UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION AND ENVIRONMENTAL IMPACT APPRAISAL

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 2 TO FACILITY LICENSE NO. R-101

UNIVERSITY OF CALIFORNIA AT BERKELEY

DOCKET NO. 50-224

Introduction

By letter dated December 30, 1974, the University of California at Berkeley requested that the Facility License No. R-101 for their TRIGA Mark III research reactor be renewed for a period of 30 years, extending the expiration date of the license to February 3, 2005. In response to our requests, the licensee provided additional information in support of this renewal application by letters dated February 18 and December 21, 1976; August 15, 1977; and February 26, April 3 and May 14, 1979. The revised Technical Specifications (TS) submitted April 3, 1979, which completely update the existing specifications, are designed to meet regulatory requirements. The modifications have been discussed with and accepted by the licensee.

Discussion

The TRIGA Mark III reactor at the University of California is of a design developed by Gulf General Atomic, Inc. The reactor was first licensed to operate in August 1966 for a period of ten years, as measured from the construction permit issuance date (February 3, 1965). The reactor is currently licensed to operate up to a steady state power level of 1 MWt with a maximum reactivity insertion for pulsed experiments of 2.1% delta k/k. A number of other TRIGA Mark III reactors have been licensed to operate at this power level and with this reactivity insertion. Moreover, considerable operating experience to date indicates that the TRIGA reactor parameters can be accurately predicted. No unusual problems have arisen or are anticipated from operation of the University of California TRIGA reactor in the manner currently authorized by the license.

Description

The TRIGA Mark III reactor is a heterogeneous pool-type reactor with fuel-moderator elements made up of a homogeneous mixture of 20% enriched uranium (8.5 weight percent) and zirconium hydride clad in stainless steel, and designed to operate at steady state power levels up to 1 MWt. This type of fuel element has demonstrated a prompt negative temperature coefficient of reactivity which inherently limits the reactor power to a safe level during the large power pulses for which it is designed.

The core is suspended on a shroud from a bridge which rides on tracks that span the top of the tank. The reactor can be moved while the reactor is shutdown and

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operated at any position on the track. Surrounding the pool is a concrete shielding structure with openings for various irradiation facilities, an exposure room, two thermal columns and several beam ports. Other irradiation facilities in the pool include a rotary specimen rack above the core and a high speed pneumatic transfer system which will permit short-term irradiations in the core. The above irradiation facilities are similar to those installed in other research reactors.

The core loading provides a maximum excess reactivity worth of 4.9% above cold clean critical. Reactor control is furnished by three rack and pinion control rods with a total reactivity worth of about 6.3% and a transient rod worth about 2.1%. The transient rod is used as a safety rod during steady state operation and is designed to be pneumatically removed for pulsed operation.

Reactor instrumentation for steady state operation includes four channels to monitor, indicate, and control neutron flux. Reactor shutdown is caused by excessive power level, short period, neutron detector and console power failures, manual scram, and earthquake shock. During the square-wave mode of operation, the period scram is disconnected. Power level scram occurs at 110% of the full power setting. During pulsing operation, normal instrumentation is disconnected. Reactor shutdown is provided by an integrated neutron flux circuit obtaining its signal from an ion chamber.

The core is located near the bottom of a large aluminum-lined water-filled pool located above the reactor room floor. The reactor is cooled by natural convection. The pool water is cooled by a recirculating water system which pumps pool water to a heat exchanger. Secondary coolant, which is at a higher pressure than the recirculated pool water, passes through the heat exchanger and is pumped to a cooling tower on top of an adjacent section of the building.

The reactor is housed in a building known at Etcheverry Hall which is located on the northern edge of the campus. No exclusion zone is associated with the site; however, the Neutronics Laboratory, which houses the research reactor, will be considered an exclusion area and access to this room will be controlled. The reactor room lies below grade and is 148 feet long, 73 feet wide, and has a ceiling height of 34 feet. A campus patio is located over the reactor room.

The ventilation system for the Neutronics Laboratory is completely separate from the other ventilation systems. It is designed to maintain the reactor room at a slightly negative pressure with respect to ambient conditions. All air (except for that in the exposure room) is passed through a bank of absolute filters to remove particles over 0.3 microns before being discharged to the atmosphere. Associated with the reactor room ventilation system is a detector to monitor the radiation level in the exhaust gases. Should the radiation levels exceed a predetermined level, supply and exhaust fans will cease to function and butterfly valves will close to seal off the room. The room air will then be purged at a lower rate through a glove box ventilation system which includes absolute filters and a charcoal scrubber and out the exhaust system located on the roof of Etcheverry Hall. This purge maintains a negative pressure in the reactor room and insures that exhaust of activity is performed at a controlled rate with high dilution.

