PTR-24

MINUTES OF SECOND MEETING OF SPERT ADVISORY PANEL HELD IN IDAHO FALLS, IDAHO ON MAY 16, 1955

J. R. Huffman

Date Prepared: June 1, 1955
Date Issued: December 8, 1955

DISTRIBUTION

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P. M. Ross - WAPD, LSR
J. B. Philipson - IDO (2)
R. H. Graham - AEC, Washington
C. R. McCullough - Monsanto Chem.
M. M. Mills - UCRL
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PHILLIPS PETROLEUM CO.
ATOMIC ENERGY DIVISION
(UNDER CONTRACT NO. AT (10-1)-205)
IDAHO OPERATIONS OFFICE
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By

J. R. Huffman

The second meeting of the SPERT Advisory Panel was held in Idaho Falls on May 16, 1955. Those attending the meeting are listed in Appendix 1 to these minutes.

Dr. R. L. Doan, who acted as Chairman of the meeting, opened the meeting with some remarks on the general program. The purpose of the meeting is to provide the groups actively interested in reactor transient tests with an opportunity to exchange views on the subject and to assist in the formulation of the SPERT program. This establishes a direct channel of communication between experimental groups to supplement the more formal channel through the AEC. Progress reports are circulated to the official members of the Committee. Phillips will welcome ideas and suggestions to assist the program, particularly types of measurements for the summer operation of SPERT I and ideas and suggestions for down the line such as SPERT II. Following this there may be specific transient tests which would be required. Such tests, formalized through AEC channels, would be conducted by the SPERT staff. Hence, the buildup of the group working on SPERT will depend on the planning of what is to be done.

SPERT I Program

Mr. W. E. Nyer talked on the SPERT I program as it is now planned. He first reviewed the results of the first meeting of the SPERT Panel in December, 1954. At that time, interest in research reactors was expressed by the Reactor Safeguard Committee. Such variables as water head, lifetime of neutrons, void coefficients, effective reflectors, ramp rate determinations and pressurization were considered. KAPL, WAPD, and ORNL were interested in testing a power reactor. For this, variables such as pressurization, plate spacing, temperature coefficients, startup accidents, flow accidents, steam control techniques and breaks in the cooling loop were contemplated. GE-ANP and WAPD were interested in fuse tests, stabilizers and control systems.

The program for SPERT I was outlined briefly as follows:

1. Non-transient tests--July 15 - August 15. In these tests rod speeds, critical mass, calibration, flux measurements, temperature coefficients, power coefficients and void coefficients are planned.

2. Transient tests--August 15 - October 15. In this series of tests excursions in the non-damaging region would be studied with alphas of 10, 50, 100, 150 and 200. At alphas of 10, 100 and 200 head changes by raising the water level would be investigated. During this period reproducibility checks would be attempted and the reliability of instruments would be determined. A limited amount of work would be done on ramp rates. The measurements which would be taken would be power, energy, temperature, pressure, and water velocity as functions of time.

3. Limited mechanical damage--October 15 - November 15. It is planned to stop before any heavy damage occurs. Things that would be measured would be maximum permissible k and pressure effects.

4. Miscellaneous--November 15 - December 31. In the original plans this period was to have been devoted to a destructive test which would possibly give maximum hazards, determine other mechanisms of energy release and study other control techniques. There are no plans now for a destructive test since it is felt that more can be gained by saving the SPERT I setup for other studies. The instrumentation on SPERT I, however, will be designed so that measurements can be taken at any time in case a destructive action should occur.

Status Report on SPERT I

Mr. C. F. Leyse described the SPERT site, the reactor tank, and the fuel assembly design. He then gave a status report with completion expected June 9, 1955. The pit building is 90 per cent complete, the terminal building is 85 per cent complete, and the control building is now being partitioned into rooms. The inner tank is here, the core structure is complete, the shim rods and control rods are complete, the drive mechanisms are in the shop and should be completed in two weeks, and the bridges are completed. There is some trouble in the fabrication of the fuel assemblies at Oak Ridge, but delivery of the first core is promised by June 15, 1955.

Questions were asked by Mr. Mills and Mr. Graham with reference to the control system and the possible removal of the pit building for a destructive test. Both of these questions were answered.

