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March 28, 1994

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, DC 20555

REFERENCE: Docket 50-186
University of Missouri Research Reactor
License R-103

SUBJECT: Technical Specification change request pursuant to 10CFR50.59(c) and 10CFR50.90.

The University of Missouri Research Reactor (MURR) plans to replace the two existing 50% capacity pool system heat exchangers (tube and shell type) with a single plate type heat exchanger that will provide 100% of pool system heat rejection needs at 10 MW. The replacement will allow us to replace aging heat exchangers, approaching their design operational lifetime, with a more efficient heat exchanger designed to meet current 10 MW heat rejection needs for the pool system.

The existing 50% capacity heat exchangers are in parallel cooling legs in the pool coolant system. Each heat exchanger leg currently has a dedicated flow measurement channel consisting of an orifice plate and associated flow transmitter which measures half of the total flow in the pool system. The pool coolant flow trip setpoint in Technical Specification 3.3 is currently 425 gpm for the flow in each heat exchanger leg, based on one-half of the minimum total pool system flow of 850 gpm required for adequate cooling of the pool, reflector, control rods and the flux trap for 10 MW operation.

The new pool loop heat exchanger piping will incorporate a single orifice plate and two flow transmitters to generate the two required pool coolant flow trips required by Technical Specifications. Each flow transmitter will indicate total pool system flow instead of half of pool system flow.

We have performed a safety evaluation (attached) for this planned heat exchanger replacement to show there are no unreviewed safety questions introduced by this change. The planned heat exchanger replacement will, however, require several changes to MURR Technical Specifications.

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We request the following changes to Technical Specifications in order to replace the parallel 50% capacity pool system heat exchangers with a single new 100% capacity heat exchanger:

a) Change the pool heat exchanger description in Reactor Coolant System Technical Specification 4.4.a. from "..., two pool system heat exchangers...." to "..., one 100% capacity or two 50% capacity pool system heat exchanger(s)....";

b) Change the Trip Set Point in Technical Specification 3.3.a. for Pool Coolant Flow from "425 gpm (min)" to "425 gpm (min) for each 50% capacity heat exchanger leg or 850 gpm (min) for one 100% capacity heat exchanger" for total pool system flow; and

c) Change note [4] page 3 of 5, Technical Specification 3.3.a. from "Flow orifice ΔP (psi) in each operating heat exchanger leg corresponding to the flow value in the table." to "Flow orifice ΔP (psi) corresponding to the flow value in the table."

Attached for your reference are revised Technical Specification pages with these changes incorporated.

These requested changes to Technical Specifications involve a change in the pool coolant system description from two heat exchanger legs to one heat exchanger leg and a change in the pool coolant flow scram setpoint to indicate measurement of total pool flow instead of measurement of half of pool flow. The attached safety evaluation indicates that no unreviewed safety question is introduced by these changes.

We plan to replace the pool heat exchangers with the plate type heat exchanger by June 30, 1994. Your expeditious review of this change request is appreciated.

If you have any questions, please contact me at 314-882-5203.

Sincerely,

Walt A. Meyer, Jr.
Reactor Manager

Christine M. Errante 3/29/94
CHRISTINE M. ERRANTE
NOTARY PUBLIC STATE OF MISSOURI
BOONE COUNTY
MY COMMISSION EXP. APR. 14,1995

ENDORSEMENT:
Reviewed and Approved

J. Charles McKibben
Associate Director

xc: Reactor Advisory Committee
RAC Safety Subcommittee
Dr. John P. McCormick, Interim Vice Provost for Research & Dean of Graduate School
Mr. Charles Cox, U.S. NRC, Region III
Mr. Al Adams, U.S. Nuclear Regulatory Commission

SAFETY EVALUATION
REPLACING EXISTING POOL COOLANT SYSTEM HEAT EXCHANGERS

This safety evaluation will show that replacing the existing pool coolant system heat exchangers (tube and shell) with a single plate type heat exchanger does not involve an unreviewed safety question. The evaluation process will follow the guidance provided in the Nuclear Management and Resources Council document, NSAC/125, Guidelines for 10CFR50.59 Safety Evaluations.

