an ASME
publication

\$2.00 PER COPY
\$1.00 TO ASME MEMBERS

RECEIVED BY DTIC JUL 19 1971

SEFOR Operating Experience¹

MASTER

J. O. ARTERBURN

Manager, SEFOR Facility
Fayetteville, Ark.

G. BILLURIS

Manager, Plant Design

G. B. KRUGER

Project Engineer, SEFOR Operation,
General Electric Co.,
Breeder Reactor Development Operation,
Sunnyvale, Calif.

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

The SEFOR program objectives and experimental results are given. Operating experience and information gained during preoperational testing through rise to power operation are presented. Problems encountered during early operation phase are discussed as well as results from operation of systems and components where good performance has been achieved. Plant availability data, along with statistical information covering specific plant components and systems are given and the applicability of SEFOR experience to commercial LMFBR plants is presented.

¹Work performed under Contract No. AT(04-3)-540 between the Atomic Energy Commission and the General Electric Co.

Contributed by the Nuclear Engineering Division of The American Society of Mechanical Engineers for presentation at the Nuclear Engineering Conference, Palo Alto, California, March 7-10, 1971. Manuscript received at ASME Headquarters December 1970.

Copies will be available until January 1, 1972.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

UNITED ENGINEERING CENTER, 345 EAST 47th STREET, NEW YORK, N.Y. 10017

an ASME
publication.

10 PER COPY
ASME MEMBERS

RECEIVED BY DTIC JUL 19 1971

SEFOR Operating Experience¹

MASTER

J. O. ARTERBURN

Manager, SEFOR Facility
Fayetteville, Ark.

G. BILLURIS

Manager, Plant Design

G. B. KRUGER

Project Engineer, SEFOR Operation,
General Electric Co.,
Breeder Reactor Development Operation,
Sunnyvale, Calif.

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

The SEFOR program objectives and experimental results are given. Operating experience and information gained during preoperational testing through rise to power operation are presented. Problems encountered during early operational phase are discussed as well as results from operation of systems and components where good performance has been achieved. Plant availability data, along with statistical information covering specific plant components and systems are given, and the applicability of SEFOR experience to commercial LMFBF plants is presented.

¹Work performed under Contract No. AT(40-3)-546 between the Atomic Energy Commission and the General Electric Co.

Contributed by the Nuclear Engineering Division of The American Society of Mechanical Engineers for presentation at the Nuclear Engineering Conference, Palo Alto, California, March 7-10, 1971. Manuscript received at ASME Headquarters December 2, 1970.

Copies will be available until January 1, 1972.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

UNITED ENGINEERING CENTER, 345 EAST 47th STREET, NEW YORK, N.Y. 10017

SEFOR Operating Experience

A. D. STEPHENSON

G. BILLURIS

G. B. KRUGER

INTRODUCTION

The Southwest Experimental Fast Oxide Reactor (SEFOR) is a 20-Mwt sodium-cooled, fast flux reactor which is operated in a cooperative program involving Southwest Atomic Energy Associates (a group of electric utilities), General Electric, West Germany, and the AEC. SEFOR is fueled with mixed $\text{PuO}_2\text{-UO}_2$ and has an overall core composition, neutron spectrum, and operating fuel temperatures similar to the characteristics of the demonstration fast breeder reactors that are now receiving considerable attention.

Previous analysis of the large, ceramic-fueled fast reactor concept (1)² indicated the presence of an intrinsic negative coefficient of reactivity from the fuel Doppler effect, which fulfilled a vital safety requirement for the utilization of fast breeder reactors in electrical power generation. With an international recognition of the importance of the Doppler coefficient to the success of the fast breeder concept, the design, construction, and operation of SEFOR was undertaken to provide a facility program in which the Doppler coefficient would be reliably measured and the effectiveness of this coefficient for safety convincingly demonstrated. Several small-sample Doppler measurements have been made in fast critical assemblies, using either foils or an oscillating fuel rod to measure the effects of temperature changes in these materials. However, SEFOR has provided the first integral measurements of the Doppler coefficient with full core fuel temperature changes characteristic of operating temperature variations in a large breeder reactor. SEFOR will be the first fast reactor facility to demonstrate the control of reactor power excursions by the Doppler effect.

