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U. S. Nuclear Regulatory Commission
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Reference: Oregon State University TRIGA Reactor (OSTR), Docket No. 50-243, License No. R-106 Letter submitted January 27, 1994

Subject: Proposed Amendments to OSTR Technical Specifications

Gentlemen:

It has come to my attention that our letter of January 27, 1994 requesting minor amendments to the OSTR Technical Specifications was not submitted under oath or affirmation. Therefore, I am resubmitting the complete letter and attachments appropriately notarized.

The purpose of this letter is to request minor amendments to the OSTR Technical Specifications in order to make them consistent with the revised 10 CFR Part 20. Attachment A to this letter contains supporting calculations regarding argon-41 releases, while Attachment B contains the necessary replacement pages should you agree to the proposed amendments.

Several of the proposed changes are of a similar nature and are discussed collectively below. Others are more specific and are, therefore, discussed individually beginning on page 2.

From the collective standpoint, many of the proposed changes are needed because a particular Technical Specification, its objective, or its basis, currently includes the term "maximum permissible concentration (MPC)." Furthermore, all of the references in the Technical Specifications to MPCs are to unrestricted area MPCs, and therefore the most appropriate current wording is "effluent concentration value," as used in Appendix B to the new 10 CFR 20. Because these changes are being made solely to conform to the new 10 CFR 20, they have no negative safety implications for the OSU TRIGA Reactor (OSTR).

At various places in the OSTR Technical Specifications, concentration units for airborne radioactivity are given as "microcuries/cc." In order to maintain conformity with the new 10 CFR 20, it is proposed that these be changed to "microcuries/ml." Since ml and cc are numerically the same, this is just a minor housekeeping change with no negative safety implications for the OSTR.

A020

Proposed Change to Technical Specification 3.6.2 (Pages 13 & 14)

Revise the objective and the basis so that they now read:

"Objective. The objective is to ensure that the concentration of argon-41 in the unrestricted areas is consistently well below the applicable effluent concentration value in 10 CFR 20.

Basis. If argon-41 is continuously discharged at 4×10^{-6} μCi/ml, calculations using current guidance show that the maximum annual average ground concentration of argon-41 in unrestricted areas would be only 3% of the applicable effluent concentration value of 1×10^{-8} μCi/ml found in 10 CFR 20. Consequently, the annual total effective dose equivalent to an individual exposed to this concentration would be less than 3 mrem. This is significantly less than the annual public dose limit of 100 mrem. Similarly, if argon-41 is discharged at 4×10^{-6} μCi/ml under the worst-case short-term weather conditions, the maximum total effective dose equivalent rate would be less than 0.02 mrem/h. Therefore, a person exposed under these conditions would receive a dose much less than the public limit of 2 mrem in one hour."

In this instance, the Technical Specification remained the same; however, the objective and the basis for the specification needed revision. This provided an opportunity to re-evaluate the atmospheric dispersion calculations for the OSTR using current guidance. These calculations are included in Attachment A. Based on the assumptions and methodology used in these calculations, the results show that although the effluent concentration value for argon-41 has decreased, releasing argon-41 at a concentration of 4×10^{-6} μCi/ml from the stack still results in an annual average ground concentration in the unrestricted area well within the regulatory limit. Additional calculations were also needed to confirm that the annual and one hour total effective dose equivalents met the new 10 CFR 20 limits. This is clearly demonstrated in Attachment A.

Proposed Change to Technical Specification 3.7.1 (Page 14)

Revise the basis so that it now reads:

"Basis. During normal operation of the ventilation system, the annual average ground concentration of argon-41 in unrestricted areas is well below the applicable effluent concentration limit in 10 CFR 20. In addition, the worst-case maximum total effective dose equivalent rate is well below the limit for individual members of the public. In the event of a substantial release of airborne radioactive material, the ventilation system will be secured automatically. Therefore, limiting the operation of the reactor to only those times when the ventilation system is operating ensures the maximum designed control over releases of airborne radioactive material."

These changes reflect the results of the calculations addressed above (See Attachment A). In addition, the wording in the last sentence of the basis was clarified.

Proposed Change to Technical Specification 3.8.e (Page 15)

Revise the last phrases so that this paragraph reads:

"e. Where the possibility exists that the failure of an experiment (except fueled experiments) under (1) normal operating conditions of the experiment or reactor, (2) credible accident conditions in the reactor, or (3) possible accident conditions in the experiment, could release radioactive gases or aerosols to the reactor bay or the unrestricted area, the quantity and type of material in the experiment shall be limited such that the airborne concentration of radioactivity in the reactor bay and the unrestricted area will not exceed the applicable regulatory concentration limits in 10 CFR 20, assuming 100% of the gases or aerosols escape from the experiment."