Mr. S. G. Forbes discussed the instrumentation of the control rod system and the instrumentation used for transient tests. These are described in considerable detail elsewhere so they will not be included in these minutes. The instruments for measuring transient data are aimed at direct measurements where possible and by as many means as possible in order to cut out interpretation. There are three parts: the detector group, the electronics group, and the recording group. Energy release will be measured by foils or wires using an activation technique. Power will be measured by ion chambers, fast flux Hornyak buttons, Ceric dosimeters and gamma flux, and possibly a photomultiplier method will be used for measuring the Cerenkov glow. Fuel plate temperatures will be measured by special evaporated thermocouples if these prove to be satisfactory. Pressure will be measured directly below the fuel in an end box, and the total thrust will be measured by strain gages in the reactor tank. Thought is being given to some

method of measuring the local peak pressures by ball indentation tests. Attempts to measure water velocity will be made by means of markers in the water above the core and by using a high-speed camera. The float accelerator on the surface will be used to attempt to measure the initial acceleration of the water surface.

The electronic equipment will be essentially log amplifiers on the ion chambers and galvanometers as linear power measurement devices. The most important recording instrument is a 26-channel oscillograph recorder which has a paper speed of 130 inches per second. Tests show that over the 3,000 feet of cable from pit to control center a one-microsecond period can be recorded without distortion. For the very fast periods it may be necessary to use film instead of paper for recording.

The status of the instrumentation is as follows: control desk--100 per cent complete; reactor controls in pit--25 per cent complete; power supplies and voltage regulator are mostly delivered; the pulse system is checked out; two ion chambers have been tested up to 2 microampere output and will be checked to 10 microampere output; Hornyak buttons are not made, but the technique is known; some of the evaporated nickel thermocouples have been made (the cementing problem has not been licked yet); strain gages and pressure transducers are partially on hand; the properties of the log amplifier are satisfactory and a model has been built and tested (two more are to be built); the linear amplifiers have been bread boarded and two will be built; sixteen driver units are complete and nine are held up until potentiometers are delivered; delivery of carrier amplifier units has been set back until July 1, 1955. Mr. McCullough suggested that a possibility for cementing the thermocouples would be magnesium oxide which would extrude very easily. He also asked the question regarding the protection of the cameras during the test. These are to be located in ports between the pit tank and the reactor tank.

The problem of attempting to record or see bubble formation inside the fuel assemblies has not been solved. In order to cut down fogging of the film near the reactor face it is necessary to use eight inches of lead. This involves 2-1/2 tons of weight.

Mr. Doan asked for any other experiments that should be included in the SPERT I program. During the discussion the following points arose. All the tests in SPERT I will start with static water in the core. The question was raised as to whether forced cooling systems could be attached. It was pointed out that in the swimming pool reactor once the water has been erupted out of the core, there is more water available to return to the core than is true in the SPERT-type test. It was estimated that the highest power one can operate at with convection cooling is the order of one megawatt. Mr. McCullough suggested experiments wherein the fuel plates can collapse, experiments with jammed control rods, and some way of measuring the total energy release calorimetrically. Mr. Forbes pointed out that the swimming pool is not so safe if a jammed rod should occur because of the positive void coefficient. Mr. Nyer raised the question as to whether attempts should be made to measure the heat transfer coefficient as a function of time. It was pointed out that KAPL expects to carry out some boiling experiments which might answer this question. Mr. Mills said it would be very desirable to have a top on the tank with an orifice plate in order to put pressure on the system

which would have some release. This could not be used for high speed transients. Mr. Forbes pointed out that we are attempting to get some of this effect by changing the water head over the core. It was suggested that boron be put in the water as a poison and a bigger core be used in order to obtain positive void coefficients. This would be a later experiment. The question was raised regarding crudding problems on the fuel surfaces. It was decided this could be handled in the hot cell. It was suggested, and accepted, that a reference point should be established early in the experimentation and repeated as a calibration point frequently during the course of the experiments. It was pointed out that void coefficients could be measured by the critical positions of the rods with and without water and then attempt to match power and poison. Mr. Kanne speculated on the effect of aluminum on the reactor and whether it would change the void situation. Mr. McCullough felt that university reactors with distorted flux patterns might require specific tests. Mr. Mills was interested in the effect of neutron irradiation on the boiling process which might be tied in with the electrical heat experiments which KAPL is undertaking.