Although the systematic measurement and demonstration of the Doppler coefficient is the primary purpose of the SEFOR program, other highly beneficial results have been obtained. These include the specific design data and relatively uncommon experiences provided by the design, construction, and operation of an actual liquid metal-cooled fast reactor. The day-to-day experiences with the hardware, involving many activities

in the particular environments and conditions in which the equipment must operate, will contribute generously to the ultimate task of providing a breeder reactor with the performance and availability that meet the requirements of the electric utility industry.

The reactor and associated radioactive components are housed in 'the reactor building'. The reactor building outer containment shell is an all-welded steel cylindrical structure, 50 ft in diameter and 115 ft high. Fig.2 illustrates the reactor building arrangement. Radioactive components are housed in an inner containment structure that consists of steel-lined concrete cells located within the cylindrical building.

The reactor vessel is located near the center of the reactor building. A refueling cell above the reactor normally contains an argon inert atmosphere and is shielded so that fuel elements can be removed from the reactor and examined through lead glass windows and periscopes, mirrors and television camera. In addition, there is equipment in the cell to perform quantitative measurements on the fuel so that its performance can be periodically checked as the test program proceeds. The cell is also used for refueling and for transferring fuel from the reactor to an irradiated fuel storage tank located in the cell and from the fuel storage tank to a cask for shipment off-site. All operations within the cell are visible to the operators.

The SEFOR cooling system consists of two parallel heat-transfer circuits. The main primary coolant system transfers 20-Mwt energy from the reactor core through an intermediate heat exchanger to the secondary system, where an air blast cooler rejects heat to the atmosphere. An auxiliary cooling loop is operated in parallel with the main loop and has a heat-transfer capability of 1 Mwt. The auxiliary system serves as an operating standby facility to remove decay heat in the event the main system is out of service.

SEFOR design, construction, and initial operation are described in detail in previous technical presentations (2,3). This paper reviews the SEFOR operating experience with emphasis on those aspects which have application to reliability, performance, and availability of future IMFER power plants.

² Numbers in parentheses designate References at end of paper.

Fig. 1 SEFOR facility — operational experience and schedule through 1970

OPERATING EXPERIENCE

SEFOR achieved its first self-sustaining fission chain reaction on May 3, 1969, five years and 2 months after the start of engineering design. This compares with $3\frac{1}{2}$ years initially scheduled for design, construction, and pre-operational testing. Construction of the facility was completed in October 1968, about $1\frac{1}{2}$ years behind the original schedule. The main factor contributing to this delay was the backlog of vendor work which extended delivery dates for major equipment.

Pre-operational testing began in mid-1968 and was completed in February 1969. The major coolant systems performed well and, with few exceptions, met the design objectives. Most of the difficulties occurred with the more conventional instrumentation. In most instances, the difficulties encountered could have been prevented by more careful design, fabrication, and installation.

Initially, it was estimated that completion of the SEFOR Experimental Program would take three years, with completion in the Spring of 1972. Rapid progress with the experimental program has provided schedule improvement and now that the exclusion tests (the last series of tests for Core I) are underway, it appears likely that the Program will be completed on schedule. A follow-on program is under development which will be initiated upon completion of the present experimental work. This program will utilize safety oriented type tests to provide further support for the design of the large breeder.

In order to meet the experimental objectives, a planned program of measurements (4) is currently being performed. The program includes several kinds of physics measurements at low power, followed by a comprehensive series of experiments at various reactor power levels to determine the Doppler reactivity effects. The tests at power included measurements of reactivity changes produced by regulated variations in power and coolant flow between different static, equilibrium condi-

Fig. 2 SEFOR reactor building

tions. In addition, the reactivity feedback and frequency response of the reactor are determined from analysis of conventional oscillator tests in which oscillatory power and coolant temperature perturbations are induced by a reactivity oscillator.

The static and oscillator experiments were followed by a series of transient tests resulting from rapid reactivity insertions that occur when boron carbide slugs are ejected from a central channel in times of the order of 0.1 sec. The transient program was initiated at low power with sub-prompt critical transients produced by reactivity insertions of the order of 0.5\$ and will culminate in super-prompt critical tests produced by reactivity insertions of the order of 1.3\$ at power levels up to 10 MW(t). Preliminary analysis of results obtained during initial operation indicate that the observed reactivity effects and fuel temperature changes are consistent with the calculated Doppler reactivity coefficient, $d\lambda/dT$, of -0.0085.

