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THE AUDITING OF REACTOR SAFETY AT  
THE OAK RIDGE NATIONAL LABORATORY

Francois Kertesz

A number of special committees and supervisory groups are involved in the approval-granting process of reactors and reactor experiments. The relationship of these groups, their scope and method of operation are described in the report.

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## THE AUDITING OF REACTOR SAFETY AT THE OAK RIDGE NATIONAL LABORATORY

### Introduction

Nuclear installations in general, and reactors in particular, present unusual problems from the viewpoint of accident prevention. These problems place a special burden on supervision, requiring vigilance beyond the customary level. At ORNL, where handling of radioactive materials and operation of radiation-generating devices is the chief activity, radiation safety is separate from the industrial safety organization. Installations and facilities involving radiation are audited by the Radiation Safety and Control Department and are also reviewed by one or several of the Laboratory Director's Review Committees (Appendix A), each of which has jurisdiction in specific areas of radiation safety. In addition, internal divisional groups examine the projects, and in some cases design review committees are appointed by the Laboratory management.

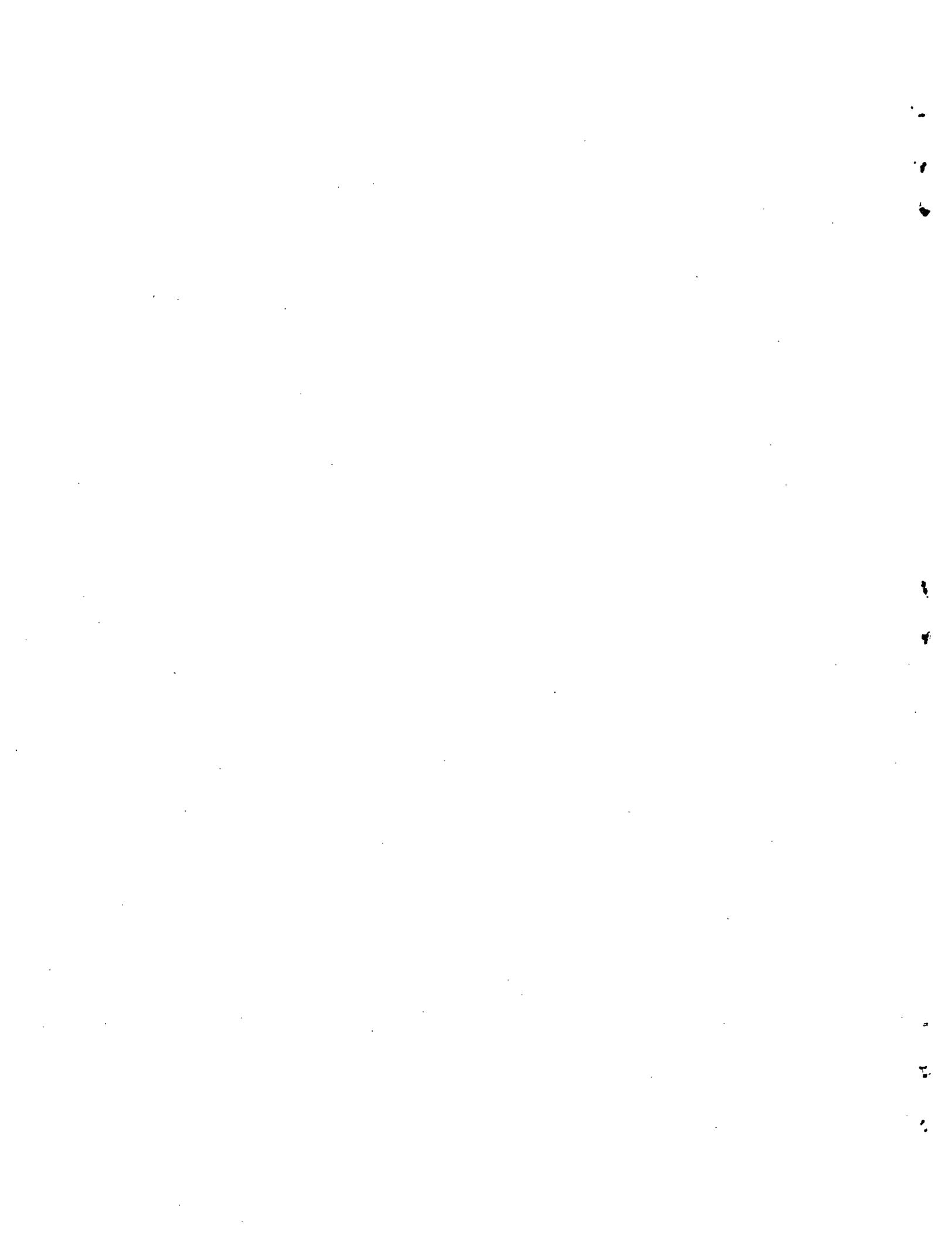
### The ORNL Accident Prevention Philosophy

