NUREG-1224

Safety Evaluation Report
related to the renewal of the operating license for the University of New Mexico Research Reactor

Docket No. 50-252

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

March 1987

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ABSTRACT

This Safety Evaluation Report for the application filed by the University of New Mexico (UNM) for renewal of Operating License No. R-102 to continue to operate its research reactor has been prepared by the Office of Nuclear Reactor Regulation of the U.S. Nuclear Regulatory Commission. The facility is located on the campus of the University of New Mexico in Alburquerque, New Mexico. The staff concludes that the reactor can continue to be operated by the University of New Mexico without endangering the health and safety of the public.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The University of New Mexico (UNM) submitted a timely application for a 20-year renewal of the Class 104c Facility Operating License R-102, to the U.S. Nuclear Regulatory Commission (NRC/staff) by letter dated June 2, 1986, as supplemented. The research reactor facility is located on the campus of the University in Albuquerque, New Mexico. The licensee is permitted to operate the reactor within the conditions authorized in past license amendments in accordance with Title 10 of the Code of Federal Regulations, Paragraph 2.109 (10 CFR 2.109), until NRC action on the renewal request is completed.

The renewal application references information regarding the original design of the reactor facility and contains information about modifications to the facility made since initial licensing. The application includes a revised Safety Analysis Report (SAR), information required for an environmental assessment, financial information, operator requalification program, security plan, and revised Technical Specifications.

The staff's review with respect to issuing a renewal operating license to the UNM has been based on visits to the facility and on information contained in the renewal application and supporting documents, plus responses to requests for additional information. This material is available for review at the Commission's Public Document Room at 1717 H Street, N.W., Washington, D.C. 20555.

The purpose of this Safety Evaluation Report (SER) is to summarize the results of the safety review of the UNM AGN-201M research reactor and to delineate the scope of the technical details considered in evaluating the radiological safety aspects of continued operation. This SER will serve as the basis for renewal of the license for operation of the UNM reactor facility at power levels up to and including 5 Wt. The facility was reviewed against the requirements of 10 CFR 20, 30, 50, 51, 55, 70, and 73; applicable regulatory guides (principally Division 2, Research and Test Reactors); and appropriate, accepted industry standards [American National Standards Institute/American Nuclear Society (ANSI/ANS) 15 series]. Because there are no specific accident-related regulations for research reactors, the staff has, at times, compared calculated hypothetical radiation dose values with related standards in 10 CFR 20, "Standards for Protection Against Radiation," both for employees and the public.

This SER was prepared by J. Dosa, Project Manager, Division of Pressurized Water Reactor Licensing-B, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. Major contributors to the review include the Project Manager and C. Cooper of the Idaho National Engineering Laboratory under contract to NRC.

1.1 Summary and Conclusions of Principal Safety Considerations

The staff's evaluation considered the information submitted to the Commission by the licensee, past operating history recorded in annual reports, reports by the Commission's Region IV Office, and on-site observations. The principal safety issues reviewed and conclusions reached for the UNM AGN-201M reactor follow.

(1) The design, testing, and performance of the reactor structure and systems and components important to safety during normal operation are inherently safe, and safe operation can reasonably be expected to continue.

(2) The expected consequences of a broad spectrum of postulated credible accidents have been considered. The staff performed conservative analyses of the most serious credible accidents and determined that the calculated potential radiation doses outside the reactor room would not exceed 10 CFR 20 limits for unrestricted areas.

(3) The licensee's management organization, conduct of training and research activities, and security measures are adequate to ensure safe operation of the facility and protection of special nuclear material.

(4) The systems provided for the control of radiological effluents can be operated to ensure that releases of radioactive wastes from the facility are within the limits of the Commission's regulations and are low as is reasonably achievable (ALARA).

(5) The licensee's Technical Specifications, which provide limits controlling operation of the facility, are such that there is a high degree of assurance that the facility will be operated safely and reliably.

(6) The financial data provided by the licensee are such that the staff has determined that the licensee has sufficient funds to cover operating costs and to eventually decommission the reactor facility.

(7) The licensee's program for providing for the physical protection of the facility and its special nuclear material complies with the requirements of 10 CFR 73.

(8) The licensee's procedures for training its reactor operators and the plan for operator requalification are acceptable. These procedures give reasonable assurance that the reactor facility will be operated competently.

(9) The licensee submitted an Emergency Plan dated March 11, 1985. The NRC approved the plan on June 11, 1985.

1.2 Reactor History and Description

The AGN-201 reactor, Serial No. 112, was transferred to the UNM from the University of California, Berkeley in August 1966. It was licensed for operation at UNM in September 1966. The reactor is housed in the Nuclear Engineering Laboratories Building on the campus of UNM.

The AGN-201M is a small research reactor, designed to operate at a power level of 5 watts, which has been widely used in experimental programs requiring a low neutron flux level ($2.5 \times 10^8 n/cm^2 sec$). The inherent design features of this reactor offer a high degree of nuclear safety, and the low power level precludes the buildup of large amounts of fission products.

The reactor core consists of a number of polyethylene disks impregnated with uranium dioxide which is <20 percent enriched in U-235. The critical mass is approximately 656 grams of U-235. Half of the polyethylene disks are supported by a thermal fuse mechanism cocked with a polystyrene plug of higher fuel density and located in a region of high flux. Melting of this plug will cause the two core halves to separate, reducing the core multiplication to below critical. The reactor is controlled by the manipulation of four control rods, all of which are fuel-bearing.

A graphite reflector and lead shielding surround the core. A gas tight core tank contains the core and part of the reflector. Additional barriers to the passage of radiolytic gas are provided by the steel reactor tank and the shield water tank which encircle the core, reflector, and lead shielding. A thermal column tank is located above the core and may be filled with water or graphite. Additional shielding is provided by a wall of concrete blocks surrounding the reactor. Figures 1.1 and 1.2 show the reactor design.

1.3 Design and Facility Modifications

In 1969 the AGN-201 reactor was moved from the old Nuclear Engineering Laboratory Building to the new Nuclear Engineering Laboratory Building on the University's campus. The maximum licensed power for the reactor was increased from 0.1 Wt to 5 Wt and the reactor was redesignated as an AGN-201M reactor. Modifications included building a shielding wall of concrete blocks around the reactor and upgrading the control instrumentation.

1.4 Operation

The UNM research reactor is used intermittently for student training and experiments. Total thermal power output since criticality in 1966 is approximately 3000 watt-hours.

1.5 Shared Facilities and Operation

The reactor facility, Co-60 irradiation facility, a graphite pile, and several other laboratories are housed in the Nuclear Engineering Laboratory Building. These are used for activities related to reactor operations, research, and education and training programs in the fields of nuclear engineering and radiological sciences. The reactor facility shares its utilities with the rest of the Nuclear Engineering Laboratory.

1.6 Comparison With Similar Facilities

The UNM AGN-201M research reactor was designed and built by Aerojet General Nucleonics as a standard teaching system. Currently, there are five other AGN-201 type reactors licensed by NRC. These all use the same fuel type (<20% U-235 enriched uranium dioxide (UO_2) powder embedded in radiation stabilized polyethlene) and have control and instrumentation systems similar in detail.

1.7 Nuclear Waste Policy Act of 1982

Section 302(b)(1)(B) of the Nuclear Waste Policy Act of 1982 provides that the NRC may require, as a precondition to issuing or renewing an operating license for a research or test reactor, that the licensee shall have entered into an agreement with the Department of Energy (DOE) for the disposal of high-level radioactive waste and spent nuclear fuel. DOE has informed the NRC by letter dated May 3, 1983, that it has determined that universities and other government

