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ADMINISTRATIVE CONTROL OF A RESEARCH REACTOR

J. A. Cox

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ADMINISTRATIVE CONTROL OF A RESEARCH REACTOR

J. A. Cox

ABSTRACT

In addition to instrument control over the reactor and experiments, safe operation requires strong administrative control. In 12 years of operation of the Graphite Reactor and five years of operation of the Low Intensity Test Reactor at Oak Ridge National Laboratory, no serious incidents have occurred. Administrative controls used to safeguard the reactors and personnel without undue interference with experiments are described, along with some of the hazards encountered in operation of research reactors.

OPERATION GROUP AT ORNL

For the past 12½ years the ORNL Graphite Reactor has been operating routinely 24 hours a day, 7 days a week, with weekly shutdowns for changes of experiments and samples. The LITR has been operated similarly for almost five years, with the same group operating both reactors. The personnel in the operation group for the two reactors total 27. Six of these are technically trained college-graduate supervisors, four are foremen supervising each of the four shifts, 16 are operators, and one is a secretary. The foremen are nontechnical men of long experience promoted from among the operators, and the operators are nontechnical men with a high-school education.

Training of the nontechnical operator is accomplished by a combination of working on the job and special training. Training guides have been written that cover practically all the duties required of the operator. After three months, the new operator is expected to be able to perform the more important of these duties.

New operators are sometimes selected partly on the basis of intelligence tests, although a more successful procedure is to hire operators who have worked at some other job in the plant and on whom work histories are available.

Supervision of operations is the responsibility of the six technically trained supervisors (a superintendent, an operations supervisor, a research coordinator, a reactor physicist, and two reactor supervisors). Each of the reactor supervisors is assigned responsibility for one of the reactors, and he spends full time planning maintenance and shutdown work, directing shutdowns, writing and revising procedures, etc. In this work he receives considerable help and instruction from the superintendent, operations supervisor, and research coordinator.

The operating group at ORNL differs from operating groups at many other laboratories in that it is a minimum group. It does not include any personnel for maintenance, design, or research. All these functions are performed by personnel loaned from other groups. It is believed that this type of organization is somewhat more economical, in that maintenance, instrument, and design personnel are used only as needed instead of being assigned full time to the reactor operating group.

The group does not have direct research responsibilities except for experiments on the reactors themselves. Its primary responsibility is safe operation of the reactor and providing assistance to research groups performing experiments in the reactors. No attempt is made to take over operation of experimental equipment; this is left to the research groups, although on occasions reactor operators may assist in the operation of an experiment. While this means that inexperienced research personnel sometimes operate experiments in the reactors, thorough liason between the operating and research groups maintains safety standards and also preserves a very desirable freedom for experimental groups. It is believed to be important, however, for the reactor operating group to be mainly concerned with the reactor rather than with the research program.

An operating group of this nature is small and economical yet able to meet the needs of research and operations. Experience has shown that the requirements for design and maintenance personnel for planning experiments and fabricating equipment vary over wide limits. It would be impractical to include in the reactor operations group enough personnel to meet such requirements in a busy period. The busy periods are often followed by periods of relative inactivity, during which the experiments are being operated, when it would be impossible to keep a large force occupied. The labor involved in designing and building a large in-pile experiment is so great that only by using central maintenance and design groups can any degree of flexibility and economy be achieved. Admittedly, however, the use of borrowed personnel, who are not always completely familiar with reactors, requires close supervision and inspection.

SAFETY IN REACTOR OPERATION

It is believed that greater likelihood of trouble exists during certain operations (startup, for example) than during steady operation. During such critical operations, safety is especially emphasized. High-flux research reactors require considerable excess reactivity, which increases the possibility of trouble. Reloading an enriched-uranium reactor is another operation where especial care is required, since it is sometimes possible to withdraw control rods manually in such a manner as to start up the reactor. In general, the safest procedure is to assume that if an operation can possibly be done in an unsafe manner special safeguards should be provided. These may include instruments, written check lists, discipline, and training, as applicable.

Written check lists are used in all operations (such as startups) in which trouble might occur; and every time a reactor is started up the supervisor must be present and must personally fill out the check list. Any change in operation or equipment must be approved by higher supervision. All safety devices designed to scram the reactors are tested on a rotating basis, and some of the more important ones are tested each week.

Startup of a reactor is always attended by announcements to give personnel adequate warning, and part of the prestartup check list requires an inspection of all holes to ensure that shielding is in place. In beam holes considered especially dangerous, locks have been installed with interlocking keys in the control rooms to prevent the reactor from being started up when a beam hole is open.

Strict rules are enforced to maintain the integrity of the safety system and to prevent blockouts without authorization, although in a few cases it becomes necessary to block out segments of the safety system. For example, a few years ago during a series of tests being conducted at the LITR on the heating of the fuel elements following loss of water, it became necessary to block out certain safety instruments. Rather than use clip leads which might be forgotten and left on, a blockout panel was built with indicating lights so that there would be no possibility of the blockout being forgotten.