It should be emphasized that the basic philosophy of the ORNL review system concept is that no review and subsequent approval releases the operator or the experimenter from his responsibility concerning the safety of the personnel and the accident-free operation of the facilities entrusted to his charge. Actions of the direct line supervision are the chief defense against accidents. Their great familiarity with the design, operation, and special problems of the facilities enables the supervisors to take the necessary steps and to initiate the needed administrative actions for preventing accidents. An important corollary of this philosophy is the assignment of the responsibility to the person in authority.

The purpose of the various review committees is to seek out potential hazards and to assure Laboratory management that all reasonable steps have been taken to eliminate them by having an independent evaluation performed by competent staff members. The main value of the committees is the independent, competent, "fresh look" which it brings to bear on the question at hand.

### Initiation of New Projects

New projects are originated in the various operating or research divisions. The proposed construction, changes in existing facilities, or new experiments are usually reviewed first by an internal group which is appointed by the director of the division involved. In addition to



safety questions, this committee considers all aspects of the project, both technical and administrative. For small projects, such an internal group is sufficient in itself.

#### Design Review Committees

For large projects such as new reactors and major in-pile loops, a design review committee is appointed by the Laboratory Director. These committees meet at frequent intervals with the designers, reviewing safety and operational problems and suggesting changes throughout the design period. The committee itself does not participate in the design but limits itself to evaluating the proposal which is presented by the designers. Its chief purpose is to perform an independent review during the design stage.

#### Other Support Groups

By the time the project leaves the conceptual design stage, other divisions become involved. The Health Physics Division specialists are called upon at an early stage to give advice on health physics problems. The Engineering and Mechanical Division engineers also participate from the start in the detailed design of the structure, utilities, ventilation, emergency power supply, removal of waste effluents, and similar problems in which they have competence. If external contractors are engaged during the construction stage, a field engineer of this division provides liaison with them.

The Radiation Safety and Control Department\* (Appendix B) is notified at the start of the design activity; a staff member with special experience in the field in question advises the designers on the criteria to be followed. This assistance to the designers does not imply final approval; such approval is given only after the project is completed in order to ascertain that the final design satisfies all safety requirements. The drawings are also checked by the Applied Health Physics Department representative (Appendix C) who reviews the health physics monitoring problems. If the project includes pressure vessels which must be code certified, the Inspection Engineering Department (Appendix D) is notified. The advice of the experts in this organization is sought by the designers; in addition, the department carries out the checks and routine inspections of pressure vessels and of other equipment.

The above steps and procedures apply to all new experimentation, the scale of which exceeds that of the usual laboratory experiments. As indicated previously, reactor experiments, modifications to existing reactors, and new reactor construction projects are subjected to additional review.

\* This department of the Director's Division represents the Laboratory management in all aspects of radiation safety.

The committees, organizations and procedures, which apply to the operation of reactors, are as follows:

#### Review of Reactor Experiments

The details of experiments to be inserted in one of the reactors operated by the Operations Division are first submitted to the Technical Assistance Department of that division. The department usually assigns an engineer to work with the designers and experimenters of all major experiments such as the loop experiments in the ORR to ensure that they will follow the criteria set by the division. Review of minor experiments does not require the full time of an expert, but in each case at least one staff member of the Technical Assistance Department is familiar with the details of the proposed experiment. These individuals know well the reactor in question and are aware of the problems presented by the neighboring experiments and thus are in an excellent position to aid the experiment designer. The design of major loop experiments may take several years -- even simple reactor experiments require relatively long periods of design. During this time the design engineers collaborate closely with the Technical Assistance Department's staff, receiving continuous assistance in matters of safety and experiment control.

Experiments which are not acceptable to the superintendent of the Technical Assistance Department must be modified before they are even submitted for review by the Reactor Experiment Review Committee, although in a few cases when a technical disagreement cannot be resolved, the experiment, accompanied by a list of objections of the Operations Division, may still be submitted to the Committee. As the reactor operators must "live" with the experiment inserted within the reactor under their jurisdiction, the differences of opinion must be resolved to mutual satisfaction of the two parties. The reactor operators are never forced to accept the installation of an experiment which is objectionable to them for safety reasons.

#### The Reactor Experiment Review Committee

The Reactor Experiment Review Committee, like its counterpart the Reactor Operations Review Committee, represents the Laboratory Director in its special area of responsibility. It is comprised of experts in various areas of importance to reactor experiments.

