UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

June 16, 2009

The Honorable Gregory B. Jaczko
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL APPLICATION FOR THE NATIONAL BUREAU OF STANDARDS TEST REACTOR

Dear Chairman Jaczko:

During the 563rd meeting of the Advisory Committee on Reactor Safeguards, June 3-4, 2009, we completed our review of the National Institute of Standards and Technology (NIST) license renewal application for the National Bureau of Standards Test Reactor (NBSR) and the staff's revised final Safety Evaluation Report (SER). During our 561st meeting, April 2-4, 2009, we reviewed a previous version of this application and the associated staff's SER. Our Plant License Renewal Subcommittee also reviewed this matter during its meeting on February 4, 2009. During these reviews, we had the benefit of discussions with the NRC staff and the applicant, NIST. We also had the benefit of the documents referenced.

CONCLUSION AND RECOMMENDATION

1. NBSR can be operated in accordance with its current licensing basis, as amended by its application for license renewal, for the period of extended operation without undue risk to the health and safety of the public.

2. The NIST application for renewal of the operating license of NBSR should be approved.

BACKGROUND

The NBSR is a tank type, heavy water-moderated reactor. The reactor is used for neutron research and contains nine radial beam tubes, two through-core tubes, a cold neutron source, a thermal column, four pneumatic tubes, and seven vertical tubes. NBSR is operated by NIST and is located on the NIST campus in Gaithersburg, Maryland.

The National Bureau of Standards (the forerunner of NIST) applied for a construction permit (CP) for NBSR in 1961 and a CP was issued by the Atomic Energy Commission (AEC) in 1963. Application for an operating license (OL) at 10 MW_t power was submitted in 1967 and the AEC issued a provisional OL in the same year. The reactor achieved initial criticality on December 7, 1967, and began full-power operation at 10 MW_t on February 6, 1969. The ACRS reviewed each licensing action and recommended approval of operation at 10 MW_t in 1970, and a permanent facility-operating license (TR-5) was issued in 1970 for a period of 15 years. In 1980, the National Bureau of Standards requested a power increase from 10 MW_t to 20 MW_t

and a 20-year renewal of its license for the NBSR. On May 17, 1984, the NRC issued the renewed license, including authorization to operate at the increased power level of 20 MW_t for a period of 20 years.

NIST operates the facility in accordance with its current license issued in 1984 and expired on May 16, 2004. Prior to expiration, this operating license was extended under the provisions of 10 CFR 2.109, "Effect of timely renewal application," when NIST filed an application for license renewal on April 9, 2004. This filing date met the time frame of 30 days for a timely renewal prior to the time when the license would have expired.

NBSR is licensed as a test reactor, under the provisions of Sec. 104c of the Atomic Energy Act of 1954, as amended (AEA or "the Act"). The Act states, inter alia, that "…utilization facilities for research and development should be regulated to the minimum extent consistent with protecting the health and safety of the public and promoting the common defense and security." The licensing principles set forth in the Act recognize that the radiation source term for research and test reactors is orders of magnitude lower than that of power reactors and that the service conditions for reactor plant components are very mild. Thus, the potential consequences of an accident are extremely small.

The licensing principles set forth in the Act are promulgated in 10 CFR 50.40 and 50.41 and other parts of 10 CFR which regulate class 104 reactors. However, a number of 10 CFR parts do not apply to class 104 reactors, among which are 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," and 10 CFR Part 50, Appendix A.

In lieu of specific regulations to prescribe the detailed requirements for the initial application and renewal of licenses for class 104 reactors, the staff developed a standard review plan, NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors." The staff's review of the NBSR license renewal application covers all areas that would be reviewed for a new license application. To that end, NIST was required to update its Final Safety Analysis Report and its Technical Specifications to reflect the plant's operating history, the current status of the plant, all plant modifications, any new safety analyses, and operating procedure revisions.

DISCUSSION

In the revised final SER, the staff documented its review of the license renewal application, the revised safety analyses, and other information submitted by the applicant or obtained by the staff through Requests for Additional Information, audits, and inspections at the reactor site.

NIST reevaluated and updated the NBSR core physics and accident analysis using state-of-the-art calculational methods and up-to-date design information. In this updated analysis, detailed three-dimensional Monte Carlo neutron and photon transport calculations were performed to determine the key safety parameters for the NBSR. Core depletion and burnup-dependent fuel compositions were calculated using the MONTEBURNS code. Time dependent analysis of the primary loop was determined using the RELAP5 code. Monte Carlo statistical analysis of the uncertainties was used to provide assurance that critical heat flux ratios (CHFR) realistically represent accident conditions within the core.

Design information was updated to reflect the addition of the cold neutron source structures, including the effect of rapid removal of high-reactivity worth experiments. Plant performance

test data, including flow coast-down resulting from loss-of-AC power accidents, were reevaluated to ensure adequate margin.