Following reactor start-up in May 1969, several months of operation at zero power were completed with the reactor vessel head removed. During this period, approximately 300 reactor start-ups were made, demonstrating the excellent performance of the reflector control drive system, reactor instrumentation, and the sodium coolant systems. Extensive fuel transfer operations were accomplished, including approximately 2000 fuel transfers. This experience demonstrated the ease with which fuel can be visually located and then grappled and transferred by remote mechanisms. Fuel rod transfers in a 15-min. time interval are lim-

ited only by the crane speed. Reflections from the silvery sodium pool contribute significantly to the ability to see and identify core locations. This favorable operation has confirmed the design basis for open-pool, hot-cell refueling, and gives increased confidence to LMFBR designs utilizing this form of refueling.

Broad experience was also obtained with the refueling cell man-access suits. Many refueling cell maintenance and repairs have been accomplished, and a high degree of competence has been achieved with men working within the suits. More than 60 cell entries have been made and over 80 man-hours of in-cell operations logged.

Performance of sodium systems has been very good. The electromagnetic pumps have proved to be reliable, stable, and responsive. More than two years of successful coolant system operation have been accumulated without difficulties. Operation of the sodium to air heat exchangers at power has met the design objectives, and other heat-transfer equipment has performed well. One of the operational highlights has been the completely stable reactor operation over all power levels. The reactor operators have complete confidence in the plant with its stable control characteristics over the full range of reactor power. Fig.1 summarizes the reactor operating experience, with fuel loading beginning on April 8, 1969. Initial criticality was attained on May 3, 1969 with 550 fuel rods. During subsequent material worth measurements, a number of fuel rods were determined to be deficient in plutonium content. An intensive investigation using both reactivity comparisons and out-of-core gamma and neutron scanning techniques was conducted to indentify the deficient fuel and to confirm the uniformity of fissile content of the remainder. After removal of the deficient fuel, another critical array was obtained with 522 rods nearly identical to that predicted, confirming the engineering calculational methods and results from the ZPR-3 experiments.

During the period of the zero power tests, May to November of 1969, the reactor was shut down for approximately two months to accomplish maintenance and modification activities, including the annual containment leak checks and identification and repair of inter-cell leakage paths between the argon and nitrogen cells. Fig.2 illustrates the general building arrangement and the location of argon and nitrogen regions. Intensive efforts were expended to eliminate the leakage of nitrogen (with approximately 1 percent oxygen and a dew-point of 40 F) into the argon (with oxygen and moisture content of a few ppm). Oxygen laden nitrogen entered the sodium when the reactor vessel head was removed and this affected the performance of sodium level probes, cold traps, and argon puri-

fication system (Nah bubbler). Gas leakage paths were identified around the reactor vessel seal between the refueling cell floor and the reactor head. Final repair was achieved by welding a continuous membrane seal between the cell floor and reactor outer head. Repair of leakage paths has significantly reduced in-leakage, which has subsequently resulted in improved system performance.

Difficulties arose with the sodium level probes during periods of high in-leakage from the nitrogen zone. The level probes are resistance probes which rely upon the contact of sodium to make an electrical circuit and signal a level change. An oxide film buildup on the external surface of the probe created a high resistance path which did not allow the electrical circuit to make up when the level was raised. In some instances, the oxide film was removed by raising the coolant level and allowing a "soak" period. The probes were re-designed to permit removal from the vessel and have, on occasion, been removed, cleaned, and reinstalled. The re-designed probes have allowed plant operation to continue with a minimum of difficulties. Further development of liquid level probes should be undertaken in the future to improve reliability.

