10-April-2019

U.S. Nuclear Regulatory Commission
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Subject: Response to NRC Request for Additional Information (RAI) letter to The Ohio State University Research Reactor (OSURR, License R-75) dated January 16, 2019

In response to a letter sent to the OSURR dated January 16, 2019 with the subject "THE OHIO STATE UNIVERSITY – REQUEST FOR ADDITIONAL INFORMATION RE: LICENSE AMENDMENT REQUEST TO MODIFY 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)", we are providing the requested additional information below. The NRC questions from the RAI letter are shown in bold italics, with the answer to each question following in plain text.

1) The NRC staff reviewed the supplemental information provided in Ref. 2, OSURR safety analysis report (SAR), change No. 2, which described the calculational methodology using an average over five effective half-lives of Argon (Ar)-41, in which the effective half-life takes into account losses from exhaust. The NRC staff is not clear, based on this SAR change, how the use of an effective half-life would account for losses from the ventilation exhaust.

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Provide a detailed description of the methodology used, including any calculations and the resulting Ar-41 concentrations, which indicated that the average of the five effective Ar-41 half-lives would take into account losses from exhaust, or justify why no additional information is needed.

As can be seen in SAR Section 6.3.4.2, losses from exhaust are accounted for by use of an effective half-life as follows:

This leads to the concept of the effective half-life, defined as follows;

$T_e = (T_d \times T_p)/(T_d + T_p)$

where T_e = *effective half-life*

T_d = *half-life from radioactive decay, and*

T_p = *half-life from building purging.*

From the building exhaust rate of 1000 CFM, and a building volume 70,000 cubic feet, a purging time of 70 minutes is obtained. A relatively simple analysis of the inflow and outflow of the building, assuming an equilibrium condition, shows that the value for T_p *in the above equation*

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should be 70 minutes. Using this, and assuming a value of 1.83 hours for the radiometric half-life of ^{41}Ar, an effective half- life of 42.75 minutes is obtained for ^{41}Ar in the reactor building.

It can be seen in the equation for average Ar-41 concentration (C_{ave}) in Section 6.3.4.2 that the average concentration is a function of a decay constant that corresponds to the effective half-life, which takes into account losses from exhaust. However, because this concentration is averaged over five effective half-lives for analyzing the effect of a puff release of saturation activity in Section 6.3.4.2, the reliance on exhaust rate drops out.

For context of this calculation, it should be noted that while this analysis for a puff release of saturation activity is helpful for providing a conservative envelope on the instantaneous and average concentrations that could possibly be reached in such a situation, it is not particularly insightful for actual expected exposures. The analysis in Section 6.3.4.3, which analyzes a continuous release from the rabbit, gives better insight into activity concentrations that might be encountered by workers. For a puff release from the rabbit, given the 1.83-hr half-life of Ar-41, it would take nearly 2 hr of full-power reactor operation without the blower running to reach 50% of saturation activity in the rabbit tube, and it would take over 6 hr to reach 90% of saturation activity. Therefore, a puff release of near-saturation activity cannot happen frequently, which was likely a contributing factor in determining that averaging over 5 effective half-lives was a reasonable methodology.

To get a feel for the practical impact of averaging over 5 effective half-lives for analyzing puff releases, consider the case of the building exhaust fan operating at the lowest considered (and therefore most limiting) flow rate of 500 cfm. In this case, the effective half-life for decay + exhaust is 61.5 minutes. 5.1 hr of full-power reactor operation without the rabbit blower running would produce a puff release of 86% saturation activity from the rabbit. After the puff release, in the time of the 5 effective half-lives (5.1 hr) that it would take for activity to build back up again to that 86% saturation activity, the activity concentration in the building will have fallen to 3% of the initial concentration from the puff release. Therefore, while averaging activity concentration over 5 half-lives seemingly does not take into account the losses from exhaust, this is not impactful on the consideration of the activity concentrations to which workers might actually be exposed. Rather, it sets a conservative envelope on activity concentration from a rabbit puff release. For the exhaust fan running at a flow rate greater than 500 cfm, the activity concentration will be even further from this conservative envelope. For example, for an exhaust fan flow rate of 1500 cfm, the effective half-life would be 32.8 minutes. Therefore, for a rabbit puff release of 86% saturation activity, the activity concentration in the building would drop to 0.2% of the initial release concentration in the 5.1 hr it would take to build back up to 86% saturation activity in the rabbit tube. As was stated above, the analysis in Section 6.3.4.3, which analyzes a continuous release from the rabbit, gives better insight into average activity concentrations that might actually be encountered by workers, and it more explicitly reflects the effect of exhaust fan flow rate on potential building activity concentrations.