Detailed accident analyses were performed to evaluate accidents involving excessive positive reactivity insertion accidents and power-cooling mismatch accidents. Key core safety parameter requirements, such as hot-spot CHFR and fuel centerline temperature, are met with adequate margin in all accident analyses.

We inquired about the applicant's identification of the plausible aging mechanisms associated with NBSR. Active components which are safety related are periodically tested in accordance with the surveillance requirements of the Technical Specifications. Passive components are evaluated for aging effects by inspection. We reviewed the age-related information pertaining to corrosion of core components, including fuel assemblies, shim safety control rods, and reactor vessel, as well as the information on the moderator chemistry. The mild environment (115°F and 7.2 psig) and stringent chemistry control in the core and surrounding piping and vessels result in minimum corrosion of components.

Fuel elements are plate-type fuel consisting of U_3O_8 mixed with aluminum powder contained in aluminum-clad plates. In-pile fuel burnup is limited to 2.0×10^{27} fissions/m^3 by the Technical Specifications to prevent unacceptable fuel swelling. This limits in-core fuel use to about 15 months. Experience has shown that fuel clad corrosion is negligible with in-core residences as brief as those at NBSR.

There are two types of control rods in use at NBSR; four semaphore-type shim safety rods and one automatic regulating rod. The shim safety rods are cadmium plate clad with aluminum. The in-core life of the shim safety rods is determined by their neutron absorption value (rod worth) when inserted into the core. Experience at NBSR has shown that the rods reach their burnup limit and must be replaced before any noticeable corrosion occurs. NBSR shim safety rods have been replaced three times due to absorber depletion.

The reactor vessel is an aluminum tank in the form of a right circular cylinder with an elliptical bottom head and a flanged top. The vessel is designed and built to comply with the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels, with a design pressure of 50 psig. Integrity of the reactor vessel and associated components is monitored by leakage monitoring and by periodic visual inspection of selected accessible portions of the vessel. Recent visual and photographic examinations of the vessel showed a minimum of corrosion or other deterioration of the vessel. Neutron embrittlement was considered as a prospective aging mechanism. The fluence levels are such that the highest embrittlement effect is at the edges of the thimble guides closest to the core. Even in this case, the material retains significant ductility. The neutron fluence at the vessel walls is too low to cause significant embrittlement within the proposed vessel lifetime.

The overall potential for corrosion of the reactor vessel and core components is related to the water chemistry and the service conditions of the components. For NBSR, the service conditions are mild. The chemistry of the reactor water (D_2O) is well controlled by a coolant purification system which removes suspended particles and maintains pH and conductivity by use of filters and demineralizers. The Technical Specifications require that the primary system materials be compatible with the D_2O environment to minimize potential system corrosion. In addition, the D_2O is periodically replaced to reduce the radiation exposure to personnel due to the buildup of tritium in the coolant. We conclude that aging mechanisms are adequately controlled at NBSR to permit continued safe operation for the license renewal term.

The staff reviewed the applicant's analyses of severe accidents and abnormal occurrences, including the engineered safety features and the emergency plan. The staff concluded that the facility will continue to meet all applicable regulations, should an accident or abnormal operating event occur and that there is sufficient diversity and defense in depth to ensure that the likelihood of such events is low. We agree with this conclusion.

In response to the concern regarding the seismic design basis of the reactor, raised during the February 4, 2009 Subcommittee meeting, the applicant performed a seismic walk-down. A potential problem with an unreinforced block wall was noted. The applicant has committed to reanalyze this situation and take necessary corrective actions. The staff will follow up on this issue.

We reviewed the staff's acceptance criteria and the evaluation findings as set forth in the SER. The staff concludes that NIST can continue to operate the NBSR, in accordance with the current licensing basis for the period of the renewed license.

We agree with the staff that there are no issues related to the matters described in applicable parts of 10 CFR and NUREG-1537 that preclude renewal of the operating license for NBSR. The programs established and committed to by NIST provide reasonable assurance that the NBSR can be operated in accordance with its current licensing basis for the period of the renewed license without undue risk to the health and safety of the public, the NIST campus personnel, or to the environment. The NIST application for renewal of the operating license for the NBSR should be approved.

Sincerely,

/RA/

Mario V. Bonaca
Chairman

References:

1. U.S. Nuclear Regulatory Commission, Safety Evaluation Report Related to the License Renewal of National Institute of Standards and Technology Reactor, May 2009 (ML090990135)

2. Letter dated April 9, 2004, from Seymour H. Weiss, National Institute of Standards and Technology to U.S. Nuclear Regulatory Commission, transmitting the License Renewal Application for the National Institute of Standards and Technology Reactor (ML041120167)

3. NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," February 1996

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SUBJECT: Report On the Safety Aspects of the License Renewal Application for the National Bureau of Standards Test Reactor

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