During the latter part of November and December of 1969, the reactor was shut down for inspection and review of radiography of the coolant system pipe welds (5). Although design, fabrication, and erection of the sodium coolant system piping was performed under strict quality control procedures, using the latest codes and acceptance procedures, a portion of the radiographs taken during construction were found to have some deficiencies relative to code requirements. Upon finding the radiographic deficiencies, an audit of the original construction films was initiated, and, as a result, 78 coolant system welds required re-radiography. In the course of the inspection, nine welds were found which contained deficiencies requiring repair. In performing the repair work, experience was gained with working conditions, procedures, and techniques required in handling and maintaining liquid metal systems components. Piping repairs proceeded on an individual system basis. Portions of the coolant system were drained, as required, and the piping allowed to cool to room temperature. Following removal of insulation and trace heaters, the piping was ready for inspection and repair. During this repair phase, an argon gas purge was maintained in the piping, and in the case of the large diameter piping, balloons were used to isolate the piping and prevent contamination. In making the coolant system piping inspection and weld replacement, invaluable experience was gained in performing coolant system maintenance repairs. It was found that the piping re-

Fig. 3 Reflector guide structure

pair work could be performed efficiently and with little difficulty. As a result, the repair work was completed effectively and the systems were returned to service ahead of schedule.

During the initial rise to power in early March 1970, a number of reflector guide structure thermocouples, installed within the control segment guide structure, had been noted to be failing (6). These thermocouples, installed within the control segment guide structure and the reflector segments to monitor thermal conditions in this area, are relatively inaccessible. The design of the guide structure is illustrated in Fig. 3. This structure surrounds the reactor vessel and is located in an inert atmosphere. Nitrogen gas passes through the guide structure to provide the required cooling. Fifty thermocouples are installed in the guide structure, and ten of these are connected to the reactor safety system. These thermocouples are installed in a relatively low-temperature region (100 to 200 F), and had not experienced radiation fields substantial enough to induce damage. Investigation of the thermocouples failures was hampered by thermocouple inaccessibility and biological shielding requirements. Exact location of the failures could not be determined, as the open circuits were located in the upper regions of the guide structure. The left side of Fig. 3 illustrates the thermocouple routing of lead wire for the original guide structure thermocouples. Each thermocouple is enclosed in a 1/16-in. stainless sheath and imbedded in the aluminum guide structure. The sheathed portion extends out of

Table 1 Reactor Scram Tabulation

the high-temperature region and terminates in the lower shield region with a connection to the glass-insulated thermocouple leads. The installation of the additional thermocouples in the lower end of each reflector segment is shown on the right side of Fig. 3. The new thermocouples are ungrounded, with magnesium oxide insulation and a 1/16-in.-dia 304 stainless-steel sheath. There are no sharp bends in the sheathed portion of the thermocouples, and all of the glass-insulated lead wire is accessible for inspection and repair, if required. The thermocouples can be replaced, if necessary, from the reflector drive cell. Three thermocouples are installed in each segment providing two spares, which reduces the need for cell entry, should failure occur. The installation of additional replaceable thermocouples in the lower end of each reflector segment was accomplished by replacing the control drive shafts with the thermocouples instrumentation built in. In order to accomplish this operation, it was necessary to remove the control drives, and lower the serpentine shield segment and reflector segment down to an accessible location in the reflector drive cell. Due to the high radiation levels (5 rad/hr) of the activated nickel segments, localized shielding packages were devised which protected personnel working in the area and at the same time acted as support fixtures for removal and installation of the control drive extension shafts. Repair work was sequenced with the installation of new drive shafts to gain the most efficient use of time and to minimize radiation exposures. The installation effort proceeded smoothly in spite of the radiation fields and was completed ahead of schedule. Experience with the replacement thermocouples at power has been entirely satisfactory.

Rise to power was initiated in late June, and 5-MW(t) operation was attained early in July 1970 with successful operation of all systems. On August 14, 1970, power was raised to 10 MW(t).

On September 5, 1970, power was increased to 17.5 MW. The successful rise to power, following several months of delays and difficulties, is en-

Table 2 Major Outages

Major Outages	Dates	Major Accomplishments	Outage Period Days	% Of Total Time 5/7/69-9/30/70
Containment Leak Test	6/27/69-9/2/69	Inner and Outer Containment Leak Test Repair of Argon/Nitrogen Cell Interleakage Repair Pipe Penetrations Refueling Cell Crane Refueling Cell NaK Cleanup	67	12.5
Coolant Piping Inspection & Repair	11/1/69 - 1/4/70	Inspect Coolant System Piping Re-radiography Repair Nine Welds Replace Primary Cold Traps Refueling Cell Crane Maintenance Replace Main IHX Level Probe Calibrate Main Primary Flow Venturi Repair N ₂ Blower Motor	65	12.1
Reflector Guide Structure T/C's	3/21/70-6/26/70	Reflector Guide Structure T/C Replacement Fabrication of Nex Extension Shaft Shield Fixtures & Tools Disassy. & Reassembly-Checkout Containment Leak Test NaK Bubbler Argon/Nitrogen Cell Interleakage	97	18.0
TOTAL			229	42.6%