As originally written, this specification was confusing because it addressed releases to both the reactor bay and the unrestricted area, and then included the phrase "averaged over the year." It is clearly incorrect to average restricted area (reactor bay) airborne concentrations over the year, and therefore, the specification was carefully rewritten to make it applicable to releases into both the restricted and unrestricted area.

In addition, the last three words were added to clarify the fact that the 100% release assumption applies to the experiment and not to the reactor bay or unrestricted area. This is clearly the intent, since the next specification after 3.8.e (i.e. 3.8.f) details the various assumptions to be used regarding releases to the reactor bay.

Proposed Change to Technical Specification 3.8.f (Page 15)

Change the statement, "pursuant to d., above," to "pursuant to e., above,"

This is just a correction of a typographical error. Referencing d. is clearly incorrect.

Proposed Change to Technical Specification 6.7.e.6, Liquid Waste, (a) (2) (Page 36)

Change "microcuries/cc." to "microcuries/ml."

Proposed Change to Technical Specification 6.7.e.6, Liquid Waste, (a) (4) (Page 36)

Revise the last phrase so that paragraph (4) reads:

"(4) Estimated average concentration of the released radioactive material at the point of release for each month in which a release occurs, in terms of microcuries/ml and fraction of the applicable concentration in 10 CFR 20."

The 10 CFR 20 liquid concentration limits for sewer releases are given in terms of monthly average concentrations. Also, from the heading on this set of specifications, the liquid waste releases are currently required to be summarized on a monthly basis.

Therefore, this proposed change merely clarifies what is meant by the words "the reporting period" in the old wording. Furthermore, since liquid releases from the reactor have been reduced to virtually zero, there will be nothing to report under this requirement except in those few months where a release is made. The new wording clarifies this fact and thus improves the specification.

Proposed Change to Technical Specification 6.7.e.6, Gaseous Waste, (a) (2) (Page 36)

Correct the grammatical errors by revising this to read:

"(2) Total estimated quantity (in curies) of argon-41 released during the reporting period based on data from an appropriate monitoring system."

Proposed Change to Technical Specification 6.7.e.6, Gaseous Waste, (a) (3) (Page 36)

Revise this to read:

"(3) Estimated average atmospheric diluted concentration of argon-41 at the point of release for the reporting period, in terms of microcuries/ml and fraction of the applicable effluent concentration value."

In the current wording, it is not clear whether the concentration being referenced is at the point of release or in the unrestricted area. It has always been interpreted and reported in the OSTR Annual Report as being at the point of release, and as a fraction of the 4×10^{-6} μCi/ml concentration limit given in Technical Specification 3.6.2. This makes the most sense, since to report an unrestricted area concentration would require agreement on the annual weather conditions and calculations, while the concentration at the point of release can be obtained directly from stack monitor measurements. Therefore, this revision clarifies the situation that has been assumed since the start-up of the facility.

Proposed Change to Technical Specification 6.7.e.6, Gaseous Waste, (a) (5) (Page 37)

Change "cc" to "ml".

Proposed Changes to Technical Specification 6.7.e.6 Gaseous Waste (a) (6) (Page 37)

Replace the word "waste" with "effluent", "MPC" with "effluent concentration" in two places, and "cc" with "ml", so that it now reads:

"(6) An estimate of the average concentration of other significant radionuclides present in the gaseous effluent discharge in terms of microcuries/ml and fraction of the applicable effluent concentration value for the reporting period, if the estimated release is greater than 20% of the applicable effluent concentration."

In keeping with Radiation Center policy and OSTR procedures, all of the proposed changes to the OSTR Technical Specifications have been reviewed and approved by the OSTR Reactor Operations Committee. In addition, proposed revised pages for the Technical Specifications are attached for your convenience. Should there be a need for further information, please let me know. Thank you for your consideration of this request.

Yours sincerely,

Brian Dodd
Director

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cc: Non-Power Reactor, Decommissioning, and Environmental Projects Directorate, USNRC, Washington, D. C. 20555 ATTN: Mr. Al Adams
Regional Administrator, USNRC, Region IV, Arlington, TX
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D. S. Pratt, Senior Health Physicist
A. D. Hall, Reactor Supervisor

STATE OF OREGON)
)ss
COUNTY OF BENTON)

Brian Dodd, being first duly sworn on oath, deposes and says that he has affixed his signature to the letter above in his official capacity as Director, Oregon State University Radiation Center; that he has signed this letter requesting minor amendments to the OSTR Technical Specifications in order to make them consistent with the revised 10 CFR Part 20; that in accordance with the provisions of Part 50, Chapter 1, Title 10 of the Code of Federal Regulations, he is attaching this affidavit; that the facts set forth in the within letter are true to his best information and belief.