In selecting the members of this committee, care is taken to include technical men whose experience covers the disciplines involved in reactor experiments. Thus, the committee always has among its members an instrumentation and controls expert, a reactor operator, a health physicist and an experimenter.

With the exception of periodic re-examination of old experiments, the Committee does not initiate reviews, but awaits notification from the Technical Assistance Department. After an experiment has been found

acceptable, that department issues a list of restrictions which is carefully reviewed in the Reactor Experiment Review Committee meeting which is devoted to that experiment. This memorandum, the original detailed questionnaire filled out by the experimenter, and all the pertinent design reports and blueprints of interest from the viewpoint of safety are sent to the Committee about two weeks prior to the review.

As a rule, the review sessions are held just prior to the insertion of the experiment in the reactor, but in the case of large experiments, reviews are held at key stages of the design effort in order to prevent the designers from spending too much time on an unacceptable concept. However, these preliminary design reviews do not culminate in recommendation for approval; rather, it is simply noted that the Committee does not have any objection to the material presented. Approval is recommended only when the experiment is ready to operate.

During the review, the Committee's attention is focused on its primary responsibility: determination of the safety of the proposed design. The maximum credible accident is very closely examined during the review sessions. The experiment is unacceptable if it significantly increases the hazard of operating the reactor. Details of the experiment's design, instrumentation and control system, containment, thermodynamics, radioactive effluent system, etc., are examined.

As a general rule, the Committee is guided by the principle laid down by Laboratory management requiring two independent barriers between the confined radioactivity and the point at which no control can be exercised\*. A single contingency may not breach both containments, releasing fission products, or pose any significant hazard. The members must be convinced that the experiment does not represent an unacceptable hazard to the Laboratory as a whole and to the individuals working in the reactor building. In addition, care is taken to ensure that the new experiment does not interfere unduly with the normal operation of the reactor, to the detriment of the other users of the facility. For this reason, the Committee may also evaluate the potential interaction of the various neighboring experiments with each other.

Most of the reactor experiment reviews are completed during the four-hour long sessions of the Committee, but in the past several of the large experiments required a number of sessions; the review of a major loop experiment, for instance, has required as many as ten sessions of the Committee.

The arguments presented by the experimenters are discussed in executive session. After agreement is reached, the Committee's recommendations are listed in the Minutes of the meeting. The experiment is either "approved as presented" or approval is recommended with certain conditions. Enforcement of the conditions set is the responsibility of the Operations Division.

\* Letter by J. A. Swartout of December 11, 1959, "General Criteria for Containment of Radioactive Operations".

In addition to the review of new experiments, the Committee examines annually the experiments already installed. The main reason for the "re-reviews" is to ascertain that minor changes made during the year do not alter the character of the experiment in the direction of increased hazard.

### Review of the Reactor Operations

Because of their special nature, the operation of the reactors is reviewed in a somewhat different manner. First of all, most of the reactors have been in operation for relatively long periods of time, and major changes in equipment and control systems are relatively rare. New reactor designs and new construction plans are also submitted only infrequently.

Under the present organization, the ORNL reactors are operated by two divisions: the Graphite Reactor (OGR), the ORNL Research Reactor (ORR), and the Low Intensity Test Reactor (LITR) are under the jurisdiction of the Operations Division, while the Bulk Shielding Reactor (BSR), the Pool Critical Assembly (PCA), the Health Physics Research Reactor (HPRR), the Tower Shielding Reactor (TSR), and the Critical Experiment Facility (CEF) are operated by the Neutron Physics Division.

All the operators of the ORNL reactors are required by management to submit to the Reactor Operations Review Committee a summary of their yearly activities. These reports include operational data such as the reactor operating history, the power levels reached, and shutdown periods. Particular attention is given to operational difficulties and unscheduled shutdowns. Unexplained shutdowns are very carefully surveyed: the Committee takes the position that any irregular and inexplicable behavior is undesirable, even though the safety circuit operated and shut down the reactor. Consideration is given to the condition of the facility drawings, reactor operating procedures, maintenance program, operating personnel changes, and reactor mechanical details which could, for instance, affect shutdown margin.

In order to strengthen the Committee, a working subcommittee plan was inaugurated three years ago. The experience with this is very satisfactory. Thus, instead of inspection of the facility by the entire committee consisting of seven or eight persons, a three-member subcommittee is assigned to each reactor. This subcommittee consists of a main Committee member acting as the chairman, an instrumentation specialist, and a reactor operations specialist.

These three individuals go through the reactor as a group and return as often as they feel necessary to gain a complete understanding of the operational problems of the reactor. They make a special point to observe one or more reactor startup and shutdown operations; in addition, the log books and other written material kept in the control room are carefully scrutinized. At the time of the formal review, the subcommittee may present an informal report to the full Committee pointing out the items

that were found unsatisfactory; these items are then answered by the operator's representatives during the meeting.