couraging. The high plant availability factor during the last several months of operation has demonstrated the improvements that can be obtained through a systematic investigation and correction of equipment malfunctions. The improved system performance. This, along with the achievement of significant power levels, has given increased confidence in the operation of SEFOR and the contribution being made to the IMPER AVAILABILITY program.

SIGNIFICANT EVENTS

During operation of the facility since initial start-up, a majority of the systems and equipment have performed adequately with little or no problems. However, certain areas of the plant have been susceptible to difficulties, and as an aid in assessing the need for improvement, events of significance have been categorized as illustrated in Tables 1 through 3. Table 1 provides data from reactor scrams (7), and Tables 2 and 3, for significant equipment and system malfunctions (8). Total effect upon the reactor operation and experimental program is summarized in terms of accumulated delays due to certain recurring problems or events. In general, most of the major problem areas have been improved or corrected, and the increased plant availability over

In the planning and preparations for operation, a survey of experiences at the various liquid metal-cooled facilities (EBR I, EBR II, Fermi, and Rapsodie) was made to assist in the determination of a Test Program availability³ factor for SEFOR. From this survey, a factor of 28 percent was estimated. The actual availability factor obtained from the start of fuel loading in April 1969 to October 1970 (a period of 17 months) was 36 percent. This factor included four outages for major equipment modifications, annual containment leak tests, equipment installation, and repair. For the period of June 26 to October 1, 1970 a Test Program efficiency of 71 percent was obtained. Table 4 illustrates the monthly SEFOR availability

³ Availability is defined as: Time reactor is available to perform experimental program/Total Time.

Table 3 Significant Events

System/Component	Problems	No. of Incidents 8/69-10/70	Delay In Operation (Days)	Delay In Operation % of Total Time 5/7/69 - 9/30/70
Oscillator	Positioner Motor Installation Problems Positioner Gears	5	33	6.0
Primary Cold Trap	Low Cold Trap Flow High Plugging Indication	1	15	2.8
Level Probes	Oxide Contamination Failure of Internal Wiring	8	13	2.4
Refueling Cell System	Grapple Malfunctions Crane Clutch Mechanical Crane Electrical	11	12	2.2
	Vacuum Distillation Station Fuel Assy./Disassy. Station	4 2		
	Man Access Suit	3	2	0.4
Instrumented Fuel Assembly	First Time Installation Problems	1	6	1.1
Cell Argon Purifier	Low Flow-Plugging Carryover - Cell Clean Up NaK Measurement/Addition	1	7	1.3
Reactor Instrumentation Wide Range Monitors Safety System	Switching Transients Relay Malfunction	18 3	5	0.9
Electrical	General	10		
Volt-Pacs	Burn-Out	12	1	0.2
Heater Circuits	Short	5	3	0.6
125 V Inverter	Malfunction	2	1	0.2
Leak Detectors	Short	4		
Argon System	Plug in Argon Line Cell Moisture	1 1	3 3	0.6 0.6
Nitrogen System	Nitrogen Blower Controls, Freon System	10		
Building Air Conditioner	Compressor, Condenser Fan	3		
Gaseous Radwaste System	Compressor Oil Leak	1	3	0.6
Miscellaneous (includes scrams)		49	4	1.1
TOTAL		154	113	21.0

for those periods of time when the experimental program was under way. With experience from SEFOR construction and operation available to the engineering design personnel, there is increased confidence that large fast breeder reactors can be designed and constructed with an availability factor as great as that of the best water reactors.

RELATIONSHIP TO COMMERCIAL IMFBR PLANTS

SEFOR was designed primarily as an experimental facility to provide fast reactor physics and safety data. In addition, operation of SEFOR is providing valuable experience and engineering data that can be utilized in the large IMFBR power

plants for which demonstration plant programs are now underway.