OFFICIAL SEAL
SHIRLEY CAMPBELL
NOTARY PUBLIC - OREGON
COMMISSION NO.026332
MY COMMISSION EXPIRES AUG. 28, 1997

Brian Dodd
Director

Subscribed and sworn to before me, a Notary Public, in and for the County of Benton, State of Oregon, this 1st day of August, A.D., 1994.

Notary Public of Oregon

8/28/97
My Commission Expires

ATTACHMENT A

ARGON-41 RELEASES FROM THE OREGON STATE UNIVERSITY TRIGA REACTOR

Maximum Annual Average Ground Concentration of Argon-41 in the Unrestricted Area

Data:

Actual stack height = 20.1 m.

Stack diameter = 0.533 m.

Building height = 13.0 m

Air exit velocity from the stack = 21.6 m s^{-1}.

Air volume release rate from the stack = 4.83 m^3 s^{-1}.

Pasquill/Gifford dispersion coefficients (σ_y, σ_z), (extrapolated where necessary for distances less than 100 m using the parametric equations in ref. 1).

Assumptions:

Elevated Release

USNRC Regulatory Guide 1.111 (ref 2.), in position 2.a., states that elevated releases should be assumed "for effluents exhausted from release points that are higher than twice the height of an adjacent solid structure". This is not the case for the OSTR. However, regulatory position 2.b. goes on to say that "for effluents released from vents or other points at the level of or above adjacent solid structures, but lower than elevated release points, the effluent plume should be considered as an elevated release whenever the vertical exit velocity of the plume is at least five times the horizontal windspeed at the height of release". Since the vertical exit velocity of the OSTR plume is 21.6 m s^{-1}, this release can be regarded as elevated for most weather conditions, and certainly for all of the annual average conditions (see below).

Annual Average Weather Conditions of:
1/3 Pasquill Type C, wind speed 3 m s^{-1}
1/3 Pasquill Type D, wind speed 2 m s^{-1}
1/3 Pasquill Type F, wind speed 2 m s^{-1}

Some assumptions have to be made with respect to the annual average weather conditions, with respect to stability category and wind speeds. Due to the fact that actual stability category data are unavailable for the area around the OSTR, it was decided to follow the guidance provided in ANSI/ANS-15.7 (ref.3.). Section 4.2.3 of this standard states that the assumptions given above should be used "in cases where diffusion estimates are sought for periods exceeding 4 days".

Plume Rise of:
8.5 m for 3 m s^{-1} wind speed, and
14.9 m for 2 m s^{-1} wind speed

Regulatory Guidance (ref. 2.) allows for plume rise above the stack height under appropriate conditions. ANSI/ANS-15.7 Appendix B provides more detailed guidance. The first formula given in the appendix is applicable to the OSTR. "For small volume releases (≤ 50 m^3 s^{-1}; OSTR's is 4.83 m^3 s^{-1}), having significant exit speeds (≥ 10 m s^{-1}; OSTR's is 21.6 m s^{-1}), but with little temperature difference (≤ 50°C above ambient; OSTR's is ≤ 20 °C most of the time) the plume rise can be calculated as follows:

$$\Delta h = D\left(\frac{V_s}{\bar{u}}\right)^{1.4}$$

where: Δh = height of plume rise above the release point, m.
D = diameter of the stack, m.
V_s = effluent vertical efflux velocity, m s^{-1}.
u = mean wind speed at actual stack height, m s^{-1}.

Using the values for these parameters given in the data section, provides the following results:

Wind speed = 3 m s^{-1} :	Δh = 8.5 m	h_e = 28.6 m
Wind speed = 2 m s^{-1} :	Δh = 14.9 m	h_e = 35.0 m

where: h_e = effective release height, m.