During the meeting, Committee members have an opportunity to ask the operators to clarify any point. These questions are usually based on the material supplied by the operators and the report of the subcommittee. At present, it is the practice of the Committee Chairman to appoint the subcommittee members a long time prior to the review, thus encouraging them to keep "their" reactor under close observation for several months rather than restricting the inspection to the period immediately preceding the review session.

The composition of this Committee is also carefully balanced to ensure that individuals having the needed competence are among the members. The fields represented include reactor physics, reactor engineering (operations) health physics and instrumentation. This problem is reviewed in greater detail in the chapter on the qualifications of Committee members (page 9).

In addition to reviewing the experience and current practices of the reactor operators, the Committee also examines for technical accuracy reactor documents intended for outside distribution, including those submitted to the Advisory Committee on Reactor Safeguards or to other AEC groups. In this respect the Committee acts as the reactor consultant of the Laboratory management. Recently, the Committee has been made responsible for review and approval of experiments to be performed at the HPRR. This group, rather than RERC, was assigned this responsibility because the HPRR experiments present problems that are primarily of a nuclear physics rather than an engineering nature.

After listening to the operators' explanations concerning the points brought up by the subcommittee and Committee members, the operators' presentation is reviewed in executive session which culminates in specific recommendations on the needed improvements. The recommendations containing the conditions set for the continued operation of the reactor are listed in the Minutes of the Committee.

The Committee is not directly involved in the enforcement of the conditions; this is the responsibility of the Radiation Safety and Control Department. A staff member of this department is assigned to maintain contact with the reactor operators, ensuring fulfillment of the conditions.

The annual reviews of the Committee are usually held during November and December to avoid an overlap with the AEC-ORO Committee which reviews these facilities during the first half of the year. In addition, special sessions are held whenever the operator intends to make a major change in the reactor or whenever a document is to be submitted for examination prior to transmission outside of the Laboratory. New facilities, such as the Health Physics Research Reactor, are reviewed prior to startup.

### Functions of the Other Laboratory Director's Review Committees

The Reactor Experiment and the Reactor Operations Review Committees are the two most intimately involved groups in ensuring the safe operation of the ORNL reactors. However, the Laboratory has three other radiation safety review committees which may be called upon occasionally to advise on specific features of reactors or reactor experiments. A short summary of the activities of these committees, with special attention to reactor safety, is given below.

1. The Criticality Committee has jurisdiction over operations which involve the handling, storage, and transportation of fissionable materials above a stated minimum quantity. Reactor fuels within a core are specifically exempted from the jurisdiction of this Committee, but the handling of the fuel elements before insertion into the reactor and storage of the spent fuel elements must be approved by it.
2. The Hot Cells and Sources Committee may be called to review large radiation sources used in conjunction with the operation of a reactor. It also has jurisdiction over hot cells installed near reactors, as in the case of the ORR.
3. The Waste Effluents Committee, which audits the waste disposal activities of the Laboratory, examines the steps taken to remove the liquid, solid, and gaseous radioactive wastes at the individual reactors. As a general rule, the RERC and RORC follow the waste streams only up to a point where they reach the joint collection facilities of the Laboratory, but in order to avoid the possibility of overlooking an important point, certain portions of the waste stream might be reviewed by two committees.

All the above-listed five committees are consultants to the Laboratory Director; therefore, in safety matters they represent top management to the operators. Although most committee business is handled by the Radiation Safety and Control office, direct contact between the committees and the Laboratory Director is encouraged and left to the discretion of the Committee chairmen. Contact between the Director and the committees is assured by an annual meeting with each committee. On this occasion, the highlights of the past year's activities are reviewed, particular problems of concern to the committees are discussed, and plans for the coming year are described. The Radiation Safety and Control Department is responsible for informing divisions of all Committee recommendations affecting their operations and for seeing that the Committee's recommendations are, in fact, implemented.

### Divisional Committees

In addition to the Laboratory Director's Review Committees, four divisional committees are closely involved in the review of reactors or reactor experiments. A short summary of the scope of their activity is given below.

(a) The Instrumentation and Controls Division's In-Pile Instrumentation Committee may review the details of the instrumentation of the individual reactors and the major reactor experiments.

(b) The Neutron Physics Division's Reactor Safety Review Committee is an internal committee which checks the safety features of the experiments carried out at the facilities under its control, except the HPRR. The committee meets at each site at least once a year, or upon request, to consider special problems of the proposed experiments.