SPERT II Program

Mr. Nyer reported upon the present thoughts regarding the SPERT II program. Since there would be no destructive tests on SPERT I, it would be on standby for several special tests. For SPERT II two questions arise: 1) the kind of experiments to do, and 2) the means by which they are accomplished. It is felt that under the kinds of experiments to do the main thing was the exploration of the variables affecting reactor behavior in order to determine a model. This work could be broken down into three groups: experiments on nuclear systems, experiments on hydrodynamic systems, and experiments on thermal systems. Topics under these programs would be 1) changes in flux distribution and their effects on nuclear and hydrodynamic systems (shutdown coefficient, peak power, peak pressure, and total energy would be of interest); 2) changes in neutron lifetimes both in the reflector and in the core; 3) fuel plate spacing which changes the shutdown coefficient; 4) ramp rate studies (this involves the addition of Δk at a fixed rate); 5) cladding changes; 6) pressurization. For this, Borax II should be reviewed. Possibly something will also come from the NDA stainless steel reactor studies. In this regard Mr. Graham reported that NDA is looking at the stainless steel reactor analytically and that he thought that in the future Phillips would make the transient tests.

The question was asked, what bottle necks exist? Mr. McCullough pointed out that there are too many things to do. Mr. Donaven said the program would go faster if one looks at the basic understanding only. He felt there should be a higher ratio of theoretical people to experimental people. He also felt that the heat transfer investigation should be carried on simultaneously and not as a part of the SPERT program. Mr. Doan said that Phillips has an expansion problem in manpower and that loans of from six to twelve months from other establishments would be most welcome. The names of nominees would be appreciated.

Mr. Nyer pointed out that we would have the standby SPERT I reactor as a pulse source and from other tests. The problem will be the relative use of two pits if these two pits are in the same pit area. The load of work may mean that a complete duplication of all equipment would be necessary as compared to an altering use wherein only a duplicated pit would be necessary. A third method of operation would be to use only one pit but change the cores, which would involve considerable "down" time.

Report on Borax II

Mr. Thie gave a detailed description of the results being obtained in Borax experiments. These were broken down into three types: 1) excursions, 2) steady boiling tests, and 3) pressure transients. Since this work will undoubtedly be presented in other reports, it will not be described in these minutes.

Pressurized Test Reactor

Mr. Doan read a letter received from KAPL quite some time ago (letter from K. R. VanTassel to the Manager, Schenectady Operations, dated December 1, 1954) proposing a rather extensive set of experiments. It was pointed out in this meeting that the recommendations of this letter have been substantially changed.

Mr. Nyer stated that to undertake these types of tests means a shift of the SPERT work to a much larger scope. It covers not only nuclear tests, but also system tests. For this purpose a large-scale experiment must be planned in which a whole reactor system is included. As a rough preliminary estimate it is felt that from $1-10 million would be needed for the work. Time would be necessary to prepare a proposal for this experiment. It was proposed that five people be assigned to prepare a preliminary proposal and it was hoped that the interested laboratories would assign some people to this group. Phillips desires to know what is the scope, what are the requirements, and what is the extent of SPERT versus other laboratory participation. In this regard, Mr. Doan again urged that direct participation by direct assignment of personnel be considered by other laboratories. The main question is, what are the appropriate objectives for this facility?

Mr. McCullough felt that initial efforts should be confined to military reactors since this would simplify the scope and move the schedule up. Mr. Brodsky indicated that he felt that the parameters which needed to be covered should be outlined and that engineering aspects could be studied later. The concensus of the group was that experiments aimed toward basic understanding rather than toward specific tests should be undertaken. Mr. Ross said there is a tendency to prototype testing rather than basic testing. In his opinion, the prototype is really a proof test and it is difficult to separate all phenomena in one experiment. In addition, much of such testing is non-nuclear in nature wherein the reactor is really only used as a source of heat. He urged for more heat transfer for hydraulic experiments in the transient and boiling fields. He feels there should be nuclear tests in the SPERT-type program which should parallel the other tests. Attempts should be made to keep the tests simple and not have too many carried on in one facility. There was a feeling that temperature, pressure and void coefficients could be better studied in facilities which do not test power excursions. There should be experimental and theoretical liaison. These are the nuclear type of phenomena which should be tested. The thermal and hydraulic phenomena could be tested by electrical methods in order to get information on the formation of voids as a function of energy. The relation of voids to activity is a nuclear problem and experimentation should be devised to prove the theory. His philosophy in general is that basic studies of a nuclear, thermal, and hydraulic nature should be undertaken and a final experiment down the line should be made to tie them together. He felt the tests should be limited in pressure in order to stay in the subcritical water region.

