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THE ROLE OF THE NATIONAL LABORATORIES
IN THE RDT STANDARDS PROGRAM

by

W. J. Hallett

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Engineering and Technology Division
Argonne National Laboratory
Argonne, Illinois

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W. J. Hallett*

ABSTRACT

The national laboratories have three major functions in the RDT standards program: (1) preparing and maintaining tentative standards; (2) using RDT standards to determine their effectiveness in yielding the desired results; and (3) developing technology which ultimately will be recorded in standards. The objective of the RDT standards program is engineering standards for RDT reactor and test facility projects and associated engineering and component development programs. The national laboratories contribute to the efforts directed toward this objective by bridging the gap between present and future practices through technology development programs.

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In this paper, I propose to discuss the RDT** standards program and the parts played in it by the national laboratories. I will emphasize the efforts to develop standards for the Liquid Metal Fast Breeder Reactor (LMFBR) primarily because I am active in that program, but the general comments are applicable to the water reactor program. In conclusion, I will show how the RDT standards program will result in standards that will be the record of the technology developed for the LMFBR, technology based on tests of materials, components and systems designed and built to those standards.

* Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
(Work performed under the auspices of the United States Atomic Energy Commission)

** Reactor Development and Technology Division of United States Atomic Energy Commission

The national laboratory has several functions in the RDT standards program. The first is that of preparing and maintaining tentative standards. The second is that of using these tentative standards. This latter role is of importance in that the provisions of the standards are put into practice and tested to determine their effectiveness in producing the desired results. Lastly, a major function of the national laboratory is the development of technology which will ultimately be recorded in standards.

The objective of the RDT standards program is engineering standards for use in design, construction, and operation of RDT reactor and test facility projects and associated engineering and component development programs. Standards must contain criteria for safety and performance, with methods prescribed to determine that the criteria are satisfied. If the state of the art is not advanced enough to allow this determination to be made by analysis, a program of tests should be defined. The results of the tests will establish a new level of the state of the art, assuming satisfactory verification has been achieved by demonstration of proper function in service beyond present practice. Achieving incremental advances in the state of the art by verifying through tests that a component can perform under service conditions beyond present practice is fundamental to reaching the objectives of the entire LMFBR program. Standards represent the technology base on which RDT development programs build and they record the step-by-step advances in technology through a controlled procedure for their continual upgrading.

The nuclear industry can benefit substantially by the use of proven engineering practices consolidated into standards acceptable to the licensing and regulatory bodies concerned with public safety. "When acceptable standards for design and analysis are developed, design aspects conforming with these standards can be identified in a particular application and a detailed review of these

aspects dispensed with in that case. Efforts of designers and reviewers can then be concentrated on other significant matters."¹

The use of standards provides confidence that the system or component can be operated with minimal hazard to the public. Standards also incorporate engineering practices that will assure that an agreed-upon level of performance will be met. The quality-assurance methods needed to establish requisite safety and performance reliability are emphasized in the RDT standards program.

Adequate workmanship, performance, and safety required for experimental equipment to be used in the LMFBR program can also be assured by proper selection and use of standards for design and fabrication of the equipment. For LMFBR experimental activities, recognized standards (RDT, commercial, or other) must be selected that will be appropriate to the conditions of operation, life of the experiment, reliability, and ability to maintain the apparatus. If one of the functions of the experiment is to provide data to support or upgrade RDT standards, this consideration must be overriding.

Standards must contain criteria for acceptance and methods for determining that the criteria are satisfied. These methods may be either analytical or experimental. When analytical methods are within the state of the art, proven by use, tests may be needed only to reduce the level of uncertainty or to confirm satisfactory operation. If no satisfactory analytical methods are known or data is lacking for use in the analyses, more extensive testing is required to demonstrate that the criteria for acceptance are met.

Standards represent the state of the art at any time because they contain generally accepted engineering and construction methods proven by use. As the state of the art advances, tentative standards will include more advanced techniques, the demand for which arises from the need for components for service

¹ E. G. Case, AEC Program in Nuclear Standards: Regulatory Functions - Division of Reactor Standards, Nuclear News, November 1967, pp. 44-47.

beyond present practice. Bridging the gap between present and future practices for fast breeder reactor systems is the LMFBR technology development program. Standards for RDT reactor and test-facility projects will be based on existing proven technology with incremental advances as needed to meet project requirements. These advances will be verified by testing programs and further substantiated by operation in the reactor or test facility. Test and operating data will be combined with information from related technology development in the LMFBR program. With these new data, standards will be upgraded for the next application. This process is illustrated in Figure 1. Component development projects, test facilities, FFTF, and other LMFBR projects being conducted at the national laboratories will all benefit from and contribute to the standards program. With each application of standards, the cycle of feedback of information and successive use will repeat, leading ultimately to standards solidly founded on experience.