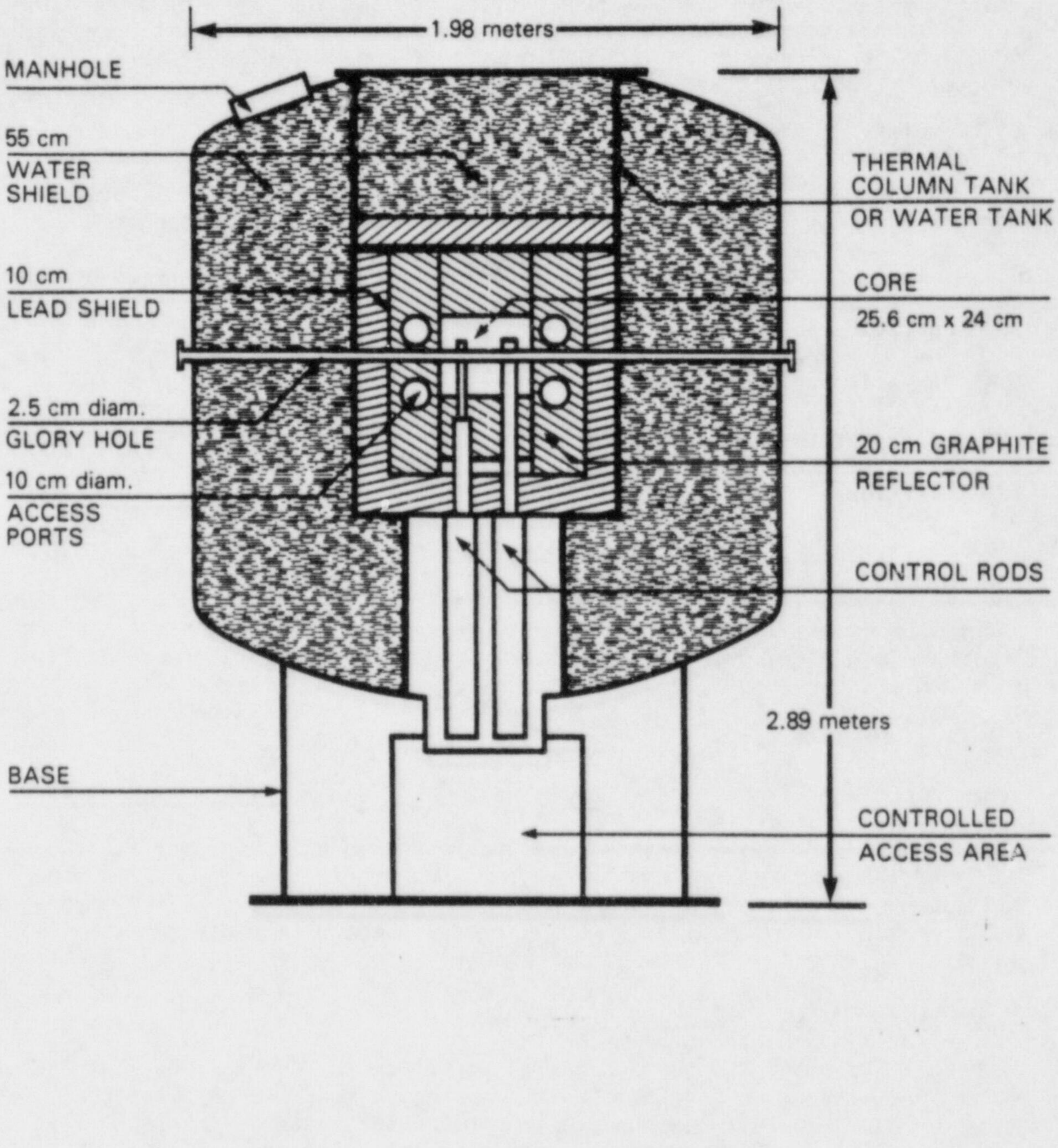

Figure 1.1 AGN-201M research reactor

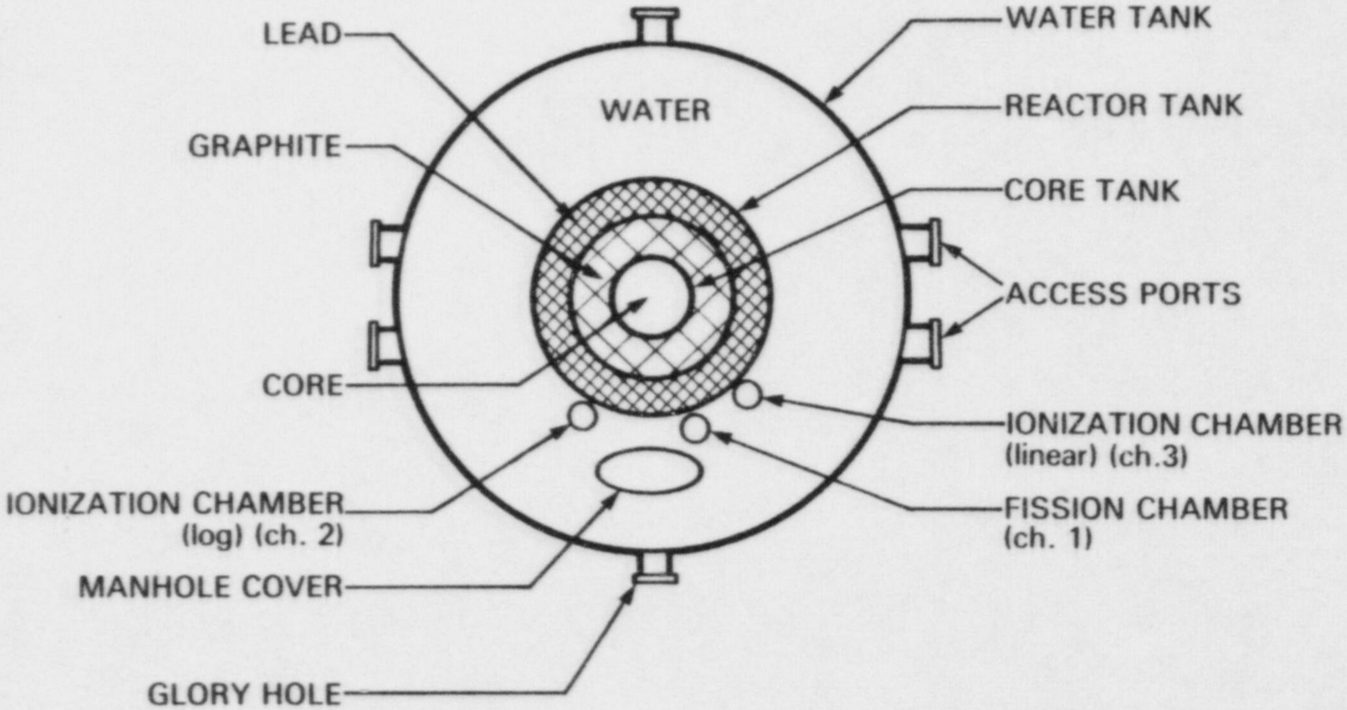

Figure 1.2 Schematic of the reactor (looking from above)

agencies operating nonpower reactors have entered into contracts with DOE that provide for DOE to retain title to the fuel and to be obligated to take the spent fuel and/or high level waste for storage and reprocessing. Thus UNM is in compliance with the Nuclear Waste Policy Act of 1982.

2 SITE CHARACTERISTICS

2.1 Reactor Site

The University of New Mexico is located in the city of Albuquerque, Bernalillo County, New Mexico. The reactor site is near the southwest corner of the central campus inside the city limits (see Figure 2.1). The surrounding land is used primarily for residential purposes to the west and south; the University is to the north and east. The Albuquerque metropolitan area is largely situated in the Rio Grande Valley and on the mesas and piedmont slopes that rise on either side of the valley floor. The Rio Grande flows from north to south approximately 3 miles west of the reactor. The Sandia and Manzano Mountains rise abruptly at Albuquerque's eastern edge with Tijeras Canyon separating the two ranges. West of the city the land gradually rises to the Continental Divide some 90 miles away.

2.2 Demography

The population of Albuquerque was 332,336 in the 1980 census; the UNM campus population consists of about 24,000 students and 4,000 staff, although not more than 14,000 people are on the campus at any one time. Based upon the 1980 census, there are about 1,600 permanent inhabitants within 1 mile of the reactor.

The closest residential areas are located about 0.25 mile from the reactor. Buildings closer than this are classrooms and laboratories, and commercial buildings which are usually occupied during normal school hours.

2.3 Nearby Industrial, Transportation, and Military Facilities

There is no heavy industry in the vicinity of UNM campus. The nearest airport, Albuquerque International Airport, is about 2 miles south of the campus. Kirtland Air Force Base and the Sandia Military Reservation are also located 2 to 3 miles south and southeast of campus. U.S. Interstate Highways 40 and 25 pass within a mile of the University on the north and west sides, respectively.

In view of the safe operating history of the past 20 years and the location of nearby transportation and military facilities, the staff concludes that these facilities pose no significant risk to the safe operation of the UNM research reactor.

2.4 Meteorology

The climate of Albuquerque is best described as arid continental with abundant sunshine, low humidity, scant precipitation, and a mild seasonal range of temperatures. The average annual temperature is 55.8°F (1955-1984) and the average annual precipitation is 8.35 inches including 10.7 inches of snowfall. Most of this precipitation falls July through September during evening thunder showers. Winds are generally from the SE direction in the summer and N/NW direction in the winter with 80 percent occurring at speeds less than 12 mph and only 3 percent greater than 25 mph.