Mr. McCullough pointed out that the Columbia heat transfer tests are pointed directly toward burnout although they are aimed at answering questions for Savannah River only. These could be extended to generalize farther. Mr. Ross pointed out that WAPD was already using Columbia through an NRL sponsorship. General Electric and KAPL are also in on it. Steady state heat transfer is going on elsewhere. It was felt that a four-microsecond period could be obtained in the tests at WAPD. Columbia can do the flow tests. The void content has not been studied very well.

Mr. Donaven raised the question as to whether or not the $10 million effort which would mean 100 engineers would give worthwhile answers. He questioned whether the problems could not be solved otherwise, and felt that design of reactors should aim toward fail-safe systems. Mr. Mills disagreed because the cost of an accident cannot really be determined. One objective would be how to design failure-safe systems.

Mr. Ross re-emphasized his feeling that a simplified streamlined attack on basic problems should be undertaken. He felt that pressures up to 2500 psi and temperatures up to 660°F should be planned. The power level should be based on heat fluxes of interest such as 750,000 to 1,000,000 BTU/hr/ft^2. He felt that with a minimum loading a reactor 20 to 24 inches in diameter and operating at 15 to 20 megawatts would solve the problems. It probably should contain removable subassemblies to check different fuel types. He felt that a one-loop system would be desired and a stainless steel rather than a carbon steel system should be used. He felt the flow should be variable from zero to full flow and that attempts should be made to determine the rate of loss of flow and its effect upon the reactor. There was some feeling that hot criticals should be done in the SPERT program, but others felt that there should be a break between the hot criticals and the transient facility.

It was proposed that another meeting be called of the people interested in high pressure water reactors in order to formalize the objectives of any transient studies. It was proposed also that there be a group set up to correlate the nuclear, thermal, and hydrodynamic test programs.

Other Programs

Mr. Donaven reported that on fuse testing GE would be interested in studying triggers and shutdown mechanisms for critical experiments. They would be ready to do this in approximately three months. Next year they would be interested in testing similar mechanisms between 300 and 2,500°F. They will not be interested in testing reactor stabilizers. They will be interested, probably two years hence, in microscopic phenomena which will shut down runaway experiments. He felt that this year they would like a period of one week for approximately two hours a day and that later they would come back for another one-week period. It is possible that they might require six weeks at any one time. They would like to have an nvt of 10^{13}. He feels that they would carry on their experiments outside the core mostly.

Mr. Ross reported that they are interested in determining the safe shutdown methods for the critical experiments being carried on at Bettis Field. They are relying on the expulsion of water. They would like to make a test by inserting plastic fuel elements in a critical mass in the SPERT I. This would take the order of one month.

Mr. Hudson reported that NAA is interested mostly in high power reactors, which means that they would be interested next year. On most power reactors they might be interested a day at a time in FY 1957 to conduct tests.

APPENDIX I

Attendance - SPERT Panel

Name	Organization
Mark M. Mills	UCRL - Livermore
Thomas W. Donaven	ANP - General Electric Company
W. R. Kanne	KAPL - General Electric Company
C. Rogers McCullough	ACRS - Monsanto Chemical Company
N. E. Huston	North American Aviation
R. L. Waterfield	ANP - General Electric Company
H. T. Wensel	AEC - Reactor Hazards Evaluation Staff
Allan C. Johnson	AEC - Idaho Operations Office
N. H. Godbold	AEC - Idaho Operations Office
R. H. Graham	AEC - Washington
R. S. Brodsky	AEC - Naval Reactors Branch
Dave Hetrick	North American Aviation
P. M. Ross	WAPD
J. A. Thie	ANL
S. G. Forbes	PPCo - SPERT
W. E. Nyer	PPCo - SPERT
F. Schroeder	PPCo - SPERT
T. R. Wilson	PPCo - SPERT
G. O. Bright	PPCo - SPERT
F. L. Bentzen	PPCo - SPERT
C. F. Leyse	PPCo - SPERT
R. L. Doan	PPCo
J. R. Huffman	PPCo
J. W. Webster	PPCo