I. PROPOSED CHANGE TO THE FACILITY POOL COOLING SYSTEM AS DESCRIBED IN THE MURR HAZARDS SUMMARY REPORT (HSR) dated July 1, 1965, AND HSR ADDENDA

This safety evaluation is limited to evaluating changes to the facility which may affect the design, function or method of performing the function of the pool coolant system and its component pool system heat exchangers, as described in the Hazards Summary Report (HSR).

The original HSR Section 5.3 describes the design base heat transfer specifications for the pool loop cooling system at 5 MW and 10 MW operation. These are summarized below:

5 MW		10 MW	
Heat Removal Capability	2×10^6 BTU/hr	Heat Removal Capability	4×10^6 BTU/hr
Pool Flow	600 gpm	Pool Flow	1200 gpm
Secondary inlet	87°F	Secondary inlet	87°F
Secondary Flow	400 gpm	Secondary Flow	400 gpm/hx
Pool Temp Cold	99°F	Pool Temp Cold	99°F
Pool Design Pressure	100 psig	Pool Design Pressure	100 psig

For operation at 10 MW with 1200 gpm pool system flow, heat rejection capacity required was estimated to be 3.7×10^6 BTU/hr. The 10 MW specified pool loop cooling system included two 50% capacity pool loop heat exchangers primarily because the University of Missouri originally wished to defer installation of the additional heat exchanger equipment necessary for 10 MW operation until the reactor had operated several years at 5 MW (reference:

SAFETY EVALUATION BY THE DIRECTORATE OF LICENSING SUPPORTING AMENDMENT NO. 2 TO FACILITY LICENSE NO. R-103, dated May 24, 1994, p.2.). In other words, if the University had not chosen to install heat exchanger equipment incrementally for both the reactor and pool cooling systems, the pool system heat exchangers described in Original HSR could have been specified as a single heat exchanger with double the heat rejection capability of the initial 5 MW heat exchanger. HSR, Addendum 3, Section 2.2 describes the change to the pool cooling system to facilitate 10 MW operation as a doubling of the heat removal capability of the 5 MW pool water cooling system.

The new plate type heat exchanger will replace the two 50% capacity tube and shell pool system heat exchangers. Its capacity will be based on existing parameters (heat load, flow rates, and temperatures) for 10 MW operation.

Pool cooling system flow is currently measured by a flow orifice and associated flow transmitter in each of the two pool system heat exchanger 4 inch diameter legs (FE 921B/FT 912F and FE 921A/FT 912D). Each flow orifice is made out of stainless steel and set in between 300# ASA, 3003 aluminum flanges with pressure taps going to each pressure transmitter to monitor pool flow. (MURR Drawing 2117 and HSR Addendum 3, Section 2.2.2.9 and MURR Drawing 666.) The 4 inch flow elements are sized for maximum flow of 800 gpm each, and are attached to differential pressure transmitters (0-750 inches of water).

Each of the existing pool flow channels measures half of total pool flow and provides an alarm when pool system flow drops to 90% of normal 10 MW flow in each leg (approximately 540 gpm). Technical Specification 3.3.a. sets the scram trip point for the pool cooling system flow at 425 gpm (min)/leg.

The new pool flow element will be a single 316 stainless steel flow element set between a 300 psia, 6061T6 aluminum flange with four sets of pressure taps (only two sets will be used initially). The plate will be sized for a maximum flow of 1800 gpm and will connect to two 0-750 inches of water differential pressure transmitters. Normal operating flow will be 1200 gpm for 10 MW operation. Two sets of taps will be utilized to provide independent sensing points for the pool flow channels. The scrams provided by each pressure transmitter will be placed in separate safety legs of the reactor scram circuits to provide redundancy. The pool coolant system flow alarm will be set to about 90% of normal 10 MW flow (1080 gpm) when an annunciator will alarm. Before flow drops to the required 850 gpm, the reactor will be scrammed.