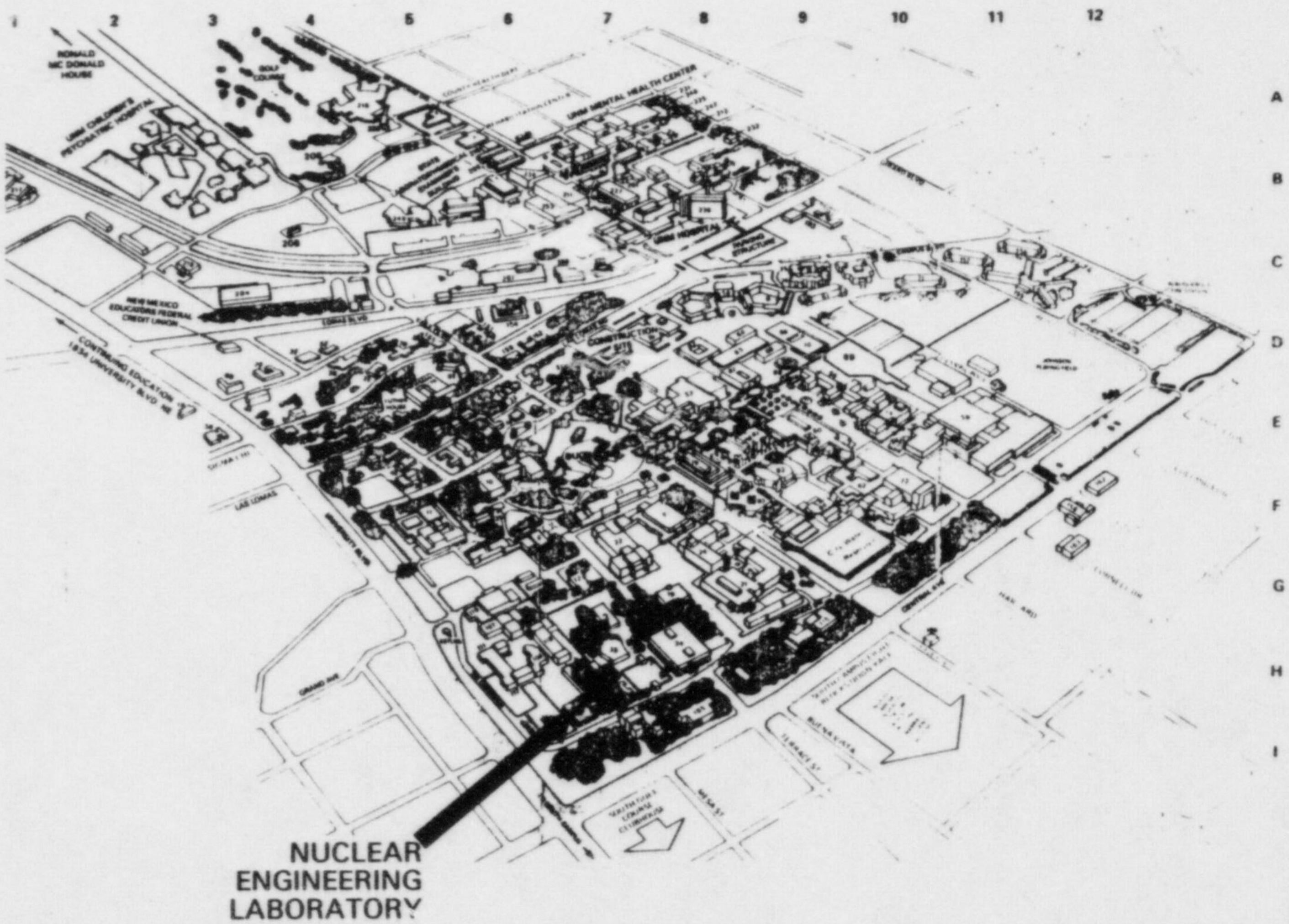

Figure 2.1 University of New Mexico central and north campus

Because the facility produces negligible gaseous effluents, the temperature inversions in the area present no radiological hazard to the public from the facility.

2.5 Geology and Hydrology

The University of New Mexico and Albuquerque, New Mexico are situated in the Rio Grande Rift Valley. This structural depression is bordered on the east by the Sandia Uplift and the Manzano Mountains and is bordered on the west by the Nacimiento Uplift.

The sloping surface of the rift valley fill from the base of the eastern border mountains to the Rio Grande River is referred to as the East Mesa. The University of New Mexico campus is on the East Mesa. The East Mesa is underlain by the Sante Fe group to a depth of over 5000 feet. The Santa Fe group consists of unconsolidated to loosely consolidated gravel, sand, silt, and clay with some interbedded volcanic rocks.

The Santa Fe group yields water of acceptable quality for most purposes. Most of the water has a specific conductance of less than 1000 micromhos. The water table slopes, and groundwater moves, southwestward from the Sandia-Manzano Mountain front and southeastward from the Rio Grande River toward a groundwater depression about 8 miles west of and roughly parallel to the Rio Grande.

The groundwater reservoir in the area is recharged from precipitation, from perennial and ephemeral streams, from irrigation systems, and from water applied to the land. Considerable recharge occurs near the top of alluvial fans near the mouths of many canyons in the Sandia and Manzano Mountains.

2.6 Seismology

The Rio Grande Rift and related structures tend to be sites of most of the earthquakes in New Mexico. In the region around Albuquerque there is a zone of concentrated epicenters on the Nacimiento Uplift about 80 kilometers northwest of Albuquerque. The largest historic earthquake in the Albuqerque area occurred January 4, 1971. It had a magnitude of 4.7 and a maximum Modified Mercalli intensity of VI. The U.S. Geological Survey description of this event states: "Cracked and fallen plaster, one old adobe building sustained both interior and exterior cracks, merchandise fell in markets, dishes broke, University of New Mexico had shelf damage and thousands of books fell." Even if an earthquake of this size were to occur near the site, damage would be negligible in buildings of good design and construction and slight in well-built ordinary structures.

2.7 Conclusion

On the basis of the above considerations for both natural and man-made hazards, the staff concludes that there is no significant risk associated with the site that would make it unacceptable for the continued operation of the reactor.

3 DAMAGE FROM NATURAL OCCURRENCES

3.1 Reactor Facility Description

The Nuclear Engineering Laboratory building is a one-story concrete structure with 6 feet of earth between 1-foot-thick concrete walls on the south and west sides. The north and east walls are poured concrete approximately 1 foot thick. A floor plan is shown in Figure 3.1. The roof of the building over the laboratory is 3 feet of earth between 5-inch-thick concrete slabs to provide additional shielding for the Co-60 facility located in the laboratory.

The Reactor Laboratory is located in the southeast corner of the Nuclear Engineering Laboratory building. In addition to having 6 feet of earth between 1-foot-thick concrete slabs, the south wall of the Reactor Laboratory is entirely below grade level. The east wall is essentially below grade level because of the exterior concrete stairs which go from the floor elevation up to the street level.

3.2 Wind Damage

Meteorological data from the Albuquerque area indicate a relatively low frequency of wind speeds in excess of 25 mph and an extremely low occurrence of tornadoes. The Nuclear Engineering Laboratory building's walls and roof are made of several feet of earth located between concrete slabs. Because of the building construction and the low frequency of high velocity winds, it is unlikely that wind damage to the reactor facility would occur.

3.3 Water Damage

The dry climate of the area, coupled with the natural drainage and storm sewers at the reactor site, have effectively prevented flooding at the reactor site since initial licensing. Therefore, it appears that water damage to the reactor by flood or groundwater is unlikely.

3.4 Seismic-Induced Reactor Damage

Seismology of the region is discussed in Section 2.6 of this report. In the event of an earthquake causing catastrophic damage to the reactor building, the reactor could be damaged and a small fraction of the fission product inventory might be released (see Section 4 for a discussion of reactor design). However, because of the low intensities of seismic events, design of the reactor, and low fission product inventory, the risk to the public resulting from any seismic-induced damage to the reactor facility would not be significant.

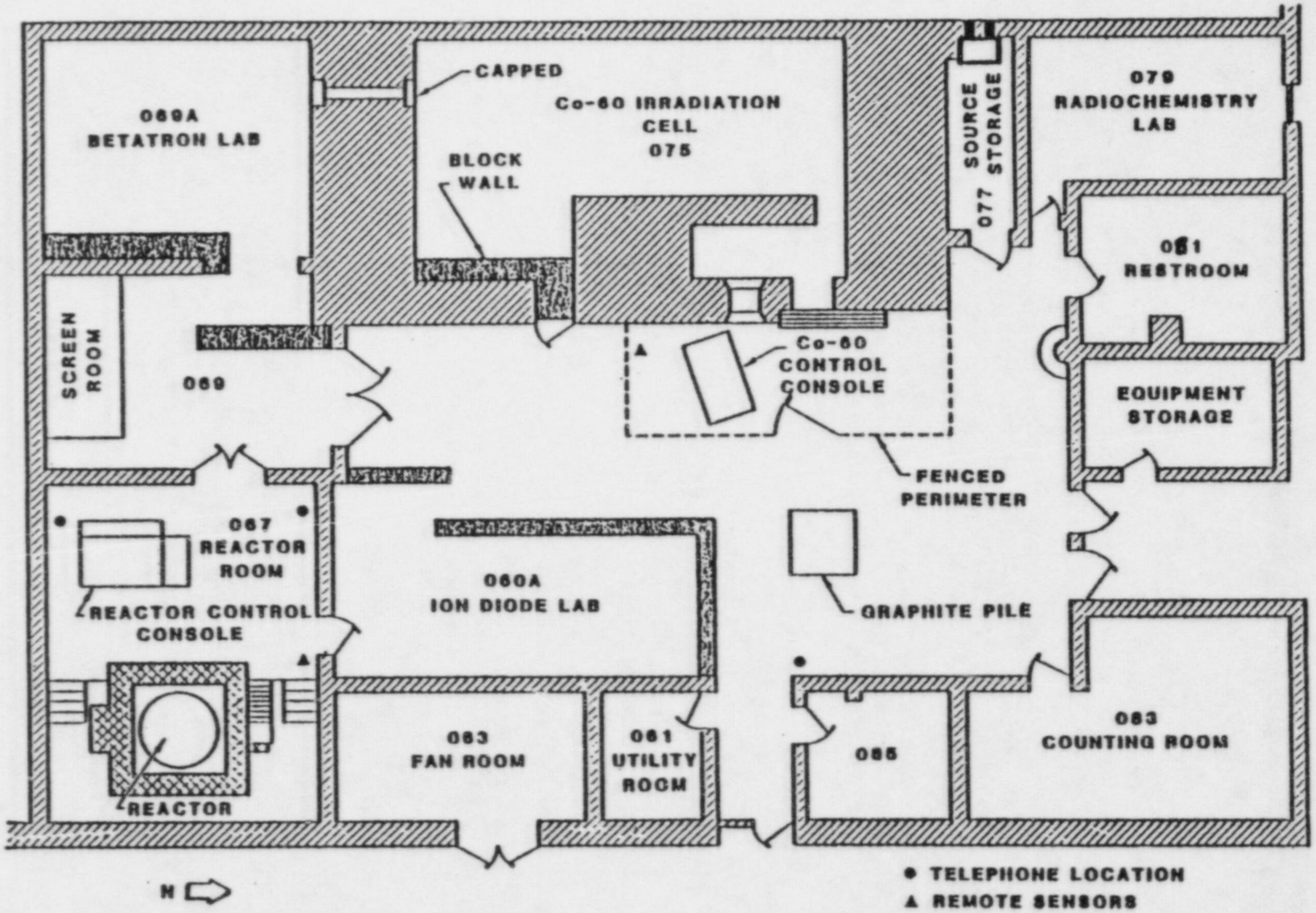

Figure 3.1 Nuclear Engineering Laboratory floor plan

3.5 Conclusion

On the basis of the above considerations, the staff concludes that the UNM reactor facility was designed and built to adequately withstand all credible and likely wind, water, and seismic damage associated with the site is adequate to provide reasonable assurance is that continued operation will not cause significant radiological risk to the health and safety of the public.