The experiments carried out with the BSR, PCA, and the TSR can be examined separately because the experimental equipment is not installed in the reactor core but some distance away; in addition, the experiment and the reactor are usually supervised by the same person. The Committee also reviews certain experiments at the Critical Experiments Facility and the operation of the HPRR.

(c) The Burst Reactor Experiments Review Committee (BRERC) of the Neutron Physics Division has been established to review all experiments utilizing the HPRR as a source of radiation.

The BRERC will examine all proposed HPRR experiments to ensure that they do not create any condition which would prevent the reactor control or safety system from functioning normally, which would cause the reactor to operate in excess of its normal limits, or which would endanger the operating personnel or the general public. In particular, the BRERC will examine the reactivity effects of proposed experiments and the method of determining the reactivity effects. It will also examine the adequacy of instrumentation and procedures to ensure that reactivity limits for the experiment are not exceeded.

(d) The DOSAR Facility Experiment Review Committee is responsible for the review of the health physics aspects of experiments carried out with the HPRR. This committee of four members is an internal committee to the Health Physics Division and cooperates closely with the BRERC of the Neutron Physics Division.

#### Qualifications of Committee Members

Members of the Laboratory Director's Review Committees are appointed by the Laboratory Director from the senior staff members for a period of three years; overlapping terms guarantee continuity of operations. The respective Division Director appoints the members of the divisional committees.

The qualifications of the members are carefully examined to ensure that specialists in the fields of interest to the committee are included. As a result, the specific viewpoints of the various disciplines are taken

into consideration while evaluating the hazards. For the same reason, scientists and engineers with both theoretical and experimental backgrounds may be assigned to the same committee.

In order to illustrate the range of experience brought to bear on reactor safety problems, the qualifications and the technical backgrounds of the RERC and RORC members for 1962 are cited. The chairman is a nuclear physicist in charge of the Reactor Analysis Department of the Reactor Division and he has participated in the design of several reactors. The members include an instrumentation engineer who is head of the Development Section of the Reactor Controls Department; a reactor physicist who currently is teaching at the Oak Ridge School of Reactor Technology; a health physicist who heads the Health Physics Technology Department and was long active in research on waste effluent problems; and a nuclear physicist who is in charge of two reactors and also Associate Director of the Neutron Physics Division. The RERC members include the head of the Reactor Controls Department as chairman; a health physicist of the Applied Health Physics Department, having considerable experience in the field of air contamination; a nuclear physicist, of the Reactor Division, possessing extensive design experience; a mechanical engineer from the faculty of the Oak Ridge School of Reactor Technology (Education Division) who participated in the design and operation of in-pile loops; and a reactor engineer from the Operations Division who spent many years as a reactor control room supervisor.

#### Radiation Safety and Control

The Director of Radiation Safety and Control establishes, on behalf of the Laboratory Director, policy with respect to radiation protection and ascertains that this policy is met at all times. Staff members of Radiation Safety and Control are assigned responsibilities for following closely the activities of certain of the Laboratory divisions which handle significant quantities of radioactive materials. Each one also specializes in key elements of the radiation safety program; for example, criticality, reactors, design criteria, training, waste disposal, containment, emergency planning, and coordination of the Laboratory Director's review committees.

#### Health Physics

The safety of all operations within the reactor buildings is greatly enhanced by the field activities of the Applied Health Physics Department. The surveyors assigned to the individual reactor buildings are in charge of the monitoring on the premises and advise the local supervision of any health physics problems that might arise. In case of unusual occurrences, they immediately alert the management by means of reports, copies of which are distributed to key individuals. Their

activities are of advisory character; the supervisor in charge of the facility must issue actual instructions.

#### Summary

The safe operation of the ORNL reactors and of the experiments carried out in them is ensured by a series of independent reviews. The following groups participate in this endeavor:

1. The initiating line organization, which has the primary responsibility for the design and operation of a facility. Staff members of the Engineering and Mechanical Division collaborate on most large projects. In addition, members of Radiation Safety and Control, Applied Health Physics, and Inspection Engineering Departments are usually called in as consultants at an early stage of the large projects.
2. Design Review Committees which are appointed to check all the features of the design, including safety, independently from the actual designers.
3. The Laboratory Director's Review Committees, one or more of which may become involved in certain cases.
4. Divisional Committees which cover specific fields, such as instrumentation, or examine areas outside of the scope of the review committees.
5. The Applied Health Physics Department which has field surveyors in the individual reactor buildings.
6. The Radiation Safety and Control Department, the staff members of which have specific duties with respect to reactors. The Director of Radiation Safety and Control acts as the focal point for collecting information concerning the safety of the reactors and reactor experiments and assures conformance to the conditions which are set.

A central file of the material submitted for review and of the Minutes of the Meetings of the Laboratory Director's Review Committees is maintained in the office of the Executive Secretary.