The materials of construction of the new plate type heat exchanger meet the requirements of Original HSR, Section 5.3.5., and Technical Specification 4.4.e. The heat exchanger plates are constructed of 304 stainless steel.

The installation of the single heat exchanger in place of the existing two parallel tube and shell heat exchangers will require modifications to the secondary cooling system. These changes will be made under a separate 10CFR50.59 safety evaluation. However, replacing the pool system heat exchangers will not effect the secondary coolant system's capability to continuously discharge the heat generated at 10 MW operation, as it currently does, as required by Technical Specification 4.4.b.

The installation of the new plate type heat exchanger will involve no field pipe welds in the pool loop piping. Pipe breaks to accommodate the change from two parallel heat exchangers to one heat exchanger will be made at existing flanges. New piping will be prefabricated and welds will be radiographed prior to installation.

The pool loop piping will be arranged to provide the recommended length of straight pipe before and after the flow measurement orifice to reduce flow disturbance. The pool cooling system will retain the same number of flow transmitters and the same number of redundant low pool system flow safety channels. Each flow transmitter will be measuring full pool cooling loop flow from a common flow orifice which is different from the current arrangement where a transmitter and orifice plate in each heat exchanger leg provides measurement of only part of the flow.

II. UNREVIEWED SAFETY QUESTION EVALUATION

A proposed change is deemed to introduce an unreviewed safety question if there is an affirmative answer to any of the three questions contained in 10CFR 50.59(a)(2). The answers to the three questions, which follow, reference summaries of the accidents previously evaluated in MURR HSR relating to the pool cooling system, and demonstrate that this change does not introduce an unreviewed safety question. The accident summaries are contained in the appendix.

1. May the proposed activity increase the probability of occurrence of an accident evaluated previously in the MURR Hazards Summary Report (HSR)?

   The planned replacement of the existing two parallel 50% capacity heat exchangers with a single 100% capacity heat exchanger would not increase the probability of occurrence of any of the pool system accidents analyzed previously in the HSR. The design characteristics of the existing heat exchangers and the new heat exchanger do not reduce the steady-state power level at which the reactor can be operated, and do not increase the probability of loss of pool system flow or pool water level.

The new heat exchanger meets the design material constraints of Original HSR 5.3.5 and Technical Specification 4.4.e. and exceeds the heat removal capability required for 10 MW reactor operation.

The proposed change to one flow orifice supporting two flow transmitters measuring full pool system flow (as opposed to a flow orifice and dedicated flow transmitter in each of two heat exchanger legs measuring half of pool flow) does not increase the probability of loss of pool system flow or pool water level.

2. May the proposed activity increase the consequences of an accident evaluated previously in the MURR HSR?

The replacement of the two 50% capacity pool heat exchangers with a single 100% capacity pool heat exchanger does not increase the consequences of the pool system accidents previously evaluated in MURR Hazards Summary. None of the previously evaluated pool system accidents involve doses to the public above NRC limits. On-site dose consequences would not be changed, because entry to the process equipment room (Room 114) where actions may be taken to mitigate the consequences of these accidents (e.g., isolating valves) would not be impeded by this heat exchanger replacement.

3. May the proposed activity create the possibility of an accident of a different type than any evaluated previously in the HSR?

Leakage of pool water from the heat exchanger to the secondary system or to the atmosphere were not previously evaluated because the probability is extremely low and the radiological consequences are not a public safety concern. Any leakage from the pool system heat exchangers to atmosphere is easily isolated. The secondary system has a radiation monitor to indicate radioactive liquid leakage to the secondary.