4 REACTOR

The reactor is a small homogenous thermal reactor (AGN-201M) manufactured by Aerojet General Nucleonics and is regularly used for operations training and student laboratory experiments at thermal power levels of 5 Wt or less. The reactor is comprised of an enriched UO_2 core, polyethylene moderator, graphite reflector, lead and water shielding, and safety and control rods, all located inside a stainless steel tank. The reactor power is controlled by inserting and withdrawing control rods that contain enriched uranium. An overall view of the reactor is given in Figures 1.1 and 1.2 and the principal design parameters are listed in Table 4.1.

4.1 Reactor Core

The cylindrical reactor core (Figure 4.1), which is 25.6 cm in diameter by 24 cm high, consists of nine separate polyethylene disks that contain particles of UO_2 enriched to <20 percent U-235. The core is contained in a gas-tight aluminum cylindrical tank (32.2 cm diameter and 76 cm high). A 2.54 cm diameter tube (glory hole) passes through the center of the core to allow experimental access. The total fuel loading is 667 g of U-235. A basic safety design feature of the reactor core is the core polystyrene fuse which supports the bottom three fuel disks of the core. The fuse contains a fuel density twice that of the fuel disks so that during operation, more fission heat is generated in the fuse than in the remainder of the core. Thus, any reactivity transient would heat the fuse twice as fast as the core. Should the temperature of the fuse reach 120°C, the polystyrene fuse will melt, allowing the three bottom disks to separate from the remaining disks and thus neutronically shut down the reactor.

4.2 Moderator

Neutron moderation is achieved by the polyethylene in which the UO_2 is homogeneously dispersed. This moderator material is a radiation-stabilized polyethylene that has a lifetime of 100 watt-years. Because this reactor does not operate above 5 Wt or on a continuous basis, the actual core life is expected to significantly exceed the duration of the license.

4.3 Reflector and Shielding

4.3.1 Reflector

As shown in Figure 4.1, the reflector consists of graphite surrounding the core. It is 20 cm thick with a density of 1.75 g/cm^3. A portion of the graphite is in the aluminum core tank and the remainder is outside. For experimental purposes there are four access holes, 10 cm in diameter, that pass through the graphite to the exterior of the water tank.

Table 4.1 Principal design parameters

Parameter	Description
Reactor type	AGN-201M
Maximum licensed power level	5 Wt
Fuel element design:	
Fuel-moderator material	UO_2-polyethelyene
Uranium content	6 wt%
Uranium enrichment	<20% U-235
Shape	Disk
Thickness of fuel	Varying from 1 to 4 cm
Diameter of fuel	25.6 cm
Number of fuel disks	9
Source type	2 Ci PuBe
Excess reactivity:	
maximum	0.65% $\Delta k/k$
with no experiments in the reactor	0.25% $\Delta k/k$
Control rods:	
Coarse control rod	1
Fine control rod	1
Safety rods	2
Total reactivity worth of rods	4% $\Delta k/k$
Reactor cooling	Natural convection of tank water
β effective	0.0075

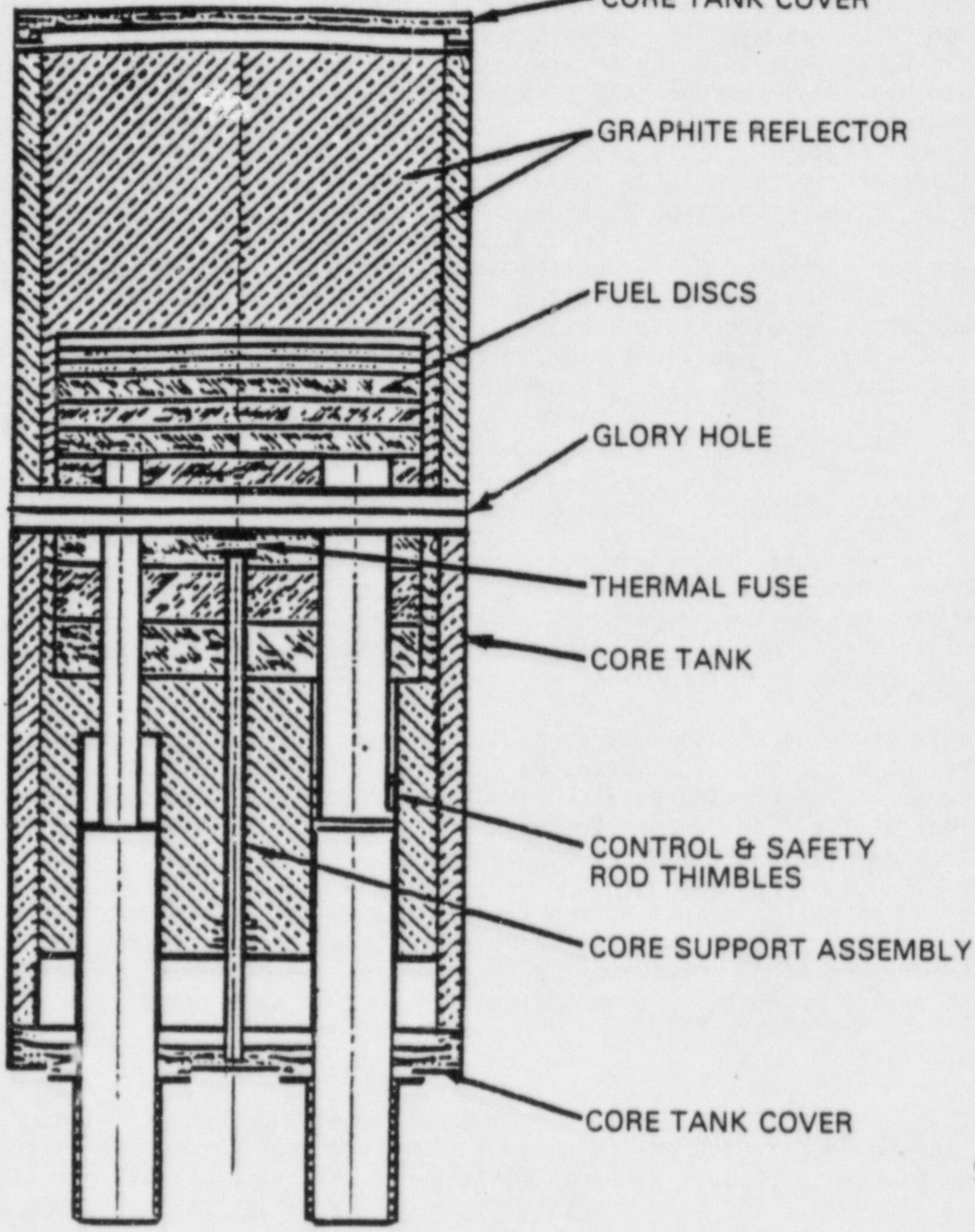

Figure 4.1 AGN-201M core tank and contents

4.3.2 Shielding

The shielding of radiation from the reactor core is accomplished by three materials: lead, water, and concrete. The graphite reflector is surrounded by a 10-cm-thick lead shield. The lead shielding, graphite reflector, and core are enclosed and supported by a thick steel reactor tank (47.5 cm radius). The stainless steel reactor tank (Figure 1.2) acts as secondary containment for the core tank and is fluid tight. The removable thermal column tank located above the core (Figure 1.1) is provided to permit access to the core tank. The thermal column tank is normally filled with water to provide biological shielding, but can be filled with graphite if a thermal column is desired.

The water tank provides effective neutron shielding during reactor operation and is the third and outermost of the fluid tight containers. It is 198 cm in diameter, made of stainless steel, and holds 3785 L of water to form the fast neutron shield. The front side of the water tank, which is in the direction of the control console, has a 60-cm-thick concrete shield, while the other sides have shielding of 40-cm-thickness. There is no concrete shielding on the top of the water tank.

4.4 <u>Control Rods</u>

The reactor uses two safety rods, one coarse control rod, and one fine control rod to control reactivity during the conduct of reactor operations. Criticality can only be achieved with addition of the fuel contained in the safety and control rods. Reactivity increases as these rods are inserted because they contain UO_2 dispersed in polyethylene.

The safety rods and the coarse control rod are individually magnetically coupled to a carriage and compress a spring as they are driven into the core. Thus, the removal of the electromagnet current deactivates the magnets and results in withdrawal of the rods by gravity, with an assist from the compressed springs. Figure 4.2 shows the control rod mechanism.

A scram signal de-energizes the magnets on the safety and coarse control rods so that they fall by gravity, assisted by their compressed springs, to a full-out safe position. However, the fine control rod must must be driven out of the reactor because it is mechanically connected to its carriage.

4.4.1 Safety Rods

Each of the two safety rods is 5 cm in diameter and contains 14.5 g of U-235 dispersed in polyethylene, with an active length of 15 cm. The active fuel is doubly encapsulated in aluminum containers, which isolates the fuel in the rods from the core. The total travel length of the safety rods is 24 cm and the full-length insertion time is 40 to 50 s. The scram removal time is approximately 200 ms for full removal of the rods. The reactivity worth of each rod is 1.25% $\Delta k/k$.