Gaussian Plume Dispersion Equation Using Sector Averaging

Regulatory Guide 1.111 provides an equation for determining the radionuclide centerline concentration at ground level using the constant mean wind direction model (eqtn. 3). This equation which is repeated more specifically in ANSI/ANS-15.7 Section 4.2.2, allows for sector averaging over a 22.5° sector for long duration exposures. The equation is:

$$\chi = \frac{2.032\, Q}{\bar{u}\, \sigma_z\, x} \exp\left(-\left(\frac{h_e^2}{2\sigma_z^2}\right)\right) \quad \mu\text{Ci ml}^{-1}$$

where: χ = concentration, μCi ml^{-1}
Q = release rate, μCi s^{-1}
h_e = effective release height, m
u = mean wind speed, m s^{-1}
σ_z = vertical dispersion coefficient, m
x = distance from release point to dose point, m

Results

Using the equations, data and assumptions outlined above the following results are obtained:

Annual Average Ground Concentration					
Distance (m)	Pasquill C χ/Q (s m^{-3})	Pasquill D χ/Q (s m^{-3})	Pasquill F χ/Q (s m^{-3})	Mean χ/Q (s m^{-3})	Unrestricted Area Conc. for 4×10^{-6} μCi ml^{-1} released (μCi ml^{-1})
50	3.2×10^{-12}	9.4×10^{-35}	0.00	1.1×10^{-12}	2.1×10^{-17}
100	1.7×10^{-6}	8.6×10^{-14}	2.4×10^{-56}	5.8×10^{-7}	1.1×10^{-11}
200	3.8×10^{-5}	2.9×10^{-7}	3.2×10^{-19}	1.3×10^{-5}	2.5×10^{-10}
300	4.5×10^{-5}	5.6×10^{-6}	6.0×10^{-12}	1.7×10^{-5}	3.2×10^{-10}
350	4.1×10^{-5}	1.0×10^{-5}	2.4×10^{-10}	1.7×10^{-5}	3.3×10^{-10}
400	3.6×10^{-5}	1.4×10^{-5}	2.9×10^{-9}	1.7×10^{-5}	3.2×10^{-10}
500	2.7×10^{-5}	1.9×10^{-5}	5.5×10^{-8}	1.6×10^{-5}	3.0×10^{-10}
800	1.3×10^{-5}	2.0×10^{-5}	1.5×10^{-6}	1.2×10^{-5}	2.3×10^{-10}
1000	9.2×10^{-6}	1.7×10^{-5}	3.1×10^{-6}	9.9×10^{-6}	1.9×10^{-10}
1500	4.5×10^{-6}	1.1×10^{-5}	5.7×10^{-6}	7.2×10^{-6}	1.4×10^{-10}
2000	2.7×10^{-6}	7.8×10^{-6}	6.3×10^{-6}	5.6×10^{-6}	1.1×10^{10}
2500	1.8×10^{-6}	5.7×10^{-6}	5.9×10^{-6}	4.5×10^{-6}	8.7×10^{-11}
3000	1.3×10^{-6}	4.4×10^{-6}	5.4×10^{-6}	3.7×10^{-6}	7.1×10^{-11}

It can be seen that the maximum annual average ground concentration in the unrestricted area is 3.3×10^{-10} μCi ml^{-1}, which is 3% of the 10 CFR 20 unrestricted area effluent concentration value of 1×10^{-8} μCi ml^{-1}.

Using the relationship implied in 10 CFR 20, that being exposed to an argon-41 concentration of 1×10^{-8} μCi ml^{-1} for one year results in a dose of 100 mrem, means that a concentration of 3.3×10^{-10} μCi ml^{-1} would result in an annual dose of 3.3 mrem. However, the actual (non-rounded) dose factor from ICRP 30 (ref.4) for submersion in a semi-infinite cloud of argon-41 is 2.173×10^{-10} Sv h^{-1} per Bq m^{-3} or 8.04×10^{5} mrem h^{-1} per μCi ml^{-1}. (This is the factor from which the 10 CFR 20 numbers are derived and then rounded.) This dose factor results in an annual total effective dose equivalent of 2.3 mrem for a continuous submersion in 3.3×10^{-10} μCi ml^{-1} of argon-41.

Worst-Case Short-Term Maximum Total Effective Dose Equivalent in the Unrestricted Area

Assumptions:

All of the data for the previous calculation are the same for this calculation; however, some of the assumptions are different.

Elevated Release

The assumption that this is an elevated release is still valid for this calculation.

Worst-Case Weather Conditions of:
Pasquill Type F, wind speed 1 m s^{-1}, or
Pasquill Type A, wind speed 0.5 m s^{-1}

ANSI/ANS-15.7 guidance in Section 4.2.1 for exposure times of less than 2 hours states that "values of the necessary parameters shall be consistent with Pasquill condition F, and with a wind speed of 1 m s^{-1}. Other Pasquill conditions should be used in cases where the F condition is not sufficiently conservative for elevated releases". Pasquill condition A will always give the highest concentration for a given wind speed and stack height. Similarly, the lowest wind speed for a given Pasquill category will always give the greatest concentration. Hence, the calculations were performed for the conditions given above.