PREPARATION OF RDT STANDARDS

Major participants in the administration of the RDT standards program are Oak Ridge National Laboratory (ORNL) and Liquid Metal Engineering Center (LMEC). These two agencies are responsible for coordinating the program including maintaining a schedule of the standards needed, establishing format and numbering system, assigning numbers to proposed standards, and reviewing the drafts of standards. LMEC and ORNL are also responsible for taking the lead in preparing standards of general applicability such as for materials, design, welding, nondestructive testing, cleaning, quality assurance, etc., as represented by the tentative RDT standards issued to date.

RDT standards are also to be prepared by other organizations responsible for RDT projects when the need for new standards has been established. Each project organization involved in an RDT reactor or test facility project or associated engineering or development program (such as those carried out at national laboratories) will determine what standards are needed to accomplish the assigned tasks. Where neither an applicable industry or regulatory standard nor an RDT standard exists, the project will recommend to RDT (through LMEC for LMFBR projects) the new RDT standards needed and will prepare them. Where more than one project needs the same new standard, LMEC will recommend to RDT the "lead" project that will be directed to prepare the standard. LMEC will coordinate with the other projects to assure that the standard in preparation is sufficient to cover the needs of the other projects and is prepared on a schedule compatible with those needs. LMEC will provide guidelines for and review and comment on the technical content of LMFBR standards in preparation. A guide for preparation of RDT standards has been issued by ORNL.

Organizations requiring an RDT standard as part of their procurement activity will be responsible for having the RDT standard prepared and will prepare specifications for procurement of all project related equipment, materials, and services. The technical portion of the procurement specification will include:

1. The applicable RDT or other acceptable standards
2. Ordering data specific to the items being purchased
3. An optional document titled "Exceptions, Modifications, and Additions"

The last document is to be prepared where an existing RDT standard is used, but it is necessary to take exception to some of the requirements of the standard, or additions or modifications to the requirements are needed to incorporate new information. If the additions or modifications are extensive, a revised or new RDT standard will be prepared. Normally, the revised or new standard will be approved by RDT along with approval of the procurement specification to which it applies. LMEC will advise project organizations on the application of RDT standards to their efforts and will review and comment on additions or modifications proposed to be made to existing RDT standards.

Ideally, tentative standards which are new or modifications to existing standards to incorporate advances in technology should precede development work to provide guidance for the work. Because tentative standards are not now available in many areas and development work is underway, certain standards are being prepared by LMEC and ORNL to provide an initial base of RDT standards. For development activities related to a specific project, such as FFTF, responsibility for preparing the tentative standard lies with the project.

RDT standards should contain provisions to assure that components utilized in the LMFBR program are designed, fabricated, and operated so as to result in safe and reliable performance. Achieving this goal requires that project

specifications and referenced applicable documents -- RDT and other industrial and professional society standards -- realistically reflect the proven technology at any given time. This requirement does not mean that first-of-a-kind components cannot be used. Rather, it implies that where performance cannot be confidently predicted by existing technology, the standards shall clearly identify limitations and provide for demonstration of adequacy by test programs. The evolutionary LMFBFR program will broaden the technology base, permitting standards to be continuously upgraded to reflect fewer technology limitations and concurrently fewer mandatory test requirements.

It must be recognized that testing cannot in all cases compensate for deficiencies in technology, particularly where data on long-time materials behavior is not available. LMFBFR program exigency will require that component design proceed with the risk inherent in this lack of information. Thus, users of the standards must recognize the risk and provide for continuous in-service monitoring of performance to provide a basis for evaluating actual remaining capabilities, as data becomes available from concurrent development programs.

USE OF STANDARDS

The emphasis and direction by RDT on the use of standards in RDT programs leave no question of whether standards shall be used, but only of how to use them. Standards are needed for every phase of engineering, from experimental programs to reactor construction and operation. The proper selection of standards, the manner in which they are used, and the assurance of conformance to the standards are of utmost importance.

Selecting appropriate standards commensurate with the end use of a component demands attention to several interrelated points. The end use of the component must be thoroughly defined, the reliability and availability requirements must be established, and the maintenance philosophy determined. These factors must be recognized in the engineering-design process, when specifications are prepared, not later, when changes are more costly. At this time appropriate standards are selected and modifications or exceptions are considered. Obviously, the responsible engineers must be thoroughly familiar with the standards available for their use and with the overall effect of their choice of standards on the success of their endeavor. In this regard, when proven technology is limited and advances in the state of the art are needed to accomplish the mission, the highest standards must be applied because part of the end result is an upgrading of the standards.