The new plate type heat exchanger uses alternating plate channels separated by gasket material to retain both the pool water and the secondary water. In this design pool water leakage to the secondary system is not likely unless one of the stainless steel plates is defective. Any pool water leakage would be detected by the secondary coolant monitor. Pool water leakage to atmosphere is more likely than to the secondary system, but with a catch pan constructed under the heat exchanger any leakage would be evident and would be directed to the hot drains in the process equipment room. The gasketing material to be used in the proposed heat exchanger is EPDM (ethylene propylene diene monomer). It is identical to the material used in the primary system isolation valves (V507A/B) which experience a higher gamma dose. The original 507 valves lasted over 25 years.

The complete or partial failure of the plate heat exchanger gasket would be the same as an end gasket failure on the tube and shell type heat exchanger. Both are isolatable from the pool and any leakage would be contained in the equipment room (room 114) or directed by hot drains to the labyrinth sump (hot sump).

Any leakage from the new heat exchanger, or the existing pool heat exchangers for that matter, would be an operational problem and not a safety concern.

The proposed change to one orifice plate providing pool coolant system flow measurement raises the question of blockage of the orifice plate. This occurrence is highly unlikely in a 6 inch orifice plate. MURR has operated over 27 years, and has not had an orifice plate blocked in a 2 inch, 4 inch or 8 inch diameter piping system. The pool water is a demineralized water system. The orifice plate will be located downstream of the plate heat exchanger. Any object large enough to block the orifice plate could not get through the heat exchanger.

4. Does the proposed activity reduce the margin of safety as defined in the basis for any technical specification?

The two pool coolant flow scram channels measuring flow in each of two heat exchanger legs (half total flow/leg), backed up by the reflector differential pressure (PT-917) scram and the "pool coolant isolation valve off open" scram, were determined to satisfy the single failure criteria of IEEE-279-1971, as evaluated in HSR, Addendum 4, Section A.3.3.8, Pool Coolant Flow Scram.

The proposed change to a single heat exchanger with one flow orifice providing the two pool coolant flow scrams must be evaluated to ensure the single failure criteria of IEEE-279 is still met. With the proposed heat exchanger, the two pool coolant flow scram channels are developed from a common flow orifice. The sensing lines for the two flow transmitters will be located on opposite sides of the orifice flange. The flow transmitters will either be the same or equivalent to transmitters used now, calibrated to the new larger diameter orifice plate and measurement of full pool loop flow. Each flow transmitter will be connected to the pool coolant flow scram channels as described in HSR, Addendum 4, Section A.3.3.8.

The two flow transmitters connected to the single flow orifice will not share any common sensing lines. This is consistent with the guidance in NRC Regulatory Guide 1.151, Instrument Sensing Lines.

The channel independence of the sensing lines connected to the single flow orifice meet the guidance in NRC Regulatory Guide 1.75, Physical Independence of Electric Systems. This Regulatory Guide references and incorporates Draft IEEE Standard, "Criteria for Separation of Class 1E Equipment and Circuits," dated July 20, 1973. Section 5.8.2 of this Draft Standard, under the heading Sensor to Process Connections, states: ". . . Redundant pressure taps located on opposite sides of a large pipe may be considered to be separated by the pipe, but the lines leaving the taps must be protected against damage from a credible common cause unless other redundant or diverse instrumentation is provided."

In MURR's case, the sensing lines from the orifice plate to the flow transmitters will be brought out of opposite sides of the flange. The sensing lines will be routed so that a credible failure could not disable both sets of sensing lines. The backup scrams from the reflector differential pressure and the pool coolant system isolation valve (V509) provide additional redundancy.

The two pool coolant flow scram channels meet the definition of Channel Independence in IEEE-279-1971 and would continue to satisfy the single failure criteria of the same document.

APPENDIX

ACCIDENTS PREVIOUSLY EVALUATED IN MURR HSR
RELATING TO POOL COOLING SYSTEM

A. Original HSR, Sections 13.2.2 and 13.2.3 address Boiling Within the Island and Boiling Within Other Regions (reflector and rod gaps) that may be caused by low pool system coolant flow.