Liquid and solid wastes from the reactor facility are collected and stored for eventual delivery to a waste disposal contractor. A 500 gallon sump tank is available to hold water waste from equipment or personnel decontamination. The contaminated water is held up until the activity has decayed below levels permitted for discharge.

I. SAFETY EVALUATION

The present facility has not changed significantly from that described in the Reactor Safety Analysis Report filed with the Commission, May 27, 1964. Changes which were made are primarily to reduce maintenance requirements and facilitate operation. These changes are reported in annual operating reports. None of these changes resulted in a decrease in margins of safety.

The proposed Technical Specifications (TS) have been reviewed and revised to meet current requirements of the regulations. The TS generally incorporate the design features, characteristics and operating conditions described in the Hazards Summary Report as updated. Comprehensive surveillance requirements and administrative controls have been included to assure early detection of any degradation of any components and will assure acceptable performance of safety related equipment and require safety related reviews, audits and operating procedures. Record keeping and reporting requirements will provide sufficient information to permit an assessment by the Commission of safety related activities and changes.

Furthermore, nearly identical reactors to this one with similar TS have been licensed to operate for periods up to 40 years. Hence, the bases and conclusion with respect to the safety of operation that were determined in our Hazards Analysis dated January 13, 1965, in support of the current operating license, remain unchanged. Moreover, due to the fact that: (1) no unusual problems have arisen during over thirteen years of authorized operation at 1 MWt, (2) revised TS require surveillance and periodic testing of safety related equipment to assure continued safe operation of the reactor and to assure that any significant component degradation will be detected in a timely manner, and (3) other TRIGA reactors of this type also have considerable operating experience without evidence of any unusual problems, we have concluded that the University of California at Berkeley TRIGA reactor can continue to be operated in a safe manner for the requested 30 year period. Based on these considerations, we have concluded that the estimated useful life of the facility will extend at least to the end of the requested 30 year period. Therefore, from a reactor safety standpoint the proposed amendment is acceptable.

The worst case accident postulated for a TRIGA facility is a fuel element failure with resultant release of fission products. In the unlikely event of such an accident, a signal from the air monitoring system would actuate dampers in the reactor room ventilation system. Any air expelled form the reactor room under these conditions would pass through the purge system. Dilution in the general building exhaust and dispersion in the atmosphere would reduce the activity level to below the maximum permissible for unrestricted areas. Therefore, there would be no danger to public health and safety in the event of this accident. The whole body dose rate to a person in the reactor room shortly after a central element cladding failure after infinite operation at 1 MWt has been conservatively estimated at 160 millirem per hour, well below 10 CFR Part 20 limits.

The reactivity accident considered by the applicant is assumed to occur as the result of violation of operating procedures with accompanying failure of several interlocks and scram trips. In effect, the accident consists of inserting the full worth of the transient rod while the reactor is operating at a high steady power with all control rods out. In such an event, the applicant's calculations, with which we concur, indicate that the maximum temperature in the hottest fuel element would be less than 800°C and that the maximum pressure within the element would be approximately 9 atmospheres. The resulting stresses on the cladding will not exceed the yield stress at 800°C. We conclude that this temperature and pressure would not cause rupture of the fuel elements.

Although it appears that complete loss of pool water is unlikely, the effect of such loss has been investigated. The applicant and we have calculated the maximum temperature to be expected within the hottest fuel element after a sudden loss of pool water. These calculations show that peak temperatures would be much lower than the melting temperature of any part of the fuel element. Further, the internal pressure generated would be less than that required to reach the yield point of the steel cladding at the elevated temperature. On the basis of these calculations we have concluded that it is highly unlikely that a fuel element would fail following an instantaneous loss of pool water. If it is assumed that a fuel element did fail due to overheating because of a cladding defect which existed prior to the buildup in internal pressure, the resulting potential whole body and thyroid dose rate would be somewhat higher than that due to the reactivity insertion accident discussed above. However, calculations indicate that a person in the reactor room would have more than sufficient time to evacuate before receiving a serious exposure. Radioactive iodine in the air would be slowly purged through a charcoal scrubber and diluted before reaching any occupied area outside the building, and the hazard to the general public would be negligible.