Standards can be used in experimental work as well as in reactor and facility construction. Standards and the related quality-assurance activities should be selected by the experimenter and used in the design and fabrication of apparatus and the purchase of equipment. The first step is to carefully define the experiment for which equipment is needed. Detailed information on the conditions of temperature pressure, mechanical and thermal loads, etc., to be imposed on the equipment in the course of the experiments must be determined. From these data, a concept for the needed apparatus can be derived and standards for design and

fabrication can be selected. Even though the equipment may be of unique design and application, standards that describe the basic engineering materials and fabrication processes will promote quality workmanship in the final product. With a library of standards available describing the "building blocks" from which a new structure can be designed and built, the attention of the experimenter can be directed to other significant aspects of the work.

Standards, being of broad application to a class of components or materials, are used by reference in specifications for procurement of components. The specifications will contain a description of the capacity, size, operating conditions, and other characteristics of the exact component needed (the ordering data) and reference to the applicable standard by specific paragraph if necessary for precise definition. If exceptions, modifications, or additions to the standards are necessary, these shall be identified. The use of standards in this manner provides the purchaser with the means to communicate clearly, to all concerned with the design, fabrication, and installation of a component, the exact requirements for safety and performance of that component.

The ultimate success of the RDT standards program will be determined in the application of these standards to production of the equipment, materials, and services required by the RDT projects. Conformance to the provisions of the standards in each step of design, manufacturing, and use of the articles is essential. Assurance of the required conformance is in itself the subject of standards. At the core of the quality-assurance standard is the requirement for a plan describing all actions to be taken by the responsible organizations to assure meeting the requirements for quality as determined by the end use of the article. Provision is made in the standard for auditing the quality-assurance activities by representatives of the concerned parties to determine the degree of conformance to the plan. Provisions are also stated covering responsibility, documentation, corrective action, and other aspects of the management of the quality-assurance program.

TECHNOLOGY DEVELOPMENT AT ANL

As initially conceived, the primary responsibility of the Argonne National Laboratory was to conduct basic research in the many areas of science pertinent to the long-range development of atomic energy. Later, the Laboratory was assigned major responsibilities in the field of reactor development in addition to the research activities. This twofold responsibility has continued to the present time, and provides the basis for the participation of the Laboratory in the liquid-metal-cooled fast breeder reactor program. This participation is strongly oriented to general engineering research in heat transfer, fluid dynamics, liquid metal coolants, high temperature fuel and construction materials, and instrumentation, as well as broad studies in fast reactor safety and physics. Operation of EBR-II as a facility for irradiating fuels and materials is an important part of the LMFBR program at ANL. The record of the technology developed by these efforts will ultimately be found in standards.

Some examples are presented to illustrate ways in which the development of new technology can lead to new or improved standards. Basic research in engineering mechanics being conducted at the Laboratory includes investigation of flow-induced vibration of single and clusters of cylindrical elements. Results of this study will be new methods of analysis and testing that can be used by designers to minimize potential for detrimental vibrations of in-core and out-of-core components, such as fuel assemblies and heat exchangers. Mathematical models were derived and comparisons made to experimental results to show that the model was successful in predicting essential features of parallel-flow-induced vibration. (Work is also underway on cross-flow). The primary objective is to develop relationships and correlations, in the form of equations or graphs, for use by designers. The initial publication of this material is in the form of a "design guide." With further development and verification of the correlations through actual use in engineering designs, these methods of analysis can be incorporated in standards.

The sodium technology development program at ANL includes the study of the chemistry of sodium and its impurities. From this effort will come standard methods of analysis of sodium, purity standards for purchase of sodium, and standards for purity of cover gas for sodium systems. The sodium technology program also incorporates the development of on-line monitoring and sampling systems for measuring oxygen, hydrogen, carbon, and other impurities in liquid sodium. Equipment standards defining these instruments will be prepared as a record of the results of the development program.

In pursuing technology development programs at ANL, the need arises for test equipment and apparatus. This opens another avenue for contributing to new and improved standards. In the engineering design and fabrication of the equipment, tentative RDT standards are used with modifications appropriate to the service requirements. In some cases, the service is more severe than present practice dictates which demands advanced techniques of analysis, and perhaps of fabrication. Operation of the test equipment then provides data on the validity of the standard (and its modifications, if any) for the intended use, and changes in the initial provisions of the standard can be recommended.

The Argonne National Laboratory has been a focal point for developments in specific areas related to liquid-metal-cooled fast reactors, and a reservoir of technical experience is available to support the preparation of standards for the LMFBR. Experience in development of instrumentation for use in the core of EBR-II provides the basis for preparation of standards, examples of which are the standard Wide Range Neutron Flux Monitoring Channel (RDT C15-2T) and High Temperature Cable Testing (RDT F3-39). Many years of experience with liquid metal systems likewise is the background for standards relating to sodium system design, construction, maintenance and operation. The technology development programs underway at Argonne will provide new information in many technical areas which will ultimately be recorded in or incorporated into standards.

Figure 1. Process for Developing RDT Standards -

W. J. Hallett