THE OHIO STATE UNIVERSITY

College of Engineering
Nuclear Reactor Laboratory
1298 Kinnear Rd
Columbus, OH 43212
reactor@osu.edu
reactor.osu.edu

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U.S. Nuclear Regulatory Commission
Document Control Desk
Attn: Xiaosong Yin
One White Flint North
11555 Rockville Pike
Rockville MD 20852-2738

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Subject: Additional Information to Support the Request for Modification of Technical Specifications 3.5 and 5.1.2 of Renewed Facility Operating License No. R-75 of The Ohio State University Research Reactor (EPID NO. L-2018-LLA-0231)

As has been conveyed in previous correspondence with the NRC, the Ohio State University Research Reactor (OSURR) has an exhaust fan that exists to minimize buildup of the noble radioactive gas Ar-41 in the facility and to provide a controlled path for its release. During a prior NRC inspection at the OSURR, it was noted that while there is text specifying "an exhaust fan with a capacity of at least 1000 cubic feet per minute shall be operable whenever the reactor is operating" in Section 3, *Limiting Conditions for Operation,* of the Technical Specifications, there is no corresponding requirement in Section 4, *Surveillance Requirements,* to measure this flow rate. Because performing a suitable measurement of the flow rate would be very difficult and potentially dangerous for the staff, and because there is no safety implication to the exact volumetric flow rate of the exhaust fan, the OSURR has requested modification of Technical Specification 3.5 to fix this inconsistency by removing the flow rate from the specification.

To support the license amendment request (LAR), the OSURR staff has provided SAR updates that include additional analyses to show that flow rates as low as 500 cfm or as high as 1500 cfm have no impact on safe operations. However, to move forward with this LAR, the NRC is requesting evidence of the fan's actual flow rate to complete its safety review. As is discussed below, making such a measurement is very problematic, so this letter has been written to provide the best information available regarding the exhaust fan flow rate. In addition, this letter provides a discussion of the lack of safety implications of the exact flow rate.

If the volumetric flow rate of the exhaust fan was lower than previously analyzed, Ar-41 would build up to higher levels in the bay than it would at the flow rate originally assumed in the SAR of 1000 cfm. However, as is shown in Appendix B to 10-CFR-20, Ar-41 is a submersion hazard rather than an inhalation hazard, meaning that the potential hazard from Ar-41 is from external dose rather than from absorption in the lungs and incorporation into the body. Therefore, there is no hazard to persons in the restricted area unless the external dose from this submersion cloud exceeds occupational dose limits. The OSURR has four area radiation monitors in the reactor bay that keep staff informed of external dose rates, so the staff would know if dose rates had increased too much from buildup of Ar-41. In addition, OSURR staff members wear personnel dosimetry while in the restricted area, so excessive dose rates would be reflected in the dosimetry results, and this has not been seen to be the case. For such a

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situation, the concentration of Ar-41 exhausted to the unrestricted area would be lower than that calculated for 1000 cfm, so there would be no negative impact on the public from a lower volumetric flow rate.

Conversely, if the flow rate was higher than previously analyzed, the concentration of Ar-41 in the building would be lower, so doses to staff would be lower than calculated for 1000 cfm. For this condition, the resultant Ar-41 releases to the unrestricted area would be higher than that calculated for 1000 cfm. However, as is seen by looking at the COMPLY code results included every year in the OSURR annual report to the NRC, the estimated annual dose to a member of the public from these releases is a fraction of a millirem. This is more than an order of magnitude less than the ALARA constraint on dose to members of the public of 10 mrem per year specified in 10 CFR 20.1101(d). If the exhaust fan was exhausting air at a volumetric flow rate greater than 1000 cfm, no limits for members of the public would be exceeded, and therefore public safety would not be negatively impacted.

Furthermore, if there were to be a release of radioactive material in an emergency situation, the exhaust fan would be turned off to isolate the building in order to minimize release to the environment and exposure of the public. Thus, public safety is assured for emergency operations by the capability to shut off the exhaust fan rather than by the flow rate of the fan, making the fan volumetric flow rate irrelevant.

To recap these points, there are no safety implications stemming from the exact value for volumetric flow rate, as:

1) The flow rate has no effect on safe operation of the reactor. In the event of emergency operations, the exhaust fan would be turned off, making the volumetric flow rate of the exhaust fan irrelevant.
2) The flow rate has no effect on the safety of the public, as emissions are only a small fraction of the allowed limit.
3) The flow rate has no effect on the safety of the staff, as staff would be aware if dose rates in the restricted area were unexpectedly elevated. Clear evidence of this is the low annual doses reflected by staff dosimetry for normal operations.

