talents have been properly budgeted relative to this problem. Dr. Okrent said he had the impression that there is a shortage of money to run computer problems. Dr. Okrent stated that only a modest amount of money would be required for computer time and for man-hours on the ECCS problem during the remainder of this fiscal year. Dr. Kavanagh suggested that the ACRS might tell the AEC that all possible effort should be directed toward solving this problem. Dr. Kavanagh stated that the Regulatory Staff is performing a study to attempt to decide the significance of the test results regarding ECCS's. Dr. Hanauer indicated that the Regulatory Staff is obtaining considerable help from LMC. Dr. Okrent said that the Regulatory Staff has a serious question on which they need considerable help.

Mr. Pressesky stated that the seismic area has suffered only a small reduction in effort between FY 71 and FY 72. Dr. Okrent said there have been three or four major recommendations regarding national programs relative to seismic research. He asked how it is decided what portions of such programs should be funded by the AEC. Mr. Pressesky indicated that, in part, the size of the AEC program relative to seismic research is a function of what the AEC believes it can fund.

The ACRS recommended some effort regarding molten core retention. DRD&T is preparing a reply to the ACRS. They believe the major defense should be to prevent an accident and that the efforts in this area should be backed up by an ECCS that will really work. DRD&T believes that these two items should absorb the available research dollars in this area. They believe that the core retention system suffers from a number of problems and that it would pose technological problems with uncertainties which would be difficult to resolve. Dr. Okrent raised the question as to whether the General Manager's part of the AEC should veto a recommendation regarding safety research. Mr. Pressesky said that DRD&T is not closing the door to discussion and that they do not have the Regulatory Staff position as yet since they have not received regulatory comments on this subject. Dr. Okrent thought that, if the General Manager's part of the AEC can decide to work only on those programs which it believes are important, there needs to be an additional funding avenue for reactor safety research. Dr. Kavanagh stated that the General Manager's portion of the AEC does not have complete authority relative to the reactor safety research budget and that it goes to the Commission for approval before submission to Congress. Dr. Okrent mentioned that almost all of the problems relative to the core melt-through accident for a water reactor are also problems for the LMFBR, plus the LMFBR has the possibility of a secondary criticality, yet RDT (on FFTF) maintains this is a "solved problem". For LWR's RDT sees no future for molten core retention.

Mr. Pressesky said that the concern regarding large accidents overshadows the need for effort relative to more probable accidents, and he indicated he believed that further work is needed in areas such as leak detection, stress corrosion, and accoustic emission. Dr. Okrent stated that he would like for DED&T to indicate at the next meeting of the Subcommittee what reactor safety research should be performed that is not being done.

Mr. Pressesky stated that, over the years, DED&T has answered a number of questions regarding Dr. Teller's remarks about using underground siting. He presented slides showing the advantages and disadvantages of underground siting. These are included as Attachments 14 and 15. Underground siting would add approximately twenty million dollars to the cost of construction. It was reported that the reactor which Con Ed will probably propose for the David's Island site will be partially underground because the Island is in a flight path. Bechtel submitted a report to Southern California Edison in August 1970 regarding underground siting. The State of California is reviewing underground siting relative to aesthetic aspects.

Regulatory Staff

Dr. Okrent inquired whether the Regulatory Staff thinks that on some modest time scale they might have a partial or complete recommendation regarding safety research relative to ECCS's. Dr. Hanauer said that this might take a few months. Dr. Okrent inquired whether it is reasonable for the Regulatory Staff to await discussion of the matter with the ACRS before they send comments to DED&T regarding research needed relative to ECCS's. Dr. Hanauer said that he would like a joint effort in this respect if it will not take too long. He said that he would not like to promise, however, the Regulatory Staff will discuss the matter with the ACRS before they send a letter to DED&T regarding ECCS research.

Executive Session

Dr. Okrent stated that the Subcommittee might suggest that Mr. Price be asked to discuss at the next full Committee meeting the regulatory assistance budget and the problems envisioned for the next year regarding this. Dr. Hendrie thought that this would be appropriate. Dr. Okrent stated that the Subcommittee had been asked to meet by the Committee partially because of budgetary considerations and the possibility that work on LMFBR research might have deleterious effects on water reactor safety research. Dr. Okrent suggested that the Subcommittee schedule a meeting after the Regulatory Staff has provided information regarding proposed ECCS safety research, assuming this is not inordinately delayed. It was suggested that the Subcommittee wait until after the meeting before providing specific recommendations to the full Committee regarding water reactor safety research.

Dr. Monson said that, if a verbal report by the Subcommittee Chairman is to be made at the full Committee meeting, it probably should be mentioned that there appears to be food f.. Committee thought in the existing situation in which RDT (A. Pressesky) says that the objective of the RDT safety R&D program is to provide the information that Regulatory needs to make its decisions, yet RDT reserves to itself the right of determination as to which of the informational needs requested by Regulatory it will pur.. e.

Mr. Mangelsdorf stated that similar problems regarding research occur in industry. He said it might be felt that, for a petroleum refining company, the manufacturing department should be served by the research and development section. If, however, the decisions regarding research and development are left to the manufacturing department, the company may rapidly encounter difficulty. M.. Mangelsdorf thought that the Committee's main concern should be the ... of the safety research and development effort and not the controls ...

In regard to the core retention problem, the Committee has indicated in writing that further work should b. performed. Dr. Okrent stated, however, that the General Manager's portion of the AEC had chosen to set priorities precluding this. Mr. Mangelsdorf stated that he has been in favor of the Committee effort thus far regarding the core retention problem but that he does not think that further Committee effort in this area is warranted. Dr. Monson said that he had heard pessimistic statements regarding core retention systems for LMFBRs but now there appears to be more optimism relative to this matter.

It was agreed that Mr. Price should be asked to provide information at the next full Committee meeting regarding the money he has available for the regulatory assistance program. It is to be requested that five minutes be scheduled at the next full Committee meeting for a reactor safety research subcommittee report and 15 or 25 minutes for discussion.

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Dr. Monson said that, if a verbal report by the Subcommittee Chairman is to be made at the full Committee meeting, it probably should be mentioned that there appears to be food for Committee thought in the existing situation in which RDT (A. Prassersky) says that the objective of the RDT safety R&D program is to provide the information that Regulatory needs to make its decisions, yet RDT reserves to itself the right of determination as to which of the informational needs requested by Regulatory it will pursue.

Mr. Mangelsdorf stated that similar problem, the Committee has indicated in writing that further work should be performed. Dr. Okrent stated, however, that the General Manager's portion of the AEC had chosen to set priorities precluding this. Mr. Mangelsdorf stated that he has been in favor of the Committee effort thus far regarding the core retention problem but that he does not think that further Committee effort in this area is warranted. Dr. Monson said that he had heard pessimistic statements regarding core retention systems for LMFBRs but now there appears to be more optimism relative to this matter. Dr. Monson said that he had never been completely confident that a core retention system could be developed but he thought it was possible. It was agreed that Mr. Price should be asked to provide information at the next full Committee meeting regarding the money he has available for the regulatory assistance program. It is to be requested that five minutes be scheduled at the next full Committee meeting for a reactor safety research subcommittee report and 15 or 25 minutes for discussion.

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