The occurrence of boiling in these regions cooled by pool flow is prevented during operation by: (1) designing for much greater flow than is required to prevent boiling; (2) providing a pool loop low flow alarm in the control room; (3) providing two redundant pool loop low flow scrams; and (4) monitoring pool inlet water temperature. The reflector high and low differential pressure scram provides a backup to the low pool coolant flow scram. Additionally, a scram from the pool coolant isolation valve (V509) leaving its full open position provides a first line of protection for a loss of flow accident in the pool system initiated by an inadvertent closure of the isolation valve. To prevent boiling during or after shutdown, a normally open convective cooling valve (V547) attached to the reflector tank permits pool water to circulate through the center test hole and reflector by natural convection.

B. Original HSR, Section 13.2.4, Shearing a Beamport and 13.2.5, Rupture of Pool Loop (HSR Addendum 1, Section 3.16 expands the analysis to severing both six inch water lines, inlet and outlet) deal more with loss of pool water level than pool system flow.

In either type of pool water level loss the reactor would be scrammed by the pool level scram [Technical Specification setpoint 23 feet (min)], preceded by a pool level Rod Run-In [Technical Specification setpoint 27 feet (min)]. For the pool loop pipe rupture, the reactor is also scrammed either by reduced flow in the pool cooling system or by low pool coolant pump outlet pressure (causes V509 to close initiating Pool Coolant Isolation Valve 509 Off Open Position scram).

In the unlikely event this pool water leakage was unisolatable, provision is made to gravity feed and pump the contents of one demineralized water storage tank into the pool in the event of pool water loss. If the leak cannot be compensated by this means a raw water hydrant has been provided at the top of the pool with a quarter turn valve located in the floor immediately adjacent to the control room. Raw water can be dumped from this large hydrant at flow rates in excess of 1000 gallons per minute. It is calculated that at a rate of water addition of 1000 gallons per minute adequate water would be provided to retain more than three feet of water above a completely severed six inch beamport with no impediments in the port.

In the case of a shear of the pool six inch return line from the pool (with drainage through the reflector tank) the equilibrium level would be 13 feet above the top of the reflector. In the case of a shear of the six inch pool supply line, the pool reflector tank would remain full of water since the return line is below the top of the reflector tank.

In the worst case scenario, if both six inch pool loop lines are severed the reflector tank may be drained. With the reactor shutdown, the reactivity effects of voiding would not present a reactor safety problem.

In the event that the pool is drained and the in-pool reactor loop convective heat exchangers were exposed, the operation of the reactor convective loop for the reactor core would be impaired. However, the reactor loop pumps would continue to run after the scram and the reactor loop heat exchangers would remove the decay heat. Also, the heat production in the reflector and rods due to fission product decay gammas will not cause melting of these members even with total water loss (HSR 13.2.5).

C. HSR Addendum 3, Section 3.0, Safety Analysis for Ten Megawatt Operation and HSR Addendum 4, Appendix A, Section A.3.3.8, Pool Coolant Flow Scram deal with how the pool system flow safety channels meet the single failure criterion of IEEE-279. Section A.3.3.8 states:

Protection against low pool flow operation is attained by use of flow elements 921A and 921B. Each flow element measures the differential pressure generated across a flow orifice by the flow in one of two heat exchangers. The reactor scram signal is generated by alarm unit 920D and 920B and actuates the scram via auxiliary relays K37 (green leg) and K31 (yellow leg). As a backup the reflector differential pressure is monitored by pressure transmitter 917. On either a high or low differential pressure, a scram is initiated by opening contacts in the green leg of the noncoincidence logic units. In the event the pool coolant isolation valve 509 leaves its fully open seat, a reactor scram is initiated by limit switches on the valve which actuate auxiliary relay 2K12 resulting in an interruption in the yellow leg of the noncoincidence logic units.

The single failure criteria is satisfied with respect to pool flow.