4.4.2 Coarse Control Rod

The coarse control rod is 5 cm in diameter and has a 24 cm travel length. The active length is 15 cm and the rod can be inserted at high ($\sim$1/2 cm/s) or low

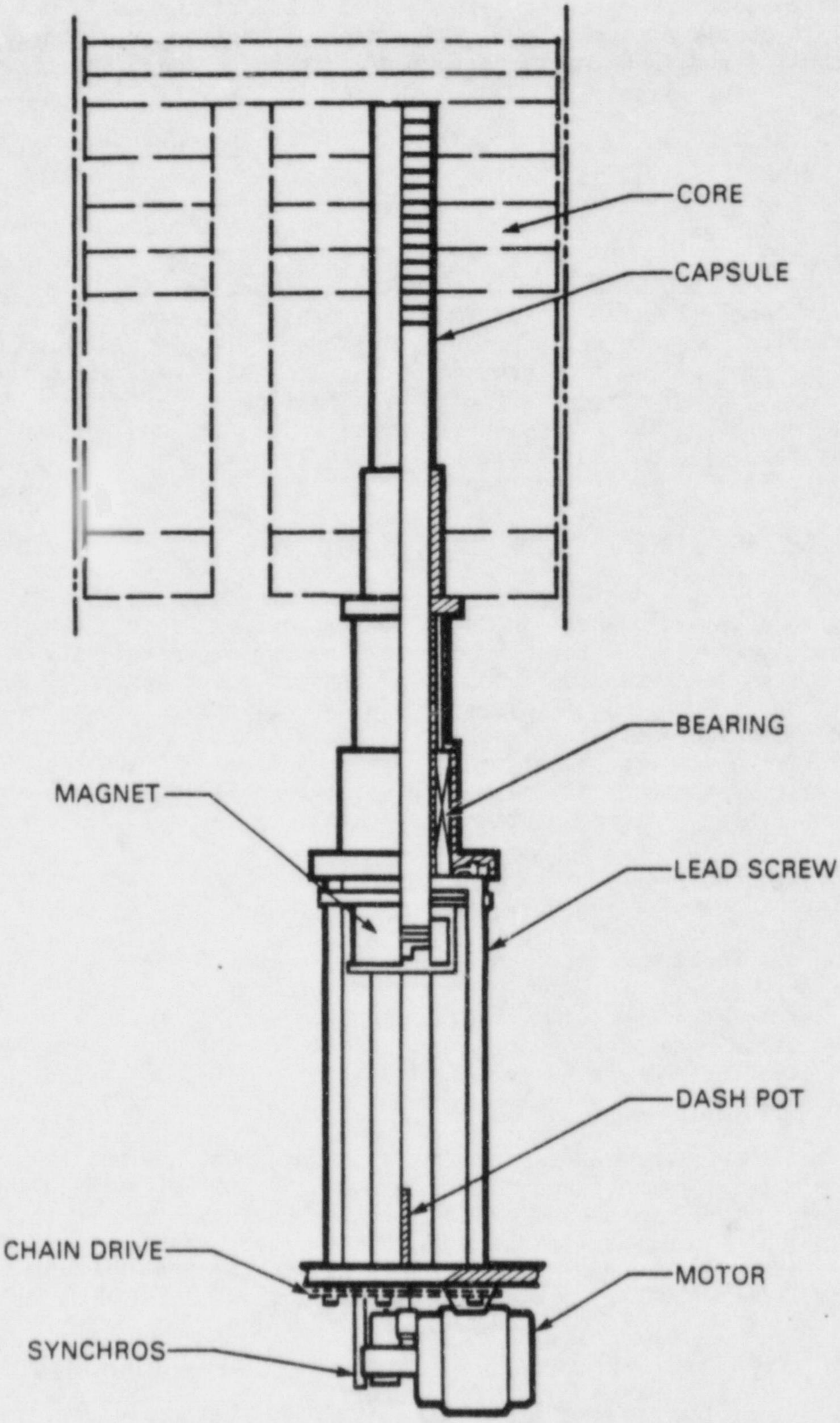

Figure 4.2 Control rod

($\sim$1/4 cm/s) speed. The rod contains 14.5 g U-235 dispersed in polyethylene and the fuel is doubly encapsulated in aluminum. Insertion or withdrawal of the coarse control rod is normally performed at the high speed and takes 40 to 50 s. Scram time is approximately 200 ms. The reactivity worth is 1.25% $\Delta k/k$.

The rod carriages are mechanically driven to full-out position following a reactor scram.

4.4.3 Fine Control Rod

The fine control rod is 2.5 cm in diameter and contains 2.71 g of U-235 dispersed in polyethylene. The rod fuel is doubly encapsulated and mechanically coupled to the carriage and can be inserted a distance of 24 cm at high or low speed. Normal operation of the fine control rod is at high speed, which results in an insertion/withdrawal time of 40 to 50 s. The slow insertion rate (1/4 cm/s) is one-half the fast insertion rate (1/2 cm/s). The fine control rod cannot magnetically decouple, but is driven out at the fast withdrawal rate upon a scram. Total reactivity worth of the fine control rod is 0.25% $\Delta k/k$.

4.5 Physics and Reactivity Control

The operation of the AGN-201M is accomplished by manipulating control rods in response to observed changes in measured reactor parameters such as neutron flux (reactor power). Interlocks prevent inadvertent reactivity additions and a scram system initiates rapid, automatic shutdown when trip set points are reached. Because the UO_2 is dispersed in the polyethylene, the reactor exhibits a strong negative reactivity feedback (temperature coefficient of reactivity is $-2.5 \times 10^{-4}/^{\circ}C$) as a result of rapid core expansion. This inherent nuclear control feature enhances stability and safety and is effective even if control rods or the safety instrumentation should fail to perform their intended functions.

4.5.1 Excess Reactivity and Shutdown Margin

The Technical Specifications limit the maximum excess reactivity of the reactor to 0.65% $\Delta k/k$ and excess reactivity with no experiments in the reactor and the control and safety rods fully inserted to 0.25% $\Delta k/k$. These limits are well below the value necessary to go prompt critical. The shutdown margin with the most reactive control rod fully inserted is at least 1% $\Delta k/k$ and the reactivity addition rate for each control rod cannot exceed 0.065% $\Delta k/k/s$.

The limitations on core excess reactivity ensure that the reactor would not go prompt critical and the reactor periods would be sufficiently long so that the reactor protection system and/or the operator would be able to shut the reactor down before any safety limit could be reached. The shutdown margin and control rod reactivity limitations ensure subcriticality, even if the rod of highest reactivity worth fails to scram and remains in the reactor.

4.5.2 Conclusion

On the basis of the information given above, the staff concludes that the limitations on total core excess reactivity and reactivity insertion rates ensure reactor periods of sufficient magnitude that the reactor protection system will be able to shut the reactor down before any significant core temperature would be reached. In addition to the electromechanical safety controls for normal and off-normal operation, the negative temperature coefficient provides an inherent backup safety feature.

In accordance with the above and the details presented in Section 7, the staff concludes that the reactivity control systems of the AGN-201M are designed to function adequately to ensure safe operation and safe shutdown of the reactor under all likely conditions.

4.6 Operating Procedures

The University of New Mexico has implemented a preventive maintenance program that is supplemented by a detailed preoperational checklist to ensure that the reactor is not operated at power unless the appropriate safety-related components are operable. The reactor is operated by NRC-licensed personnel in accordance with explicit operating procedures prepared by the Reactor Operations Committee. These procedures include specified responses to any reactor control signal. Before installation into the reactor, all proposed experiments are reviewed by the Reactor Safeguards Advisory Committee for potential effects on the reactivity of the core, damage to the reactor, and possible effects on the health and safety of the staff, students, and the general public.

4.7 Conclusion

The staff review of the University of New Mexico AGN-201M has included the study of its specific design and installation, controls and safety instrumentation, and operational limitations as identified in its Technical Specifications. On the basis of its review, the staff concludes that the AGN-201M is designed and operated to good industrial practices and there is reasonable assurance that the reactor is capable of continued safe operation as limited by its Technical Specifications.

5 REACTOR COOLANT AND ASSOCIATED SYSTEMS

The AGN-201M reactor operates at very low power for short periods of time and, for this reason, does not require an active coolant system. However, the reactor core is inside a steel cylindrical tank 1.98 m in diameter which contains 3785 L of water (for fast neutron shielding) and any heat rejection is accomplished by natural convection. When the reactor is operated under maximum conditions at 5 Wt, the bulk tank temperature will rise a negligible amount before achieving thermal equilibrium.

The staff concludes that the design of the coolant system level ensures adequate cooling capability for the AGN-201M when operated within its licensed power limits and for its fission products' decay heat.

6 ENGINEERED SAFETY FEATURES

Engineered safety features (ESFs) are systems provided to mitigate the radiological consequences of design-basis accidents. Because the University of New Mexico reactor operates at a maximum power level of 5 Wt, the fission product inventory is very low. In addition, the analyses of accidents in Section 14, including the maximum hypothetical accident, indicate that there will be no significant radiological releases. Therefore, no ESF systems are required or provided at the UNM facility.

The staff concludes that the operation of the UNM research reactor without any ESF systems does not pose a radiological hazard to the public or to the environment in the event of an accident.

7 CONTROL AND INSTRUMENTATION SYSTEMS

7.1 Systems Summary

The nuclear control and instrumentation systems for the AGN-201M reactor are similar to those generally used in other U.S. research reactors of a similar size. Control of the nuclear fission process is achieved by using coarse and fine control rods and two safety rods. The control and instrumentation systems are interlocked to provide automatic and manual scram capability in case of reactor malfunction and to provide the means for operating the various components of the reactor in a manner consistent with design objectives. The scram-producing safety instrumentation functions and set points are shown in Table 7.1. The licensee's Technical Specifications require that the reactor safety channels shall be operable in accordance with Table 7.1 whenever the reactor control or safety rods are not in their fully withdrawn position.