Appendixes

- A. Members of the Laboratory Director's Review Committees for 1963.
- B. Organization Chart of the Radiation Safety and Control Department.
- C. Organization Chart of the Applied Health Physics Department.
- D. Organization Chart of the Inspection Engineering Department.
- E. Members of the Instrumentation and Controls Division's In-Pile Committee.
- F. Members of the Applied Neutron Physics Division's Reactor Safety Committee.
- G. Members of the DOSAR Facility Experiment Review Committee.

## APPENDIX A

Laboratory Director's Review Committees for 1963Criticality Committee

A. D. Callihan, Chairman  
 F. T. Binford  
 R. Gwin  
 J. H. Marable  
 J. P. Nichols  
 J. T. Thomas  
 J. W. Wachter  
 R. G. Affel, Ex Officio  
 F. Kertesz, Secretary

Hot Cells and Sources Committee

H. F. McDuffie, Chairman  
 R. J. Jones  
 D. G. Doherty  
 J. T. Howe  
 C. H. Miller  
 W. E. Unger  
 T. W. Hungerford, Ex Officio  
 F. Kertesz, Secretary

Reactor Experiment Review Committee

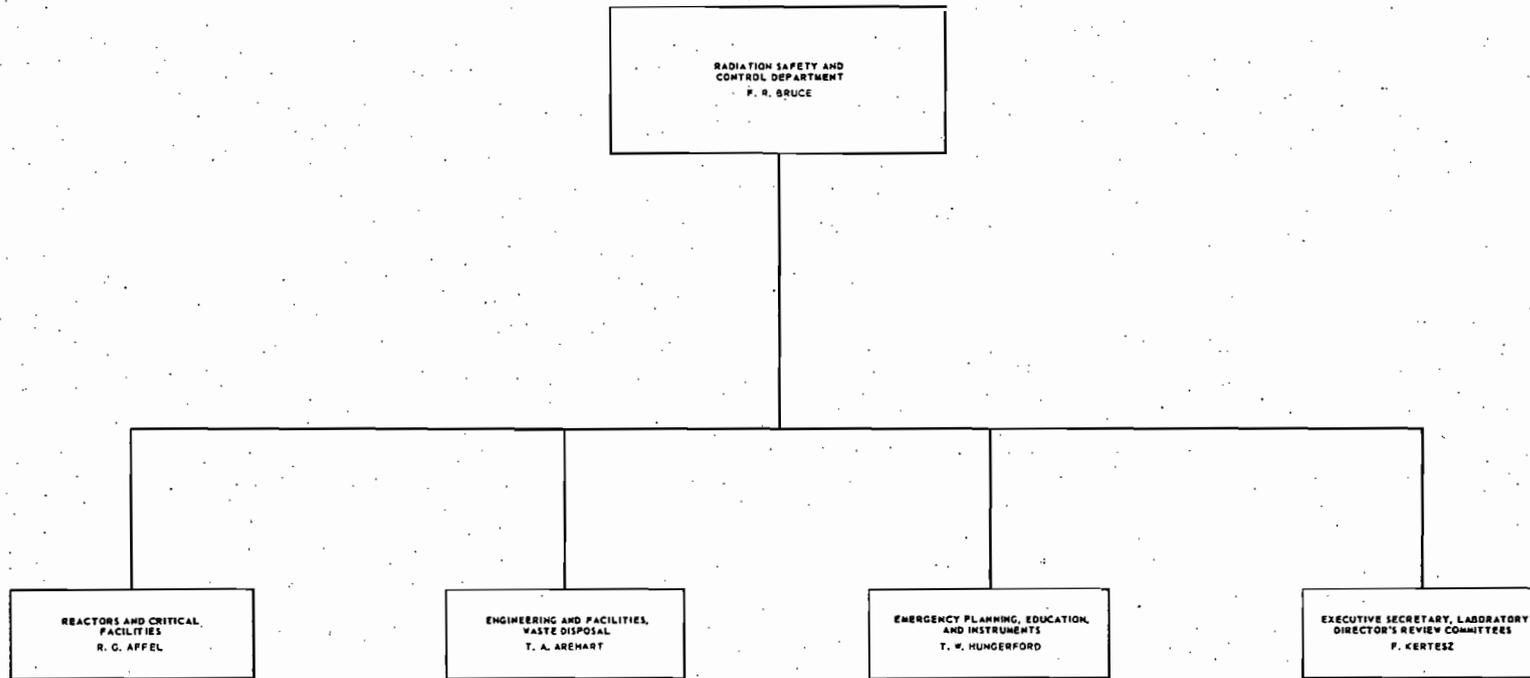
E. P. Epler, Chairman  
 K. M. Henry  
 J. Zasler  
 G. H. Jenks  
 T. J. Burnett  
 C. A. Preskitt  
 L. E. Stanford  
 R. G. Affel, Ex Officio