Occasionally it becomes necessary to make tests involving a considerable change in basic operating procedure. An example is a test currently under way on remote control of the LITR. The test has been in progress since early autumn of 1955 and involves controlling the LITR from a location about 100 yards away. The basic information on the reactor, cooling system, and experiments was brought to the remote-control desk in a compact arrangement so that it could be combined with the control desk of the Graphite Reactor and one operator could control both reactors. During this test, however, an operator has been kept at the LITR to observe operation and to take over operation if any event should require it. A record is being maintained of any events requiring the participation of the operator at the LITR, and the operator will not be removed until the results of the test have proved to the satisfaction of the supervisory groups, including the ORNL Reactor Operations Review Committee, that this can be done safely. This example is cited to illustrate the supervision of operations practiced at ORNL to ensure safety of personnel and reactors.

The Reactor Operations Review Committee consists of a group of senior staff members who annually review operation of each reactor at ORNL. Any major change in operation or equipment must be reviewed by this committee.

CONTROL OF RADIATION EXPOSURE

Control of radiation exposure in the operating group is a source of constant trouble. Since the operating group handles a great deal of radioactivity in removing samples and experiments from the reactor, it is exposed to more radiation than most other groups. Given a permissible level of exposure, supervision has the choice of doing the job at a minimum cost, as long as personnel are not over-exposed, or of spending money for more shielding, apparatus, etc., and keeping the personnel exposure much below the permissible limit. It is nearly always easier and faster to accomplish a given job by using tools and shields already on hand rather than having new ones made.

Under these conditions it is not surprising that personnel exposures tend to approach or sometimes exceed the permissible limit. By making each person responsible for his exposure and by keeping an up-to-date record of the daily exposure accumulated by each person, it is generally possible to keep the weekly exposure well below the permissible limit.

High radiation from open beam holes (>400 r/hr with the reactor shut down) makes exposures at the LITR difficult to control. It is necessary to open these holes occasionally while experiments are being changed, and, unless the beams are well guarded and roped off, people will cross the beams or even stand in them. A very strict watch is necessary in these areas, and the beam holes are plugged as soon as possible.

DISSEMINATION OF INFORMATION

Dissemination of information presents a serious problem even in a small group. Unless constant vigilance is maintained, information which is needed will not be properly passed down to the foreman or up to the supervisors. A fairly successful practice has been to issue a series of procedure memoranda for any change or addition likely to be permanent. From time to time these are collected and rewritten into permanent-type procedures. Changes of a temporary nature are usually handled by writing notes in the log book. It has been found to be important to keep information pertaining to the reactors in as few channels as possible and to standardize these so that there is no chance of a supervisor failing to get the information. Thus procedures, procedure memoranda (numbered chronologically), and, of course, the log book constitute the major channels for information in this group. The log book serves as a good medium for disseminating information about current work and for procedures of a temporary nature. In addition, it serves as a valuable permanent record. Without constant attention, the information in the log becomes sterotyped, and much useful information will be omitted.

EXPERIMENTS

Most experiments in the ORNL research reactors do not primarily concern the operating group, except from the standpoint of safety, and are performed by groups from the various research divisions. One supervisor is detailed to help research groups plan experiments and design equipment. If the experiment appears to be dangerous, it is reviewed by the Experiment Review Committee. After approval has been obtained, the experimental equipment is inserted into the reactor with the necessary tie-ins to the reactor safety system so that alarms, automatic power reductions, or scrams will occur if the safe limits of the experiment are exceeded. These must all be tested before the reactor can be started up. Special problems occur in operation, since most experiments are not attended at night. It has been found to be important to have an up-to-date information sheet on each experiment available to the reactor shift foreman so that, if trouble occurs, all possible contingencies are covered. This sheet lists the alarms, power reductions, or scrams tied to the reactor safety system, the action to be taken in various situations, and persons to be called in event of trouble.

EMERGENCY PROCEDURE

Another aspect of safety is in a good emergency procedure. Experience in emergencies at ORNL has been limited to radioactivity given off by experiments; however, in several cases these have required that the reactor be shut down and the building be evacuated. An emergency procedure, including the building evacuation, is practiced regularly so that personnel will automatically respond properly. A loud horn arranged to blow intermittently gives warning of the need to evacuate, and the reactor operations group leaves the building by several routes to be sure other personnel have evacuated. Once outside, the operators take stations to prevent anyone from entering the building.

One of the most difficult aspects of the emergency problem is in recognizing promptly that an emergency exists. With the instruments generally used, the alarm point is set at a rather low level so that, when the alarm sounds, the common procedure is for personnel to gather in the affected area to determine the source of the trouble and ask questions about how high the radiation actually is. The instruments sometimes alarm because of defects, and this possibility must be eliminated by checking with a portable instrument. Tying all radiation instruments in to the control room gives some advantages, since a general condition is quickly picked up by several instruments. However, instruments giving alarms at high radiation levels would offer even more advantages, since these could signal a true evacuation level. So far, no really serious contaminations have been caused by the ORNL research reactors or experiments performed in them.