Table 7.1 Scram-producing safety channels

Device	Function	Set points
Nuclear Safety Channel 2	Low power High power Short reactor period	1 x 10^{-13} amp 6 Wt 5 s period
Nuclear Safety Channel 3	Low power High power	5% of operating range 6 Wt
Reactor tank water level interlock	Protect shielding capability	17.8 cm below reactor tank top
Pool water temperature interlock	Limit reactivity addition	18°C or less
Seismic displacement interlock	Seismic protection	Horizontal amplitude >0.159 cm
Console electricity loss	Normal shutdown	Loss of electric power
Manual scram	Normal shutdown	Scram on operator decision

7.2 Nuclear Control System

The nuclear control system is composed of the nuclear equipment designed for operation in case of failure or malfunction of components essential to the safe operation of the reactor. A detailed description of the nuclear control system that consists of the safety rods, fine and coarse control rods, and their associated drive mechanisms is presented in Section 4.

The safety rods and the coarse control rod are interlocked so that (a) only one safety rod can be inserted at a time, (b) the coarse control rod cannot be inserted unless both safety rods are fully inserted, and (c) reactor startup cannot commence unless both safety rods and the coarse control rod are fully withdrawn from the core.

The rods are controlled by manual holddown (spring-return) switches located on the control console. The positions of the control rods are indicated to the nearest 0.01 cm on the console. The location, at either their upper or lower position, of the magnets which are located in the rods is indicated by an appropriate light on the control console. Contact between the magnets and their associated actuator rods also is indicated by control console lights.

7.3 Instrumentation System

The instrumentation system is composed of nuclear and process instrumentation circuits.

7.3.1 Nuclear Instrumentation

The instrumentation discussed below provides the operator with the necessary information to properly manipulate the nuclear controls.

The source-range channel (Nuclear Safety Channel 1) uses a gas-filled U-235 fission chamber to monitor reactor startups. The high voltage on the chamber is automatically switched off when the signal from Nuclear Safety Channel 2 exceeds 10^{-9} amps.

The log power and period channel (Nuclear Safety Channel 2) comprises a compensated ion chamber, power supply, logarithmic picoammeter, recorder, period signal, and scram. This channel covers the power range from source level to full power and will produce a scram if the power level is greater than 6 Wt. This channel also will cause a scram if the reactor period is less than 5 s.

The linear power channel (Nuclear Safety Channel 3) comprises a compensated ion chamber, a power supply, a linear picoammeter with a range switch, a recorder, and a meter. This channel has scrams at 5 percent of the operating range (as well as 120% of the licensed full power).

Both compensated ion chambers are located in watertight cans submerged in a water tank above and to the side of the core. The appropriate controls and meters and recorders are located on the control console. A manual scram (operator-controlled) also is located on the control console.

7.3.2 Process Instrumentation

The instrumentation discussed below senses and monitors non-nuclear parameters and provides, as appropriate, startup prohibits or scrams.

The pool water level monitor consists of a float switch and the associated circuit. This monitor provides an audio and visual alarm at the control console and initiates a scram if the pool water level drops to 17.8 cm below the reactor tank top.

The tank water temperature monitor consists of a resistance bulb thermometer that senses the bulk tank temperature. Temperature indication is provided on the control console. A startup prohibit or scram is initiated if the bulk pool temperature falls below 18°C.

Loss of ac power to the console will scram the reactor automatically by removing power from the rod-holding magnets allowing springs and gravity to push the safety and coarse control rods out of the core.

7.4 Conclusions

On the basis of a review of drawings, reports, and a site visit, the staff concludes that the control and instrumentation system at the UNM research reactor facility is well designed and maintained. Redundancy in the crucial areas of power measurements is ensured by overlapping ranges of the log power and linear power channels. The control system is designed so that the reactor shuts down automatically if electric power is lost. In addition, the procedures for reactor room, tank water, and personnel are adequate for the proposed reactor operating conditions. Therefore, the staff concludes that the nuclear and process instrumentation are adequate to ensure the safe operation of the facility.

8 ELECTRIC POWER

8.1 Offsite Power

The electric power requirements for the UNM AGN-201M reactor during operation are supplied by the Public Service Company of New Mexico, which services the University. The reactor facility requires 110-V ac power.

Electric power is supplied to the plug molds in the reactor room via a circuit breaker located in the main distribution panel located inside the Nuclear Engineering Laboratory Building at the east door. The reactor console is hard-wired into the south plug mold. The plug mold has a circuit breaker located on one end that will remove power for that plug mold and in turn remove power from the reactor panel.

8.2 Emergency Power

No emergency power is provided for the UNM AGN-201M reactor operation. In the event of electric power failure, the control system is designed to be fail-safe and scram the reactor. In addition to this feature, an emergency light powered by batteries is installed in the console and operates automatically if the power is cut off. Hand-held battery-powered radiation monitors are available at the console.

8.3 Conclusion

The electric power system at the UNM is a standard electrical supply system designed and constructed to specifications similar to those at other low-power research reactor facilities. This, coupled with the fact that the reactor will scram in the event of a power failure, supports the staff's conclusion that the electric power system is acceptable for continued safe operation of the UNM AGN-201M research reactor.

9 AUXILIARY SYSTEMS

9.1 Fuel-Handling and Storage Systems

Periodic fuel replacement for the AGN-201M is unnecessary because of the extremely low reactor power (5 Wt). The fuel is normally in a sealed core tank except for one laboratory experiment (approach to critical). During that experiment, a clean area is set up on the reactor top and the tank is vented and pressure equalized by drawing an air sample through a cloth and charcoal filter. Another clean area is set up to receive the top five fuel disks when they are removed from the core tank and placed on the reactor room bench. This experiment is done under supervision of the UNM Radiological Safety Officer. Protective clothing is worn while handling fuel.

The only other fuel for the reactor is an additional fuel disk, which is kept in a source storage room with a $k_{eff} < 0.9$.

9.2 Fire Protection System

The components of the AGN-201M reactor are basically nonflammable, as is the building in which the reactor is located; in the event of fire, no special precautions would be required. A carbon dioxide fire extinguisher is located in the reactor room. In case of a fire, the reactor would be shut down and locked and the Chief Reactor Supervisor or his alternate would be notified. Existing fire procedures are expected to eliminate accumulation of flammable material in the building to reduce the probability of a fire.

9.3 Communications System

The reactor room is serviced by the University's phone system, which allows communication to and from outside sources.

9.4 Ventilation System

The ventilation system is composed of an air handling system designed for the Nuclear Engineering Laboratory. The system is designed to provide a negative pressure in the building so that all exit air passes through a set of high-efficiency particulate air filters and out the ventilation stack located on the roof. Outside air is supplied through intake filters to all rooms in the Nuclear Engineering Laboratory, and a relief blower takes suction on all the rooms and transfers the air to the stack.

There is a 100% exchange of air (no recirculation). The relief fan is set to move slightly more air than the supply fan to give the negative pressure in the building. In an emergency, motorized louvers can be opened to the laboratory to increase the amount of air being exhausted. The switches for the exhaust fans are located near the east entrance to allow the laboratory to have control of the fans.

9.5 Conclusion

The staff concludes that the auxiliary systems at the UNM reactor facility are designed and maintained adequately and are capable of performing their intended functions to ensure the safe operation of the facility.

10 EXPERIMENTAL PROGRAMS AND FACILITIES

10.1 Experimental Programs and Reviews

The University of New Mexico AGN-201M research reactor provides support to the nuclear engineering undergraduate and graduate programs. Various experimental programs of the staff and students involve use of the reactor. Most of the experimental work involves activation of various materials and their subsequent analyses. These irradiated materials may be foils or small samples used to evaluate reactor parameters or material composition (neutron activation analysis), or used as tracers in various studies. Materials activated in the reactor are short half-life nuclides. These materials are surveyed for activity and contamination before use in the laboratory.

All proposed experiments are reviewed by the University's Radiological Safety Officer (RSO) and Reactor Safeguards Advisory Committee. These reviews are performed to:

(1) ensure that accidents causing changes in composition and geometry of the experiments will not cause positive changes, or ramps, in reactivity that might place the reactor on unsafe periods,

(2) provide assurance of mechanical integrity, chemical compatibility, and adequate protection against any other potential hazard,

(3) ensure any experiments containing materials corrosive to reactor components or which contain liquid or gaseous fissionable material are doubly encapsulated,

(4) provide assurance that in the event of an accident, the postulated complete release of all gaseous, particulate, or volatile components from the experiment will not result in doses which exceed 10 CFR 20 limits,

(5) ensure that explosive materials are not used.

10.2 Experimental Facilities

The horizontal glory hole has diameter of 2.54 cm and goes through the reactor core. Samples may be placed in the glory hole at varying positions in the core and reflector. Samples also may be placed in the access ports that pass through the graphite to the outside of the core.

10.3 Conclusion

The staff concludes that the design of the experimental facilities, the limitations for experiments delineated in the Technical Specifications, and the safety review process ensure proper and safe experimental programs.

11 RADIOACTIVE WASTE MANAGEMENT

11.1 Waste Generation and Management

There has been negligible generation or release of radioactive waste (airborne, solid, or liquid) because of the low power level and limited operating schedule of the University of New Mexico AGN-201M research reactor.

Materials activated in the glory hole or access ports are short half-life nuclides for student laboratory use. Activated samples are surveyed for activity and contamination before use in the laboratory. Records of radionuclides produced are documented in the reactor log book.