Regarding the determination of the volumetric flow rate of the exhaust fan, in order to make a reasonable measurement, the flow must be well-developed, such that a steady directional flow stream is established. This would need to be accomplished with a length of pipe or duct that is at least ten times the diameter of a pipe or duct that is similar in cross sectional area to the fan. If this is not done, flow will likely bypass the measurement device, resulting in a misleading measurement. Measurement of flow rate in a duct leading to an exhaust stack is fairly straightforward, but the OSURR does not have such a configuration. Rather, it has an exhaust fan attached to a circular opening in the wall with louvers on the outside. The fan is located near the top of the north wall, about 33 feet above the floor. Because of its location and configuration, access to the fan for making a measurement has always been problematic and potentially dangerous. In addition, as part of voluntary upgrades in the recent past, a sturdy protective cage was installed around the fan, which now makes a reasonable flow measurement all but impossible without going to significant effort and expense. In order to make a reasonable volumetric flow rate measurement, the cage, which weighs a few hundred pounds, would have to be removed (and be reinstalled later). A pipe or duct approximately 1 foot in diameter by about 10 feet long would have to be somehow positioned in-line with the fan for making the measurement, which

cannot not be done using the overhead crane, as the fan is located higher than the crane. Finally, personnel would have to work at the fan height to make the measurement. Given that there are no actual reactor or radiation safety concerns arising from knowing the exact flow rate but that there are legitimate safety concerns from attempting to make a measurement, the OSURR Reactor Operations Committee members have made clear that they do not want the staff to attempt such a measurement. Therefore, measuring the flow rate is not a reasonable option.

However, the theoretical volumetric flow rate of the exhaust fan can be calculated using the characteristics of the fan, so this is what the OSURR staff has done for this letter. The staff has information regarding the fan motor, which states that it spins at 1550 rpm. Regarding the fan itself, an exhaustive search through available documents was performed, but no documentation was located. Therefore, the staff has made its best attempt at estimating the necessary parameters with which to estimate fan flow rate:

1) With the fan turned off, it was observed that it has four blades.
2) Using a digital picture of the fan, pixels were measured to determine that the diameter of the fan is half of the width of one of the wall panels where it is located, which are 2 ft wide, making the fan diameter 1 ft.
3) The pitch of each blade was visually estimated as 3 in (0.25 ft) using the cage discussed above as a frame of reference.

Using this information, the theoretical volumetric flow rate of the fan is calculated as 1217 cfm using:

$$\dot{V} = A_f * S_r * P_e$$

where:

$$\dot{V} = volumetric\ flow\ rate\ (cfm)$$

$$A = fan\ cross\ sectional\ area\ (ft^2)$$

$$S_r = rotational\ speed\ of\ the\ fan\ (rpm)$$

$$P_e = effective\ pitch\ of\ the\ fan\ (ft)$$

The calculated theoretical volumetric flow rate of 1217 cfm provides an upper bound on the actual flow rate of the fan, as the calculation does not take into account that air is a compressible fluid. Therefore, the actual value for the volumetric flow rate of the fan will be less, and will likely be around 1000 cfm. This value of 1217 cfm is less than the upper bound of 1500 cfm analyzed in the SAR update. Also, it is quite unlikely that the actual flow rate is nearly 60% lower than the calculated value, making it very unlikely that the actual flow rate is less than the lower bound of 500 cfm analyzed in the updated SAR. Therefore, the actual flow rate very likely falls within the range analyzed in the updated SAR.

To summarize, knowledge of the exact volumetric flow rate of the exhaust fan is unnecessary, and attempting a measurement would be problematic and potentially dangerous. There is no scenario under which the flow rate of the fan could lead to a dangerous situation for either the OSURR staff or for the general public. Even in the unlikely case of a fan flow rate approaching 0 cfm while operating, the area radiation monitors would detect the elevated external dose rate from buildup of the Ar-41 submersion cloud in the restricted area, and staff would be aware of this and respond appropriately. However, the

OSURR staff's best estimate for the fan's volumetric flow rate has been given to provide confidence that the updated SAR analysis reflects operating conditions. The OSURR exhaust fan flow rate has no meaningful impact on either normal or emergency reactor operations, and thus removal of the stated flow rate in Technical Specification 3.5 will not negatively impact safe reactor operation.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on 06-September-2019.

Sincerely,

Andrew Kauffman
Sr. Assoc. Director, OSU Nuclear Reactor Laboratory
1298 Kinnear Rd
Columbus, OH 43212