In addition to the foregoing accident analyses and because the University of California at Berkeley TRIGA facility is located in the Hayward Fault zone, a design basis accident analysis was performed that assumes total core disruption with concomitant release of 1.5×10^{-3} percent of the total core fission product inventory (Decision of ASLAB in the Matter of the Trustees of Columbia University in the City of New York, May 18, 1972). The parameters used in the analysis are:

Reactor Type:	TRIGA Mark III
Steady-State Power Level:	1 MWt
Accidental Gaseous Fission Product Release:	1.5×10^{-3}%
Breathing Rate:	3.47×10^{-4} m^3/sec
Short-term x/Q at reactor room wall:	5.0×10^{-2} sec/m^3

A dose calculation at the reactor room wall yields:

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Thyroid: 7.5 Rem*

Whole Body: <0.1 Rem*

No cooling available except for air.

Building splits and releases fission products to the atmosphere.

*Instantaneous Release Assumed

The computed thyoid dose is a small fraction of the 10 CFR Part 100 limit. The whole body dose is negligibly small.

We have concluded, using appropriately conservative release fractions and meteorological modeling, even in the event of a major seismic event leading to a complete loss of cooling water, core disruption and breach of the building walls, the radiological consequences in the near vicinity of the reactor building are of the order of the limits of 10 CFR Part 20 and are only a small fraction of the limits of 10 CFR Part 100.

By letter dated February 26, 1979, the licensee requested a TS change that would delete the requirement for annual inspections of each fuel element. This is based on the fact that there has been no measurable change in fuel element dimensions in the thirteen years of reactor operation and that the elements should be inspected based on the number of pulses performed. The amount of reactivity inserted and the excursion the fuel experiences during a pulse is the parameter that will affect the fuel cladding, fuel temperature, and any pressure build up in the fuel elements. We have reviewed the licensee's analysis and reviewed the operations of similar type TRIGA reactors. We have concluded that this change is rational and will not significantly increase the probability of risk to fuel element distortion. In addition, this change will greatly reduce the risks to personnel caused by unnecessary exposure to irradiated fuel elements. Therefore, this TS change is acceptable.

The licensee's Operator Requalification Program has been reviewed and found to be acceptable.

Financial Considerations

We have evaluated the financial qualifications of the University of California at Berkeley to continue operation of the reactor until the requested license expiration date. Based on our review of the estimated costs and sources of funds to operate the reactor and to shut it down and maintain it in a safe shutdown condition, should that become necessary, we have concluded that the licensee is financially qualified and meets the requirements of 10 CFR Part 50, Section 50.33(f) and Appendix C to 10 CFR Part 50.

Emergency Planning

The Emergency Plan was submitted at the Commission's request by letter dated December 21, 1976, and revisions submitted in response to requests for additional information by letter dated August 15, 1977. We have reviewed the plan and

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conclude that it conforms to the requirements of 10 CFR Appendix E and provides a basis for an acceptable state of emergency preparedness. It should be noted that certain criteria of Appendix E is being revised and when effective, the licensee will be required to revise the Emergency Plan accordingly.

Security Planning

We have reviewed the current security plan submitted September 18, 1974, and Revision 1 dated December 20, 1976, and find it acceptable to meet the requirements of 10 CFR Part 50, Section 50.34(c) and 10 CFR Part 73. These documents and our evaluation findings are in the Commission's files and are withheld from public disclosure pursuant to the provisions of 10 CFR 2.790(d). This amendment, in keeping with current Commission practice, adds a paragraph to the license which identifies the currently approved security plan and incorporates the plan as a condition of the license.

Conclusion on Safety

We have concluded that 1) continued operation of the reactor does not involve a significant increase in the probability or consequences of accidents and does not decrease the safety margin and there is not a significant hazards consideration, 2) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the manner prescribed by the T.S., and 3) continued operation of the reactor will not be inimical to the common defense and security or to the health and safety of the public.