Transfers of radioactive materials to other licensees are rare and conducted in accordance with appropriate State and Federal regulations. All radionuclides to be removed from the reactor facility are transferred using the UNM radiation permit issued by the New Mexico Environmental Improvement Division. All such material is then handled in accordance with University guidelines.

11.2 Conclusions

The staff has reviewed the operational history of the UNM AGN-201M and concludes that any airborne radioactivity released from operating the reactor at 5 Wt will be insignificant. The staff also concludes that the waste management activities of the UNM have been and are expected to continue to be conducted consistent with 10 CFR 20 and ALARA (as low as is reasonably achievable) principles.

12 RADIATION PROTECTION PROGRAM

The University of New Mexico has developed a radiation protection program with adequate staff and monitoring equipment to ensure detection, control, and documentation of occupational exposure.

Health physics for the AGN-201M reactor is provided by the UNM Radiological Safety Office, which consists of several senior health physicists plus technicians and the appropriate monitoring instrumentation. The radiation monitoring instrumentation is calibrated on a regular basis to ensure that accurate readings are taken during the periodic radiation surveys conducted by the Radiological Safety Office.

12.1 ALARA Commitment

The President of the University of New Mexico has instructed the Reactor Operations Committee to formally establish a policy that operations are to be conducted in a manner to keep all radiation exposures ALARA. All proposed experiments and procedures at the reactor are reviewed for ways to minimize the potential exposures of personnel. All unanticipated or unusual reactor-related exposures will be investigated by the Radiological Safety Office and the operations staff to develop methods to prevent recurrences.

12.2 Health Physics Program

Health physics activities at the reactor are performed by the Radiological Safety Office staff who are available for consultation in all matters concerning radiological safety. The Radiological Safety Office staff conducts radiation surveys of the reactor room on a monthly basis with at least two surveys per year performed while the reactor is in operation.

The staff believes that the radiation safety support is adequate for the research efforts within this facility.

12.2.1 Procedures

Written procedures have been prepared that address the radiation safety support that is provided to the operations of the AGN-201M research reactor. These procedures identify the interactions between the operational and experimental personnel. They also specify numerous administrative limits and action points, as well as appropriate responses and corrective actions if these limits or action points are reached or exceeded. Copies of these procedures are readily available to the operational and research staffs and administrative personnel.

12.2.2 Instrumentation

The University of New Mexico has a variety of detecting and measuring instruments available for monitoring potentially hazardous ionizing radiation. The instrument calibration procedures and techniques ensure that radiation of any significant magnitude will be detected promptly and measured correctly.

Radiation monitoring instrumentation available to the reactor operator includes a console-mounted meter and portable survey meter. These and other such instruments available within the reactor laboratory are calibrated periodically by the Radiological Safety Office of the University. There are remote area monitors with automatic alarms installed to monitor the reactor room and the building exhaust stack.

12.2.3 Training

All reactor-related personnel are given an indoctrination in radiation safety before they assume their work responsibilities. Additional radiation safety instructions are provided to those who will be working directly with radiation or radioactive materials. The training program is designed to identify the particular hazards of each specific type of work to be undertaken and the methods to mitigate their consequences. Retraining in radiation safety also is provided. All reactor operators are given an examination on health physics practices and procedures at least once every 2 years. The level of retraining given is determined by the examination results. This radiation safety training appears to be appropriate for the facility.

12.3 Radiation Sources

12.3.1 Reactor

The only source of radiation directly related to reactor operations is the radiation from the reactor core. Operation at 5 Wt results in a very small fission product inventory that decays to a low level in a few days. The level in the polyethelyne is so low that a fuel disk can be handled without shielding 24 hours after shutdown. All of the fission products generated by reactor operation are contained in the polyethylene. Radiation exposure from the reactor core is reduced to acceptable levels by water, lead, and concrete shielding.

12.3.2 Extraneous Sources

Sources of radiation that may be considered as incidental to normal reactor operation, but associated with reactor use, are activated foils or samples. Personnel exposure to radiation from intentionally produced radioactive material, as well as from the required manipulation of activated experimental components, is controlled by rigidly developed and reviewed operating procedures that use the normal protective measures of time, distance, and shielding.

12.4 Routine Monitoring

12.4.1 Fixed-Position Monitor

The AGN-201M reactor room has one fixed-position radiation area monitor (RAM) on the reactor room wall. The monitor has an adjustable alarm set point and provides an audible alarm to the operators at the control console if the radiation level exceeds a 10 mR/h set point.

12.4.2 Experimental Support

The UNM Radiological Safety Officer participates in experiment planning by reviewing all proposed procedures for methods of minimizing personnel exposures and limiting the generation of radioactive waste. Approved procedures specify the type and degree of radiation safety support required by each activity. As an example, procedures require that changes in experiment configuration include radiation surveys by health physics personnel and that all items removed from the reactor room be surveyed.

12.5 Personnel Monitoring

The UNM personnel monitoring program is described in the Radiation Safety Manual. Personnel exposures are measured by the use of film badges assigned to individuals who might be exposed to radiation. Instrument dose rate and time measurements may be used to administratively keep occupational exposures of other personnel below the applicable limits in 10 CFR 20. Table 12.1 provides the latest annual summary of doses to UNM reactor-related personnel from all activities conducted in the Nuclear Engineering Laboratory.

Table 12.1 Number of individuals in exposure interval

Whole-body exposure range (rem)	Number of individuals in each range				
	1985	1984	1983	1982	1981
No measurable exposure	1	2	4	3	0
<0.10 rem	6	4	2	2	4
0.10 to 0.25 rem	0	0	0	0	1
0.25 to 0.50 rem	0	0	0	0	0
>0.5 rem	0	0	0	0	0
Number of reactor-related personnel monitored	7	6	6	5	5

12.6 Potential Dose Assessments

Natural background radiation levels in the Albuquerque area result in a dose of about 100 mrem/y to each individual residing there. At least an additional 8% (~8 mrem/y) will be received by those living in a brick or masonry structure. Any medical diagnosis X-ray examination will add to these natural background radiations, increasing the total cumulative annual dose of those individuals.

Exposures from potential airborne or liquid releases from the AGN-201M have been estimated by the staff and are considered to be negligible. Conservative estimates indicate radiation exposures from operation of the reactor at 5 Wt to individuals in both restricted and unrestricted areas are well below 10 CFR 20 limits.

12.7 Conclusions

The staff concludes that (a) the radiation protection program is staffed and equipped properly, (b) the reactor radiation safety-related staff has adequate lines of communication, (c) the procedures are integrated correctly into the research plans, and (d) surveys verify that operations and procedures achieve ALARA principles.

Additionally, the staff notes that throughout 20 years of operation, there have been no instances of reactor-related exposures of personnel above applicable guideline values and no identification of significant releases of radioactivity to the environment. There is reasonable assurance that the personnel and procedures will continue to protect the health and safety of the public during reactor operations for the renewal period.

13 CONDUCT OF OPERATIONS

13.1 Overall Organization

The University of New Mexico reactor facility organization, including the interrelationships between operating and supporting units, is indicated in Figure 13.1.

13.2 Training

The training of reactor operators is done by in-house personnel. The licensee's Operator Requalification Program has been reviewed, and the staff concludes that it meets the applicable regulations [10 CFR 50.54 (i-1) and Appendix A of 10 CFR 55] and is consistent with the guidance of ANS 15.4, 1977.

13.3 Operational Review and Audits

The Reactor Safeguards Advisory Committee provides independent review and audits of facility activities. The Technical Specifications outline the qualifications of members. The Reactor Safeguards Advisory Committee must review and approve plans for modifications to the reactor, new experiments, and proposed changes to the license or procedures. The Committee is also responsible for conducting audits of reactor facility operations and management and for reporting the results thereof to the University administration.

13.4 Emergency Planning

10 CFR 50.54(q) and (r) require that a licensee authorized to possess and/or operate a research reactor shall follow and maintain in effect an emergency plan that meets the requirements of Appendix E of 10 CFR 50. A revised emergency plan was submitted by the licensee and approved by the NRC on June 11, 1985.

13.5 Physical Security Plan

The UNM reactor facility has established and maintains a program to protect the reactor and its fuel and to ensure its security. The NRC staff has reviewed the Physical Security Plan and concludes that the plan meets the requirements of 10 CFR 50.34(c) and 73.40(a). The Physical Security Plan and the staff's evaluation are withheld from public disclosure under 10 CFR 2.790(d)(1).

13.6 Conclusion

On the basis of the above discussions, the staff concludes that the licensee has sufficient experience, management structure, and procedures to provide reasonable assurance that the UNM AGN-201M reactor will continue to be managed in a way that will cause no significant radiological risk to the health and safety of the public.