Reactor Operations Review Committee

A. M. Perry, Chairman  
 S. J. Ditto  
 E. Silver  
 E. E. Gross  
 B. R. Fish  
 R. G. Affel, Ex Officio  
 F. Kertesz, Secretary

Waste Effluents Committee

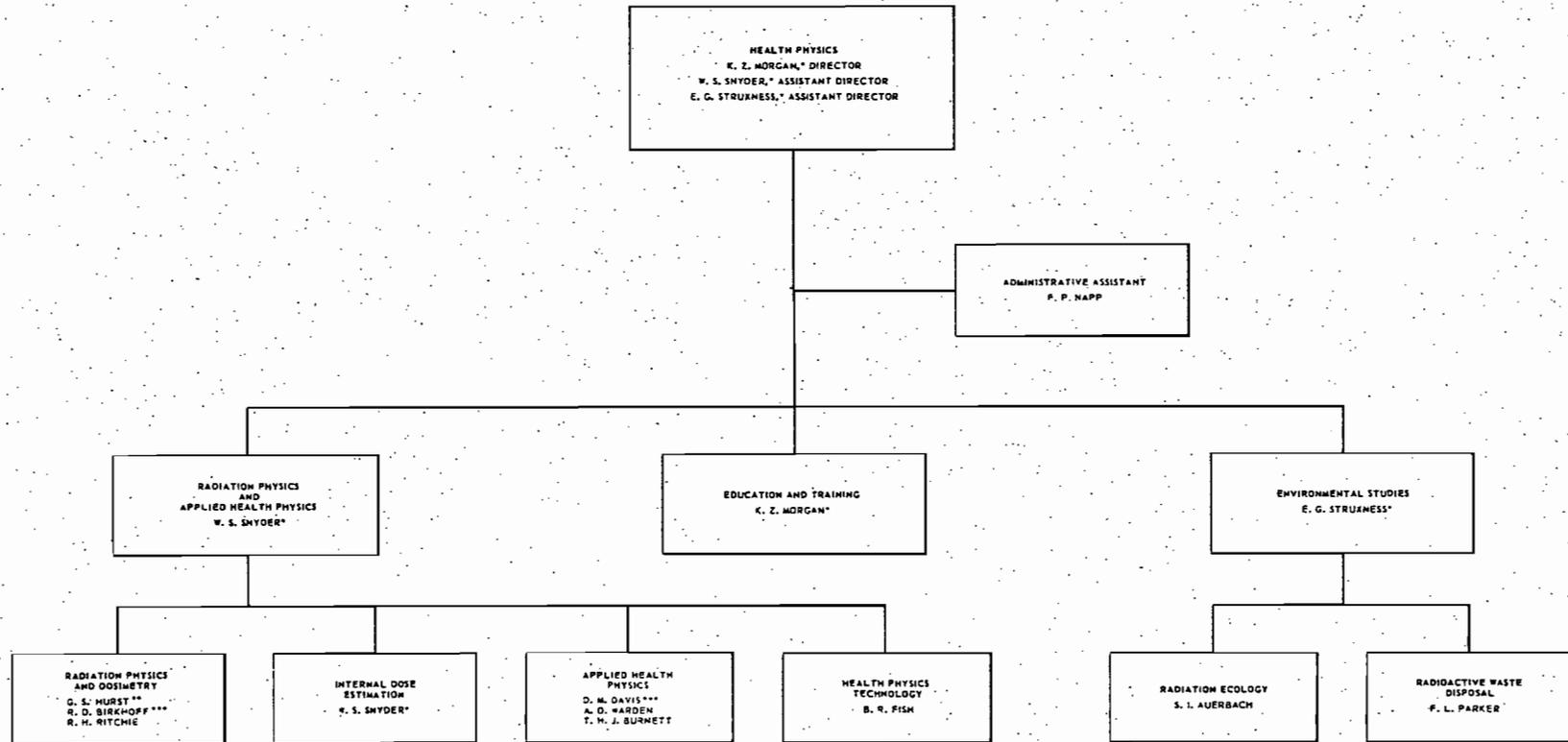
R. N. Lyon, Chairman  
 S. F. Carson  
 W. E. Browning  
 G. C. Cain  
 E. G. Struxness  
 T. A. Arehart, Ex Officio  
 F. Kertesz, Secretary