II Environmental Impact Appraisal

The environmental impact associated with operation of research reactors has been generically evaluated in a staff memorandum (D. Muller to D. Skovholt, dated January 28, 1974, see Safety Evaluation dated April 25, 1979, for the Texas A & M University, Docket No. 50-59). This memorandum concludes that there will be no significant environmental impact associated with the licensing of research reactors to operate at power levels up to 2 MWt and that no environmental impact statements are required to be written for the issuance of construction permits or operating licenses for such facilities. We have determined that this generic evaluation is applicable to operation of the University of California at Berkeley TRIGA reactor and that there are no special or different features which would preclude reliance on the generic evaluation. Consequently, we have determined that the conclusion reached in the generic evaluation is equally applicable to this license renewal action and that an environmental impact statement need not be prepared. Furthermore, based on our review of specific facility items which are considered for potential environmental impact, discussed below, we have concluded that this license renewal action is insignificant from the standpoint of environmental impact.

Facility

There are no pipelines or transmission lines entering or leaving the site above grade. All utility services (water, steam, electricity, telephone and sewage) are below grade and are comparable to those required for typical campus laboratories.

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The facility is licensed to operate up to a maximum steady state power level of 1 MWt. Pulsed operation is authorized. Heat generated during operation is dissipated through natural convection. The pool water is cooled by a recirculating water system which pumps pool water to a heat exchanger. Secondary coolant which is at a higher pressure than the recirculated pool water, passes through the heat exchanger and is pumped to a cooling tower on top of an adjacent section of the building. The reactor is located in Etcheverry Hall at the northern edge of the University campus, and no additional construction is expected during the license renewal period.

The radioactivity released to unrestricted areas results from disposal of spent activated samples and the release of Argon-41 from neutron activation of air in various exposure facilities. The licensee's calculations and our independent analysis indicate that release of Argon-41 will not exceed concentrations specified in 10 CFR 20 limits for restricted and for non-restricted areas which could be occupied.

Furthermore, the direct radiation levels from this facility and from the facility's effluents are undetectable. No changes in the method of reactor operation have occurred since 1955 which would significantly increase these values.

Environmental Effects of Facility Operation

Release of thermal effluents from a 1 MWt TRIGA reactor will not have a significant effect on the environment. The small amount of waste heat generated by the reactor is rejected to the pool water, which is cooled through a heat exchanger and secondary cooling system. Yearly doses to unrestricted areas from external radiation will be at or below 10 CFR Part 20 limits.

No release of potentially harmful chemical substances will occur during normal operation. Small amounts of chemicals and/or high-solid content water may be released from the facility through the sanitary sewer from laboratory experiments.

Other potential effects of the facility, such as esthetics, noise and societal or impact on local flora and fauna are expected to be too small to measure.

Environmental Effects of Accidents

Accidents ranging from the failure of experiments up to the largest core damage and fission product release considered possible result in doses of only a small fraction of 10 CFR Part 100 guidelines and are considered negligible with respect to the environment.

Unavoidable Effects of Facility Operation

The unavoidable effects of operation involve the fissionable material used in the reactor. No adverse impact on the environment is expected from these unavoidable effects.

Alternatives to Ope. .o- r the Facility

To accomplish the objectives associated with research reactors, there are no suitable alternatives. Some of these -jectives are training of students in the operation of reactors, p. ion of radioisotopes, and use of neutron and gamma ray beams to experiments.

Long-Term Effects of Facility Constructior ... Operation

The long-term effects of research facilities are considered to be beneficial as a result of the contribution to scientific knowledge and training. There is no construction planned dur ig the renewal period; and therefore, no construction is authorized under :nis licensing action.

Because of the relatively low amount of capita. resources involved and the small impact on the environment very little irreversible and irretrievable commitment is associated with such facilities.

Costs and Benefits of Facility and Alternatives

The monetary costs involved in operation of the facility are approximately $130,000 per year. There will be limited environmental impacts. The benefits include, but are not limited to, some combination of the following: conduct of activation analyses, conduct of neutron radiography, training of operating personnel and education of students. Some of these activities could be conducted using particle accelerators or radioactive sources; however, these would be more costly and less efficient. There is no reasonable alternative to a nuclear research reactor for conducting this spectrum of activities.

Conclusion and Basis for Negative Declaration

Based on the foregoing analysis, we have concluded that there will be no significant environmental impact attributed to this proposed license renewal. Having made this conclusion, we have further concluded that no environmental impact statement for the proposed action need be prepared and that a negative declaration to this effect is appropriate.

Dated: September 28, 1979