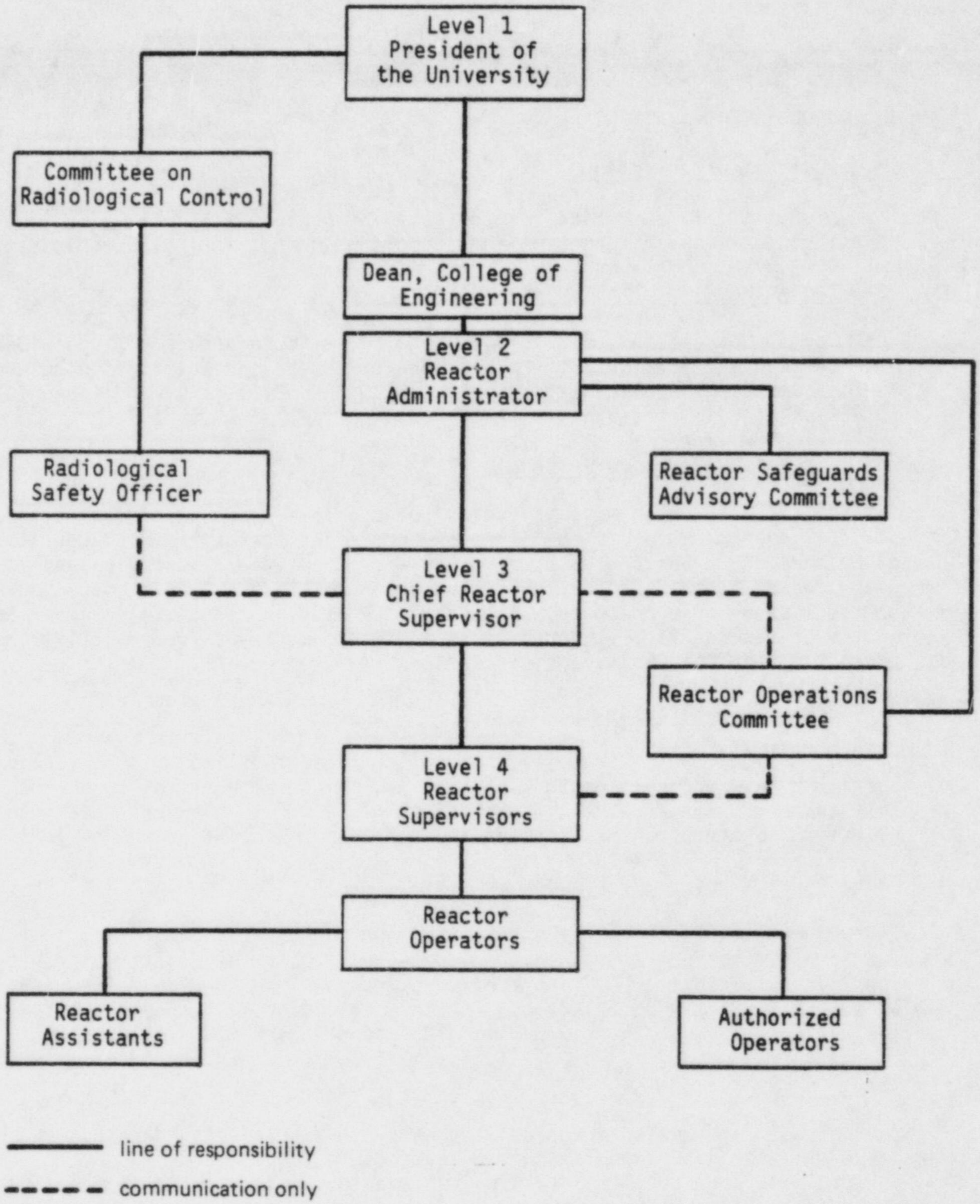

Figure 13.1 Administrative organization of the UNM AGN-201M reactor facility

14 ACCIDENT ANALYSIS

Two accidents are considered for the AGN-201M reactor. The first is the maximum hypothetical accident which places an upper bound on radiological consequences, and the second is an operator error which demonstrates adequate protection during normal and off-normal operation.

14.1 Maximum Hypothetical Accident

The maximum hypothetical accident (MHA) considered for the AGN-201M reactor is the insertion of fissionable material (U-235) into the reactor core via the glory hole. The consequences of the scenario are dependent on the amount of fissionable material inserted and the insertion speed. Argument is given in the applicant's documentation to justify that a 2 percent step increase in reactivity will easily encompass any possible fissionable material insertions because of the reactor's scram systems and inherent safety.

Three assumptions are used as a basis for calculating the power generated in the accident.

(1) At time zero, a 2 percent step increase in reactivity is inserted with the reactor at 5 Wt power.

(2) Also at time zero, the energy in the core is negligible compared with the energy liberated during the accident.

(3) No heat is removed from the core during the excursion.

During the MHA, the reactor would reach 75.0 MWt peak power and have a total energy release of 2.41 MJ in a time interval of approximately 150 ms. The resulting average temperature rise would be 100.7°C, and the temperature at the center of the core would rise to about 150°C. The total dose to a person standing next to the reactor during the MHA would be about 1 rem. The prediction that only the thermal fuse would melt is reasonable because the polyethylene surrounding the fuel does not melt below 200°C. The fission products would be contained within the core and primary and secondary containers. The small amount of gaseous fission products that would be released from the fuel in the fuse when it melted would be small.

The power excursion is self-limiting because of core expansion resulting from the temperature rise. The prompt expansion of the fuel elements causes a decrease in the density of the moderator, which increases the leakage of the neutrons out of the core. This excursion is strongly dependent on the magnitude of a negative temperature coefficient of reactivity.

The use of polyethylene fuel elements makes the reactor extremely safe. The inherent safety of these elements, even for reactor transient periods as low as 4 to 6 ms, is based primarily on the arrangement of the fuel within the moderator. The homogeneous dispersal of the fissile material in the polyethylene results in a negligible time delay in transferring the heat from the uranium dioxide particles to the surrounding plastic moderator. The prompt heating of the polyethylene increases the average thermal energy of the neutrons, which results in a decreased fission-to-capture probability for these neutrons. The net result of this prompt heat transfer is that the reactor shuts down safely.

14.2 Operator Error

In general, an operator error occurring during the normal operation of the reactor would be rectified before any unsafe condition could result. Interlocks ensure that the proper procedure is being followed by the operator during the startup of the reactor. Abnormal conditions caused by human error will automatically shut down the reactor. Additionally, scrams are initiated by the following events which could result from operator error:

(1) exceeding a maximum preset power level
(2) placing the reactor on a period which is less than 5 s
(3) lowering of the shielding water level to less than 17.8 cm
(4) loss of electrical power
(5) pressing the reset button
(6) reaching a minimum preset power level
(7) disconnecting the electrical cables to the safety and control rods
(8) not keeping reactor power within 5 and 95 percent of Channel 3 scale

14.3 Conclusions

On the basis of the licensee's documentation and the staff's independent assessment, the staff concludes that the maximum hypothetical accident will not melt the polyethylene surrounding the uranium fuel. Consequently, insignificant fission products would be released and the direct radiation would be a small fraction of 10 CFR 20 limits. Therefore, the postulated MHA poses no risk to the health and safety of the public or to the reactor personnel. In addition, the staff concludes any abnormal condition caused by operator error will be safely controlled by automatic protection systems and no risk to reactor personnel or the general public will occur.

15 TECHNICAL SPECIFICATIONS

The licensee's Technical Specifications have been evaluated in this licensing action. These Technical Specifications define certain features, characteristics, and conditions governing the operation of this facility and are explicitly included in the renewal license as Appendix A. Formats and contents of the Tecnnical Specifications have been reviewed using the ANSI/ANS 15.1-1982 standard, "The Development of Technical Specifications for Research Reactors," as a guide.

On the basis of its review, the staff finds the Technical Specifications to be acceptable and concludes that normal plant operation within the limits of the Technical Specifications will not result in offsite radiation exposures in excess of 10 CFR 20 limits. Furthermore, the limiting conditions for operation and surveillance requirements will limit the likelihood of malfunctions and mitigate the consequences to the public in regard to off-normal or accident events.

16 FINANCIAL QUALIFICATIONS

The reactor facility is operated by the University of New Mexico, a state-supported institution of higher education, in support of its assigned educational and research mission. Therefore, the staff concludes that funds will be made available, as necessary, to support continued operations and eventually to shut down the facility and maintain it in a condition that would constitute no risk to the public. The licensee's financial status was reviewed and found to be acceptable in accordance with the requirements of 10 CFR 50.33(f).

17 OTHER LICENSE CONSIDERATIONS

17.1 Prior Reactor Utilization

Previous sections of this SER concluded that normal operation of the reactor causes insignificant risk of radiation exposure to the public and that only an off-normal or accident event could cause any measurable exposure. However, even the maximum hypothetical accident (MHA) analyzed in Section 14 resulted in radiation exposures that were fractions of applicable limits in 10 CFR 20.

The staff has reviewed the impact of prior operation of the facility on the risk of radiation exposure to the public. Although the staff has concluded that the reactor was initially designed and constructed with inherent safety, it also has considered whether continued operation would cause significant degradation in these features.

The staff review has considered the degradation of safety components and systems for the UNM AGN-201M research reactor. The review has shown that UNM reactor receives regular preventive and corrective maintenance and components are replaced as necessary. There have been some malfunctions of equipment; however, the staff's review indicates that most of these malfunctions have been random one-of-a-kind incidents. There is no indication of significant degradation of the instrumentation. The staff concludes that there is strong evidence that any future degradation will lead to prompt remedial action by the UNM staff and that there is reasonable assurance that there will be no significant increase in the likelihood of occurrence of a reactor accident as a result of component malfunction.

17.2 Conclusion

On the basis of the above considerations, the staff concludes that there are no other credible events that could produce effects greater than those already analyzed in Section 14.

18 CONCLUSIONS

On the basis of its evaluation of the application as set forth above, the staff has determined that:

(1) The application for renewal of Facility Operating License R-102 for its research reactor filed by the University of New Mexico, dated June 2, 1986, as supplemented, complies with the requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations set forth in 10 CFR Chapter I.

(2) The facility will operate in conformity with the application as amended, the provisions of the Act, and the rules and regulations of the Commission.

(3) There is reasonable assurance (a) that the activities authorized by the operating license can be conducted without endangering the health and safety of the public and (b) that such activities will be conducted in compliance with the regulations of the Commission set forth in 10 CFR Chapter I.

(4) The licensee is technically and financially qualified to engage in the activities authorized by the license in accordance with the regulations of the Commission set forth in 10 CFR Chapter I.

(5) The renewal of this license will not be inimical to the common defense and security nor to the health and safety of the public.

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