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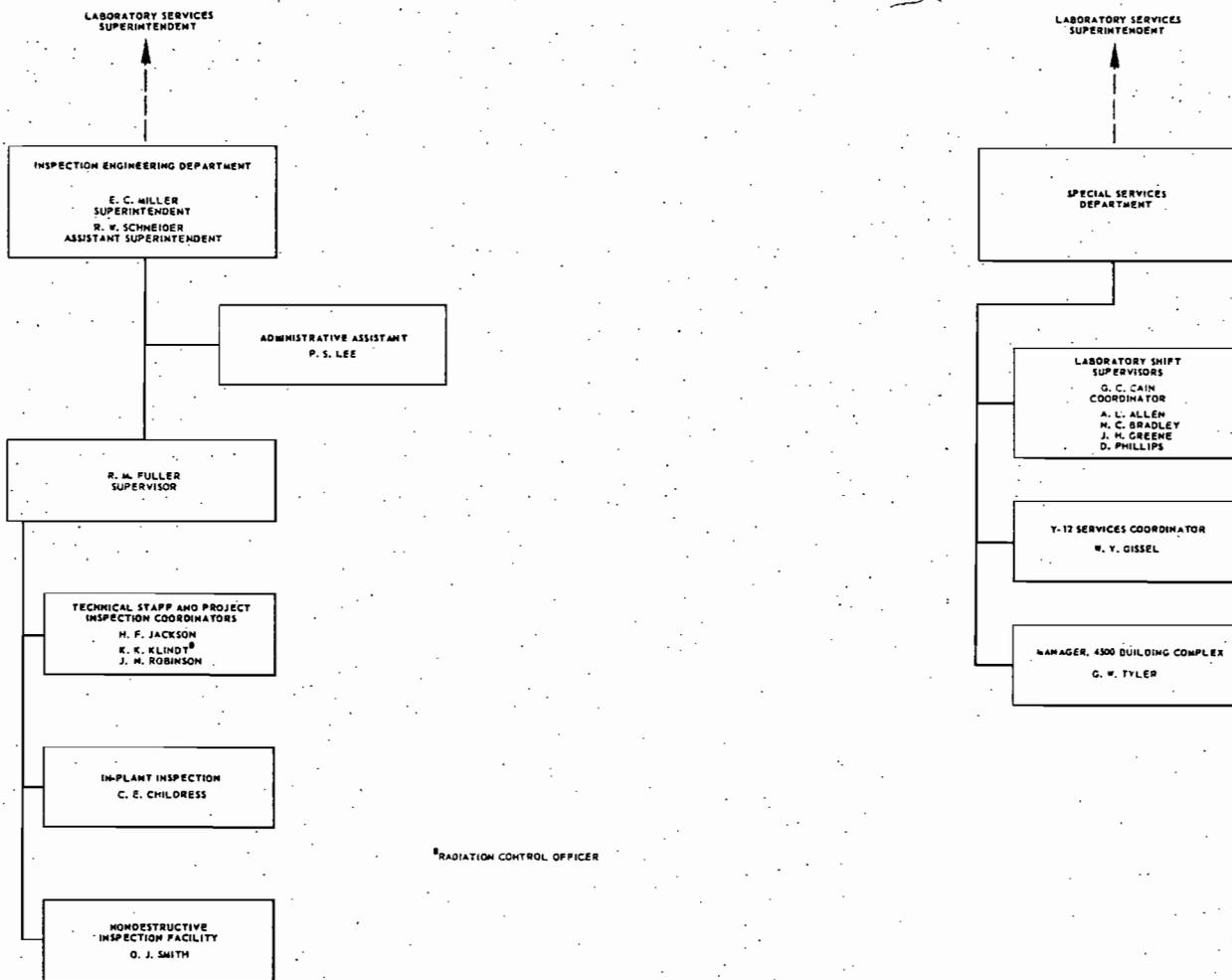
Appendix C



\*EQUAL CAPACITY  
 \*\*ON LOAN  
 \*\*\*ACTING SECTION CHIEF  
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APPENDIX E

Instrumentation and Controls Division's In-Pile Committee

E. P. Epler, Chairman  
A. E. G. Bates  
S. J. Ditto  
H. J. Metz  
R. L. Moore  
C. A. Mossman  
K. W. West, Secretary

APPENDIX F

Neutron Physics Division Reactor Safety Review Committee

A. D. Callihan, Chairman  
E. P. Blizard  
L. B. Holland  
F. C. Maienschein  
F. J. Muckenthaler  
L. W. Gilley  
J. T. Thomas

Burst Reactor Experiments Review Committee

J. T. Mihalcz, Chairman  
K. M. Henry  
J. T. Thomas

APPENDIX G

DOSAR Facility Experiment Review Committee

J. A. Auxier  
L. W. Gilley  
F. F. Haywood  
F. W. Sanders

## Distribution:

1. R. G. Affel
2. T. A. Arehart
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