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Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D. C. 20555

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University of Missouri Research Reactor
License R-103

SUBJECT: Report submitted under Technical Specification 6.1.h(2) concerning degraded operability of the mechanical equipment room exhaust system while the reactor was shutdown, but not secured.

INTRODUCTION

The reactor was shutdown, but not secured, for approximately 15 minutes on two separate occasions (June 6, 1990 and June 14, 1990) following loss of facility electrical power during severe thunderstorms. In each instance, the facility exhaust fans (EF-13 and EF-14) failed to operate when the emergency generator began supplying electrical power. Normally, either EF-13 or EF-14 runs during reactor operation and one of the two would start and run on emergency power. The operation of either exhaust fan (EF-13 or EF-14) provides ventilation exhaust for the entire reactor facility, including the reactor mechanical equipment room.

The Technical Specification definition of containment integrity (1.15) lists six conditions which must be met for containment integrity to exist. One of these conditions is that "the reactor mechanical equipment room exhaust system, including the particulate and Halogen filters, is operable."

Technical Specification 3.5(a) under Limiting Conditions for Operations requires that containment integrity be maintained at all times except when the reactor is secured and irradiated fuel with a decay time of less than sixty days is not being handled.

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After each of the reactor shutdowns mentioned above, with the concurrent loss of facility exhaust fans which provide the reactor mechanical equipment room exhaust, the reactor was not secured by Technical Specification definition 1.20 for approximately fifteen minutes in each case. Technical Specification 1.20 lists five conditions which must be met for the reactor to be considered secured. All of these conditions were met immediately upon reactor shutdown, except for condition b(1), which requires the master control switch (1S1) to be in the "OFF" position with the key locked in the key box or in the custody of a licensed operator.

DESCRIPTION

On June 6, 1990 at 0751, the reactor was shutdown by a loss of facility electrical power during a severe thunderstorm. The emergency generator started and assumed emergency electrical loads, but the fan failure alarm indicated that the exhaust fans were not running. The reactor was secured at 0805 by placing the master control switch in the "OFF" position and having the key in the custody of a licensed operator. Electronics technicians investigating the fans found that the control power fuses for each fan were blown. These fuses were replaced and an exhaust fan was started at 0820.

The cause for the blown control fuses for the exhaust fans was investigated. It was first thought that the fuses may have blown while the emergency generator was picking up the emergency load. An emergency generator load test (Compliance Procedure 17) was performed and the emergency generator picked up loads normally and neither exhaust fan control fuse was blown. During this test, normal power to the emergency power panel is interrupted, simulating a loss of electrical power and causing the emergency generator to start and supply loads. Further investigation of the exhaust fan controller diagram did not conclusively identify why the control fuses for each fan had blown. The University Power Plant verified that a lightning strike had occurred on the supply grid for MURR electrical power and it was concluded that an associated electrical transient on one phase may have caused the fuses to blow. The electrical power to each exhaust fan control circuit was found to be supplied from the voltage across the same two phases (see Figure 1). The design engineers who specified the exhaust fan controllers were contacted and asked to review the controller prints to see if there was a design problem with the fuse rating for these controllers. These controllers were part of a ventilation

system upgrade (Modification Package 88-7) to two speed, 100 horse power motor driven fans which was completed in October 1989. Until June 6, 1990 there were no anomalies associated with these new exhaust fans or their controllers.

On June 14, 1990 at 0558, the reactor again was shutdown by the loss of facility electrical power during a severe thunderstorm. The fan failure alarm again indicated that neither exhaust fan was running. The reactor was secured at approximately 0610, by placing the master control switch in the "OFF" position and having the key in the custody of a licensed operator. Electronics technicians were called in to investigate the problem and again found the control fuses for each exhaust fan blown. These fuses were replaced and an exhaust fan was started at 0720.

An emergency generator load test was performed to determine if the transient created by the emergency generator picking up emergency loads was the cause for blown controller fuses. The test was run successfully and neither control fuse was blown.

Subsequent to this second failure of the exhaust fans to operate after a loss of electrical power, replacement fuses and a procedure for fuse replacement were placed at each controller. In the event of any future loss of facility electrical power, Reactor Operations has been instructed to place the master control switch to "OFF" immediately after a loss of facility electrical power until a ventilation exhaust fan can be verified as operating, thus minimizing the time between a reactor shutdown and a reactor secured condition.

Electronics technicians again consulted with the design engineers who specified the controllers for the exhaust fans. The design engineers, in turn, consulted with the vendor who supplied the controllers. The recommendations and actions taken will be described in the ROOT CAUSE AND CORRECTIVE ACTIONS section.