2) The NRC staff observed, in its review of Ref. 2, that several OSURR SAR changes involved calculations of the Ar-41 concentration, at different volumetric flow rates (500 cubic feet per minute (cfm), 1000 cfm, and 1500 cfm), which resulted in concentrations that exceeded the derived air concentration (DAC). See OSURR SAR change Nos.: 3), 7), and 8). The NRC staff is not clear, how

OSURR complies with the requirements in 10 CFR 20.1702, "Use of other controls," to limit exposure to workers during the periods when the Ar-41 concentration exceeds the DAC.

The regulations in 10 CFR 20.1702 requires licensees to increase monitoring to limit the intake of airborne radioactive isotopes when an airborne radioactive area exists, and other processes or engineering controls are not practical. Furthermore, the regulations in 10 CFR 20.1702 provides methods, as listed in 10 CFR 20.1702 (1) through (4).

Provide a description of the methods used to limit the intake of Ar-41 during the occurrences when its concentration exceeds the DAC, as required by 10 CFR 20.1702, or justify why no additional information is needed.

10 CFR 20.1702 states:

> *§ 20.1702 Use of other controls.*
>
> *(a) When it is not practical to apply process or other engineering controls to control the concentrations of radioactive material in the air to values below those that define an airborne radioactivity area, the licensee shall, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means—*
>
> *(1) Control of access;*
>
> *(2) Limitation of exposure times;*
>
> *(3) Use of respiratory protection equipment; or*
>
> *(4) Other controls.*

Referencing Appendix B to 10 CFR 20, one can see that Ar-41 is classified as "Submersion" class, rather than falling under a classification of D, W, or Y, which correspond to airborne radioactive isotopes which are retained by the body with "a range of clearance half-times of less than 10 days for D, for W from 10 to 100 days, and for Y greater than 100 days". Belonging in the submersion class means that the exposure consideration is external exposure from "immersion in a semi-infinite cloud of uniform concentration". Therefore, dose from Ar-41 is an external dose consideration, which will be monitored on the laboratory area radiation monitors (ARMs) and worker dosimetry, satisfying the need for increased monitoring beyond the effluent monitor for this submersion-class airborne radioactive isotope.

Furthermore, because Ar-41 is a submersion-class airborne radioactive isotope, there is no intake to limit per 10 CFR 20.1702, as the noble gas Ar-41 is not retained in the body like most other airborne radioactive isotopes. However, as part of its ALARA program, the laboratory staff ensures through use of access control, dosimetry, survey meters, and ARMs that doses to workers are kept as low as reasonably achievable (and do not exceed the university's ALARA limits) and that visitor doses are kept below limits for the public.

3) The NRC staff observed, in its review of Ref. 2, that OSURR SAR change No. 9), stated that the average Ar-41 concentration over the past decade (2008-2017), was unaffected by the assumed 1000 cfm nominal volumetric flow rate of the exhaust fan, as the effluent monitor directly measures the Ar-41 concentration upstream of the exhaust fan. The NRC staff does not understand how the concentration is unaffected by the exhaust fan.

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Provide a description indicating how the Ar-41 concentration is unaffected by a change to the volumetric flow rate of the exhaust fan, or justify why no additional information is needed.

The statement referenced above from the updated SAR Section 6.3.4.9 is not meant to indicate that the building's Ar-41 concentration is unaffected by the exhaust fan volumetric flow rate, which it clearly would be. Rather, it is stating that regardless of the actual exhaust fan volumetric flow rate during the period 2008-2017, the average *measured* concentration of 6.01×10^{-8} uCi/ml, which was measured with the effluent monitor during that period, is unaffected. (The measurement "is what it is".) As is stated in the updated SAR text, "the effluent monitor directly measures the Ar-41 concentration upstream of the exhaust fan", so it is measuring an actual concentration in the building near the exhaust fan. This can be seen in the equation in Section 6.3.4.9, which shows how the number of counts measured on the effluent monitoring system during some period of time is converted to the equivalent building Ar-41 concentration. Exhaust fan volumetric flow rate is not part of this equation. Whether the exhaust fan volumetric flow rate was 500 cfm, 1500 cfm, or anywhere in between during that time, the average measured Ar-41 concentration was 6.01×10^{-8} uCi/ml, which is well below the DAC limit.

Since this statement caused confusion during the review, we propose to change the statement:

> Note that this result is unaffected by the assumed 1000 cfm nominal volumetric flow rate of the exhaust fan

with the following:

> Note that as can be seen from the equation above, this measured concentration is unaffected by the assumed 1000 cfm nominal volumetric flow rate of the exhaust fan

I declare under penalty of perjury that the foregoing is true and correct.
Executed on 10-April-2019.

Sincerely,

AL Kff

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