Plume Rise of:
14.9 m for Pasquill Type F, and
0 m for Pasquill Type A

Using the methodology and equations discussed above, much greater plume rises could have been assumed for the very low wind speeds considered here. However, this is a worst-case calculation and, therefore, the Pasquill F condition was limited to the previous plume rise which is applicable to a 2 m s^{-1} wind speed. A survey of the literature reveals that determining plume rise in very unstable atmospheric conditions is very difficult. For this reason, and for extra conservatism, no plume rise was assumed for Pasquill condition A.

Gaussian Plume Dispersion with No Sector Averaging

The standard gaussian equation for the centerline, ground level concentration for elevated releases is applicable to the worst-case short-term situation considered here (ANSI/ANS-15.7).

$$\chi = \frac{Q}{\overline{u}\,\pi\,\sigma_y\,\sigma_z}\exp\left(-\left(\frac{h_e^2}{2\sigma_z^2}\right)\right)\quad \mu\text{Ci ml}^{-1}$$

where all the parameters are as given before.

Results

Using the equations, data and assumptions outlined above, the following results are obtained:

Worst-Case Short-Term Concentration				
Distance (m)	Pasquill A		Pasquill F	
	χ/Q (s m^{-3})	Unrestricted Area Conc. for 4×10^{-6} μCi ml^{-1} released (μCi ml^{-1})	χ/Q (s m^{-3})	Unrestricted Area Conc. for 4×10^{-6} μCi ml^{-1} released (μCi ml^{-1})
37	4.6×10^{-5}	8.9×10^{-10}	0.0	0.0
50	3.0×10^{-4}	5.8×10^{-9}	0.0	0.0
90	7.7×10^{-4}	1.5×10^{-8}	0.0	0.0
100	7.6×10^{-4}	1.4×10^{-8}	0.0	0.0
150	5.3×10^{-4}	1.0×10^{-8}	3.9×10^{-28}	7.5×10^{-33}
200	3.5×10^{-4}	6.8×10^{-9}	2.4×10^{-18}	4.7×10^{-23}
300	1.6×10^{-4}	3.1×10^{-9}	4.6×10^{-11}	8.9×10^{-16}
400	8.2×10^{-5}	1.6×10^{-9}	2.2×10^{-8}	4.3×10^{-13}
500	4.6×10^{-5}	8.9×10^{-10}	4.4×10^{-7}	8.4×10^{-12}
800	1.2×10^{-5}	2.3×10^{-10}	1.2×10^{-5}	2.3×10^{-10}
1000	5.8×10^{-6}	1.1×10^{-10}	2.6×10^{-5}	4.9×10^{-10}
1500	1.5×10^{-6}	2.8×10^{-11}	4.9×10^{-5}	9.4×10^{-10}
1750	8.4×10^{-7}	1.6×10^{-11}	5.3×10^{-5}	1.0×10^{-9}
2000	5.2×10^{-7}	9.9×10^{-12}	5.5×10^{-5}	1.1×10^{-9}
2500	2.2×10^{-7}	4.2×10^{-12}	5.3×10^{-5}	1.0×10^{-9}
3000	1.1×10^{-7}	2.1×10^{-12}	4.9×10^{-5}	9.5×10^{-10}

It can be seen that the maximum worst-case short-term concentration of argon-41 at ground level in the unrestricted area is 1.5×10^{-8} μCi ml^{-1}. This converts to a total effective dose equivalent rate of 0.017 mrem h^{-1} using the implied 10 CFR 20 conversion factor, and 0.012 mrem h^{-1} using the more accurate ICRP 30 factor.

REFERENCES

1. Wong, B. M. K., Binney, S. E., Dodd, B., Johnson, A. G., Ringle, J. C., "Calculated Atmospheric Radioactivity from the OSU TRIGA Research Reactor Using the Gaussian Plume Diffusion Model." OSU-NE-7903 (1979).

2. US Nuclear Regulatory Commission, Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors." USNRC (1977).

3. American Nuclear Society, "Research Reactor Site Evaluation." ANSI/ANS-15.7, Final Draft, (Nov. 1992).

4. Internation Commission on Radiological Protection, "Limits for Intakes of Radionuclides by Workers." ICRP 30 (1979).