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SAFETY EVALUATION OF THE MODULAR HIGH TEMPERATURE GAS-COOLED REACTOR

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ABSTRACT

This paper provides a status of NRC's review of the Modular High Temperature Gas-Cooled Reactor (MHTGR). In addition, several factors which influenced the review of the MHTGR are discussed.

STATUS

A summary of what has transpired over approximately the past two years with regard to NRC's review of the MHTGR is discussed first. At the time of the MHTGR concept selection (approximately two and one-half years ago) a series of detailed interactions were planned between NRC and the MHTGR Program participants. These were to concentrate on the review of a Preliminary Safety Information Document (PSID) submitted by DOE for review in September 1986. The results of the NRC review were to be documented in a Safety Evaluation Report (SER). At that time the scheduled completion of the NRC review and issuance of the SER was January 1988.

The main purpose of our review is to establish preliminary guidance regarding licensing criteria for the MHTGR and to make an assessment of the potential of the proposed design to meet those criteria.

The way in which we conducted the review was to concentrate our evaluation on the design with respect to its ability to perform the key safety functions of reactor shutdown, decay heat removal and containment of fission products. In doing this we developed preliminary licensing criteria and assessed the potential of the MHTGR design to meet these criteria. The licensing criteria were developed by building upon existing LWR criteria, where applicable, and by developing additional criteria, as necessary to address the unique aspects of the MHTGR. The MHTGR Program had also proposed those criteria which they believed apply to their plant and these were considered also. The assessment of the ability of the design to meet these criteria was done by independently evaluating the performance of the key safety attributes of the design over a full range of accident conditions. This helped us to identify failure thresholds where accident consequences become unacceptable, as well as, identify any issues relating to calculational methods and the base technology programs supporting the design. The review was complemented by a series of meetings between NRC staff and the MHTGR Program (See Table 1) to discuss specific PSID chapters or specific issues. In addition, Advisory Committee on Reactor Safeguards (ACRS) views were solicited on the MHTGR and the staff's evaluation.

Early on in the review two key topics associated with the MHTGR were identified which needed to be brought to the Commission's attention since they were related to policy matters.

These two topics are:

- Treatment of severe accidents, including source term, adequacy of containment/confinement and emergency planning.
- Plans for standardization, including scope of plant to be standardized, level of detail to be standardized and operating experience/R&D required before Commission approval or certification.

The NRC staff has prepared papers for the Commission on both of these topics recommending a position on each and soliciting Commission guidance. Meetings with the ACRS have been held with the objective of getting the Committee's views on these papers.

Other Commission actions, which directly influenced our review of the MHTGR were:

- Issuance of a Severe Accident Policy Statement on August 8, 1985.
- Issuance of an Advanced Reactor Policy Statement on July 8, 1986.

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- Issuance of a Safety Goal Policy Statement on August 4, 1986.

- Issuance of a Policy Statement on Standardization on September 15, 1987.

These policy statements provide general guidance applicable to all types of power reactors and were factored into our review of the MHTGR. Additional guidance regarding implementation of these policy statements is forthcoming; however, certain factors associated with implementation of these policy statements had already been developing and influenced our review of advanced reactors. I would like to briefly discuss these as they relate to the MHTGR with the purpose of providing a perspective on the staff's review.

PERSPECTIVE

As a result of the above Commission policy statements the staff has been assessing their implications regarding advanced reactors. Although a final determination on their impact for the MHTGR is dependent upon implementation guidance being developed for LWRs, several factors related to these policy statements as they apply to advanced reactors can be discussed at this time. These factors apply in general to any advanced reactor type and are listed below followed by a short discussion on each.

- Enhanced Safety
- Performance Criteria/Defense in Depth
- Standardization
- Use of a Prototype Test
- Use of Existing Operating Experience
- Use of Industry Standards

Enhanced Safety

The Commission's Policy Statement on Advanced Reactors encourages the development of designs with certain attributes which, if incorporated into a design, should lead to enhanced safety. To help ensure that enhanced safety is incorporated into advanced designs the staff is considering taking the following approach:

- Giving credit for designs which have enhanced safety characteristics by a reduction in the number of and/or types of safety systems required or in changed administrative requirements.