After both shutdowns, the reactor had insufficient excess reactivity to overcome Xenon. When normal facility electrical power was restored, the reactor was refueled and returned to operation.

ANALYSIS

The reactor was in a condition on two separate occasions, for approximately fifteen minutes (on June 6 and June 14, 1990) where the reactor was shutdown but not secured. During these two time intervals, containment integrity was required by Technical Specification 3.5(a) because the reactor was not secured as provided in Technical Specification

definition 1.20, since the master control switch was not in the"OFF" position with the key in possession of a licensed operator. With the exhaust fans inoperable during the same time interval, condition (d) of Technical Specification definition 1.15 for containment integrity was not met, since the exhaust fans provide the suction for the reactor mechanical equipment room exhaust system Halogen and particulate filters.

The Technical Specification 1.20 condition known as "Reactor Secured" is one in which the reactor is safely shutdown and only knowledgeable authorized personnel have access to the means of changing its reactivity status. Some of the items in the definition of "Reactor Secured" are physical limitations, such as insufficient fuel to achieve criticality, or the master control switch turned to "OFF, and the key in proper custody. The remainder of the items in the definition are administrative such as no work progress involving transferring fuel, or no work in progress involving the control rods or control rod drives.

During both of the time intervals that the reactor was shutdown, the reactor was not secured by definition until the master control switch was turned to "OFF" with the key in the custody of a licensed operator. The intent of the definition is to ensure that the control rods cannot be moved, by physical position of the master control switch and by administrative control of a licensed operator. The reactor was effectively secured each time with respect to the intent of Technical Specification 1.20 by consideration of several conditions. Upon loss of facility electrical power, the primary and pool cooling systems are both automatically secured, initiating the associated redundant process safety system trips that would prevent restoring drive power to the control rods regardless of the position of the master control switch. During each time interval, a licensed operator was present at the control panel to additionally assure that rod control power was incapable of being restored.

The basis for Technical Specification 3.5(a) under Limiting Conditions for Operation is to assure that the containment building can be isolated at all times except when the plant conditions are such that the probability of release of radioactivity is negligible. With the reactor in a shutdown condition, the probability of release of radioactivity from the mechanical equipment room is negligible.

The containment integrity condition that requires the mechanical equipment room exhaust system to be operable, including Halogen and particulate filters, is based on mitigating the consequences of a release of radioactivity to the mechanical equipment room during an accident scenario involving fuel failure. Hazards Summary, Addendum 4, Appendix C states that no accidents other than the hypothetical Design Basis Accident would

result in a release of fission products from the fuel. The Design Basis Accident (DBA) is selected to postulate conditions which lead to consequences worse than those resulting from any credible accident associated with operating the reactor. With the reactor shutdown, no credible mechanism for a fuel failure accident exists.

Safety analysis providing the basis for the mechanical equipment room exhaust system states that significant release of activity to the mechanical equipment room is improbable because of the isolation valves in the primary and pool system that are automatically closed in the event of a drop in flow or pressure in these lines. The Halogen and particulate filter exhaust system is a redundant feature to further reduce the probability of any releases in a fuel failure accident scenario.

During the fifteen minute time interval on June 6 and June 14, 1990, all other conditions specified in Technical Specification 3.5(a) were satisfied. Since the release of activity to the mechanical equipment room is improbable when operating the reactor, the release of activity from the mechanical equipment room when the reactor is shutdown is negligible. Therefore, the degraded condition of the exhaust system for the mechanical equipment room was a deviation from performance specifications provided in Technical Specification 3.5(a), Limiting Conditions for Operation but did not represent a safety concern for the reactor or the public.

ROOT CAUSE AND CORRECTIVE ACTION

The immediate action in both instances of loss of facility exhaust fans was to investigate the reason for the failure. In each case, the control fuses for each exhaust fan were found to be blown. These fuses were replaced and a loss of power to the fans was simulated by performing Compliance Procedure CP-17 on the emergency generator. The exhaust fan controller fuses were unaffected during these controlled loss of electrical power conditions.

After consultation with the controller vendor concerning the root cause of the blown fuses, two modifications were suggested. One modification separates the voltage source for control power to each fan such that the control power for each fan is developed across different phases. This was achieved on a maintenance day shutdown June 25, 1990. A second modification was suggested after measurement of the amperage through the control fuses for each controller. The 3 amp control fuses were found to be carrying 2.5 amps steady state current. It was concluded that these fuses

could not provide enough current margin to be sustained through the type of electrical transients experienced during a severe thunderstorm with lightning striking the electrical grid.