Some of the data obtained from SEFOR, such as that on plant availability, cannot be applied directly to the commercial plants due primarily to the fact that SEFOR was designed as a relatively short life experimental facility, rather than as a prototypical power plant. Heat from the reactor, transferred through sodium coolant systems, is dissipated to the atmosphere, instead of generating steam for electrical power. Insofar as practicable, the sodium systems and related cover gas and vent systems incorporated basic designs and fabrication practices established from prior experience. Throughout non-critical regions of the

Table 4 Reactor Availability

plant, standard commercially available components were utilized.

Secondly, the nature of the experimental program has required the reactor to be shut down frequently to permit examination of fuel and change-out of experimental equipment. Also, the experimental program requires continued change in reactor operating conditions, and, therefore, long-term steady-state operation, with high fuel burnup, is not achieved. Nevertheless, a significant portion of the SEFOR plant and the associated operating experience is applicable to the future LMFB power plants. For example, the refueling cell concept, which uses an argon hot cell over the reactor, and the fuel-handling equipment are similar to that proposed for the GE demonstration plant. Also, much of the sodium, argon, and nitrogen systems and the low leakage inner containment system have features similar to those proposed for future power plants. Consequently, SEFOR operating experience does have application to the larger LMFB plants and results to date show continuing progress toward meeting the long range required objectives of performance, reliability, and availability associated with power plant needs.

The problems with equipment and systems early in plant life have illustrated the need for high quality work in design, fabrication, and installation. Experience with modification and repair of systems has been beneficial. The maintenance and repair work that has been encountered in high radiation environments and with the sodium coolant systems has given confidence in the ability to perform maintenance on the reactor systems. This experience has shown that repairs can be readily achieved in liquid metal systems, and by applying this to LMFB plants, a significant contribution can be made to plant maintainability and ultimately improved availability.

Plant availability data are of particular interest to the future LMFB plants, especially since May 1, 1969 - July 30, 1970. Most previous liquid metal plant experience has not resulted in particularly encouraging availabil-

ity results. Target plant capacity factors for the GE reference design LMFB demonstration plant are 40 percent for the first year, 60 percent for the second, 80 percent for the third, with an average of 70 percent over the plant life. Plant availability values equal to or greater than the capacity factors are necessary to meet the desired goals. In order to make SEFOR availability data reasonably applicable to the LMFB power plant, it is necessary to take into account the down time attributed to the test program requirements. Results indicate that during the first year of operation, SEFOR had an availability of 31 percent and, over the last few months, an availability as high as 80 percent. It is highly encouraging to note that the SEFOR operating experience shows significant improvement in availability with time and indicates availability values that approach those specified for the target demonstration plant. While the design objectives of SEFOR did not emphasize mechanical designs prototypical to the future LMFB plant, much of the equipment is similar to that anticipated for the future plants. SEFOR operating experience is providing input into the verification and development of these designs, as well as related information on performance, reliability, and availability for application to the future LMFB power plants.

REFERENCES

- 1 Greebler, P., and Hutchins, B. A., "The Doppler Effect in a Large Fast Oxide Reactor — Its Calculation and Significance for Reactor Safety," Proc. Symp. Phys. Fast Intermediate Reactors, Vienna, Vol. 3, 1961, p. 121, International Atomic Energy Agency, Vienna, 1962.
- 2 Billuris, G., et al., "SEFOR Plant Design," Proceedings of Fast Reactors Topical Meeting, San Francisco, 1967, ANS-101, p. 5-1.
- 3 Fidrych, L. F., and Arterburn, J. O., "SEFOR Construction, Operation: Prelude to LMFB Development," ANS Nuclear News, Mar. 1970, p. 53.
- 4 Noble, L. D., and Wilkinson, C. D., "Final Specification for the SEFOR Experimental Program," GEAP-5576, 1968.
- 5 "Southwest Experimental Fast Oxide Reactor Development Program, 23rd Quarterly Report, November 1969 - January 1970," GEAP-100-10-23, Feb. 1970.
- 6 "Southwest Experimental Fast Oxide Reactor Development Program, 24th Quarterly Report, February - April 1969," GEAP-100-10-24.
- 7 "Southwest Fast Oxide Reactor First, Second, Third, Fourth and Fifth Quarterly Reports,"
- 8 Kruger, G. B., "Southwest Fast Oxide Reactor Development Program Monthly Events Report."