- Requiring advanced designs evaluate selected design changes to see if they would result in cost effective safety improvements.

- Requiring advanced designs to document their enhanced safety characteristics.

Performance Criteria/Defense in Depth

There has been much discussion over the past several years about utilizing less prescriptive or performance based licensing criteria. Alternatives ranging from probabilistic based criteria to descriptive goal based criteria have been suggested. While the use of such criteria is still being explored and will be considered for advanced reactors it is the staff's opinion that such criteria cannot be used to totally displace engineering judgement or the defense in depth philosophy.

Standardization

A revised Commission Policy Statement on Standardization has been issued. This policy statement strongly encourages standardization by design certification. Along with this policy statement the NRC staff is developing a rulemaking (10CFR52) which, after Commission approval, will provide additional guidance on the procedural aspects and requirements for design certification.

Use of Prototype Test

According to the Commission's Policy on Advanced Reactors, a prototype test reactor is not required to be constructed and operated in order to receive a design approval or certification of an advanced reactor from the NRC. The staff will, however, need to be satisfied that, for the design being reviewed, there is a basis for each claim regarding system and equipment performance and reliability. In particular, for designs without a conventional containment building, an option being considered by the staff is to require a prototype plant be a prerequisite to design certification.

Use of Existing Operating Experience

In our review of the MHTGR PSID we considered both domestic and foreign gas cooled reactor operating experience. This is in accord with the Commission's Policy Statement for Advanced Reactors which includes the statement: "The Commission expects that these designs [for advanced reactors] will reflect the benefit of significant research and development work, and include the experience gained in operating the many power and development reactors both in the United States and throughout the world." Such information provides additional confidence regarding the potential to achieve the goals and level of safety required for the MHTGR.

Use of Industry Standards

The use of industry standards for the technical details of reactor design has been a fundamental part of reactor licensing for many years. Over the years a great body of such standards have been developed by experts in conjunction with the NRC and provide in most cases the essential details of how higher level criteria, policies, guides, rules and regulations are actually met. Like the use of appropriate operational experience, the use of these existing standards, wherever practicable, in advanced design is encouraged.

SUMMARY

For the past two years the NRC has been reviewing MHTGR licensing documents and developing preliminary guidance regarding licensing criteria. These criteria along with our assessment of the potential of the MHTGR design to meet the criteria will be documented in a Safety Evaluation Report to be issued this fiscal year.

TABLE 1
NRC STAFF REVIEW OF LICENSING DOCUMENTS FOR SER

CHAPTER	SUBJECT	NRC MEETING	PSID AMENDMENT FILED
		1987	
1-3	INTRODUCTION & GENERAL DESCRIPTION, SITE, LICENSING BASES, CRITERIA & METHODOLOGY	1/20,21	3/5
7,8	INSTRUMENTATION AND CONTROLS, ELECTRICAL	2/18	4/2
4	REACTOR	3/18,19	5/14
5	VESSEL & HEAT REMOVAL SYSTEMS	4/22,23	6/11
6, 9-14	BUILDINGS & STRUCTURES, SERVICE SYSTEMS, STEAM & ENERGY CONVERSION, RADIONUCLIDE CONTROL, RADIATION PROTECTION, OPERATIONS, TEST PROGRAM	5/27,28	7/9
15-17, RTDP	SAFETY ANALYSIS, QA, REGULATORY TECHNOLOGY DEVELOPMENT PLAN	6/18,19	7/30
PRA, EPBR	PROBABILISTIC RISK ASSESSMENT, EMERGENCY PLANNING BASES REPORT	7/15,16	8/27
4,5,15, PRA	STATUS, KEY ISSUES, OPEN ITEMS	10/16	11/27
PRA	BEYOND DESIGN BASIS ACCIDENTS	11/10	NONE
		1988	
4,5,15, PRA	FUEL, VESSEL INTEGRITY, BOUNDING EVENT SEQUENCES, OTHER KEY ISSUES	3/17,18	4/1