The controller vendor recommended using a 6.25 amp fuse in the control circuit for each fan which would also require replacement of the 480V/120V transformer rated at 250VA with one rated at 750VA. This modification was installed in the EF-13 controller on June 25, 1990. A second 480V/120V, 750VA transformer is on order and will be installed in the EF-14 controller on the first maintenance day after its arrival.

Sincerely,

Walt A. Meyer, Jr.
Reactor Manager

ENDORSEMENT:
Reviewed and Approved

J. C. McKibben
Associate Director

Enclosure: Figure 1

xc: Regional Administrator, NRC, Region III
Reactor Advisory Committe
Reactor Safety Committee

Mary Martin

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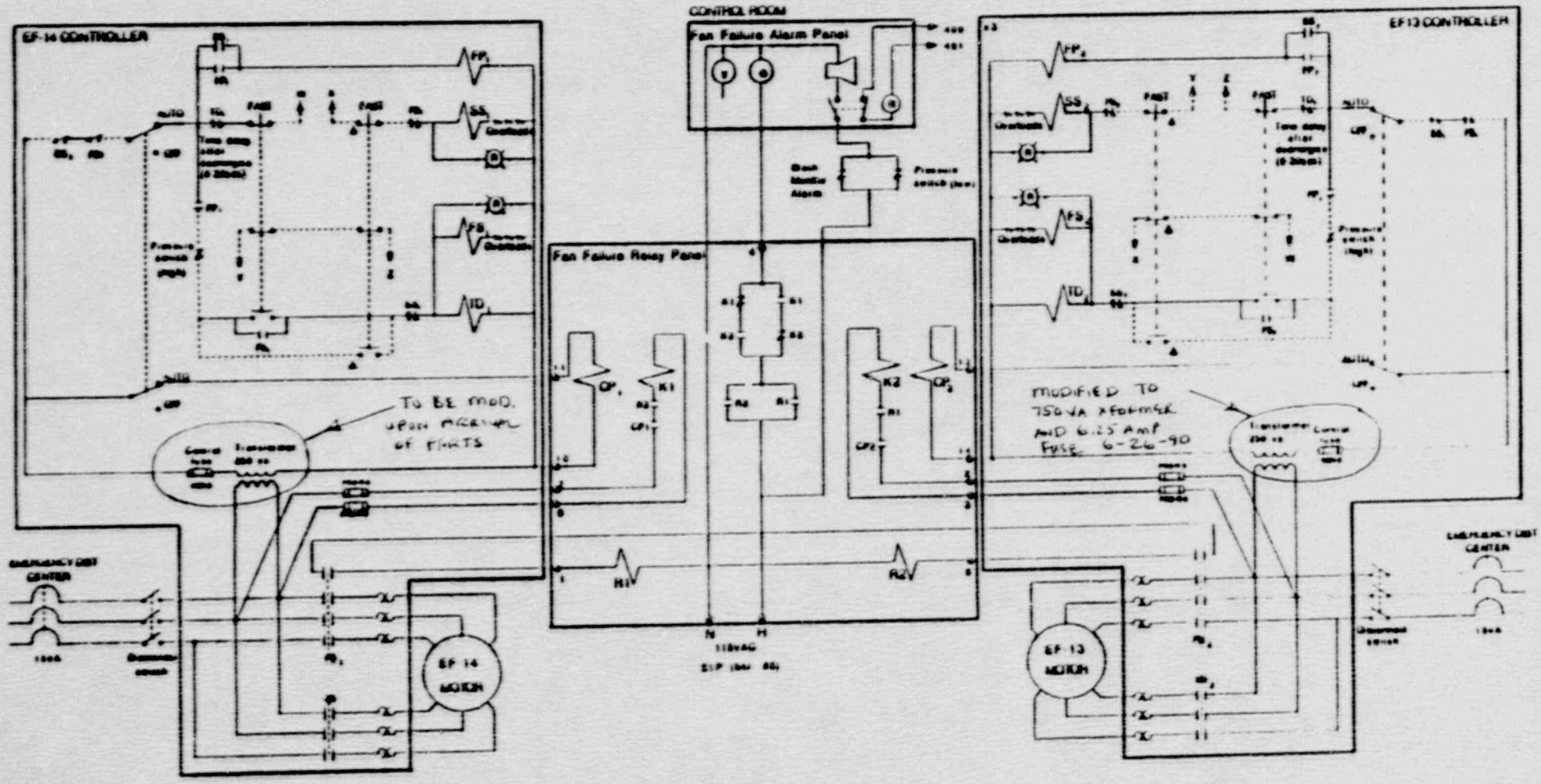

FIGURE 1. CONTROLLERS & FAN FAILURE ALARM FOR VENTILATION EXHAUST FANS (PRIOR TO 6/6/90)