APPENDIX P

Monitoring, Calculating, and Controlling Air Concentrations When Using Noble Gases or Radioactive Aerosols

Radioactive aerosols or gases are only administered when airborne concentrations are within the limits prescribed by the ALIs, DACs, and effluent concentrations, July 1993, Table I and Table II and in accordance with 64E-5.629, Florida Administrative Code, (F.A.C.).

PROCEDURE FOR MONITORING OR COUNTING TRAP EFFLUENT

Charcoal traps can significantly reduce air contamination. They can also become saturated or spoiled by improper use, humidity, chemicals, or inadequate maintenance.

Radioactive Aerosols Used: ☐ Tc 99m ☐ Other: ___________________

☐ Aerosols are directly vented to the atmosphere through an air exhaust.

☐ Aerosols are not directly vented to the atmosphere. Spent aerosols are collected in a shielded trap with an effluent air contamination monitor. The monitor manufacturer's instructions for checking its accuracy and constancy are followed and records of the checks are maintained.

☐ Spent aerosol is collected in a shielded single-use device. The trap effluent of single-use devices is not monitored.

Noble Gases Used: ☐ Xenon 133 ☐ Other: _______________________

☐ Spent gas is directly vented to the atmosphere through an air exhaust system.

☐ Spent gas is not directly vented to the atmosphere. It is recirculated within the facility's air handling system. Recirculated air meets the limits specified in 64E-5.312, F.A.C. and the limits stated in ALIs, DACs, and effluent concentrations for Xenon 133 or other noble gases, Table II, Col. 1.

☐ Spent gas is not directly vented to the atmosphere. Spent gas is collected in a shielded trap with an effluent air contamination monitor. The monitor manufacturer's instructions for checking accuracy and constancy are followed and a record of the checks is maintained.

☐ Spent gas is not directly vented to the atmosphere. Spent gas is collected in a shielded trap. The trap effluent is not monitored by a detector designed to monitor effluent gas. The activity in the trap is counted on receipt and once each month. Monthly, prior to use, during one patient study, effluent is collected from the trap in a plastic bag. The activity in the bag is counted by holding the bag against a gamma camera, with the camera adjusted to detect the noble gas. The counts per minute (cpm) of the bag are compared to background cpm with no other radioactivity in the area. A record is kept of the date, the background cpm, and the measured bag cpm.

☐ The radiation safety officer (RSO) establishes an action level based on bag cpm levels or a multiple of background cpm. A significant increase in the bag cpm indicates that the trap is breaking down and will be replaced.

☐ The trap manufacturer's instructions are followed for replacing the trap.

<u>Attached Calculations</u>

- ☐ 1. Occupational dose from airborne effluent
- ☐ 2. Public Dose from airborne effluent
- ☐ 3. Negative air pressure in work areas
- ☐ 4. Tabulation of all measured air exhaust rates
- ☐ 5. Tabulation of all measured air supply rates
- ☐ 6. Spilled gas clearance time calculations
- ☐ 7. Other-Facility diagram with supply and exhaust rates for each opening in the restricted area.

<u>OCCUPATIONAL EXPOSURE CALCULATIONS FOR NOBLE GASES</u>

☐ The total activity released to the restricted area (activity used each week multiplied by estimated fractional loss per study - 20%) divided by the total volume of air exhausted over the week (sum of all exhaust rates multiplied by the number of hours the exhaust system was "on" during the week) - is less than the applicable limit stated in the ALIs, DACs, and effluent concentrations, Table I, Occupational Values, Column 3 Inhalation DAC .

☐ Other method used to calculate exposure - see attachment.

If limits are exceeded, determine if the average number of studies actually performed agrees with the number used in the calculations. If necessary fewer studies will be scheduled.

______________ Estimated number of studies per week

______________ Activity to be administered per study

______________ Estimated activity lost to the work areas per study (assume 20% loss)

______________ Sum of all exhaust air rates in cfm [ft^3/min] in areas where xenon gas is administered

______________ Estimated number of minutes the exhaust system is on during a week (continuous = 10,080 minutes = 168 hours)

______________ Total volume of air exhausted over the week [1ft^3 = 28,317 ml *- or -* 28,317 ml/ft^3]

$$\frac{\text{Activity used per week x 20\%}}{\text{Total volume of air exhausted over the week}} \times 50 \text{ weeks} = \text{Average annual airborne concentration}$$

☐ Average annual airborne concentration < ALIs, DACs, and effluent concentrations, Table I, Occupational Values, Column 3 Inhalation DAC.

Documenting Negative Air Pressure
in Areas Where Noble Gases are Used

Attached is a facility diagram of each room where noble gas is administered. The diagram indicates the location of each air vent in the area and identifies each vent as a supply air vent or an exhaust air vent. Measured airflow in cubic feet per minute (cfm) for each air vent is recorded on the diagram.

Sum the total airflow for the supply air and sum the total airflow for the exhaust vents. Compare the total supply to the total exhaust. If the rate of total supply airflow exceeds the total rate of exhaust air flow, adjustments to the air handling system are made. Total air exhaust rate must be greater than total supply airflow, where noble gas is administered.

☐ This facility has more than two rooms where xenon gas is administered. Negative pressure calculations for the additional rooms are attached.

Xenon Room

Location or room number: ___________________________________

_________ Sum of measured airflow of supply air vents in area where gases are administered (if seasonal airflow differences occur,
the lesser airflow rate is used).

_________ Sum of measured airflow exhaust air vents in the imaging room.
_________ Measured airflow exhaust at the storage site
(e.g., a fume hood if applicable).

☐ The total exhaust rate is larger than the total air supply rate, indicating that the room where xenon gas is administered is at negative pressure, in comparison to the surrounding areas. (If more than one room is used for xenon studies, a measurement of air flow will need to be made for each additional room.)

SPILLED NOBLE GAS - AREA CLEARANCE PROCEDURES

Calculations are provided to determine for how long a room should be cleared in case of a noble gas spill. The results of the calculations are posted in areas where noble gas is administered. The clearance time may also be posted outside the administration area for reference during a spill. Clearance times are recalculated when major changes to the air handling system occur.

__________ Minutes = Calculated Spilled Gas Clearance Time for __________________

__________ Minutes = Calculated Spilled Gas Clearance Time for __________________

☐ Clearance time(s) posted as required in subsection 64E-5.629(5), F.A.C.

☐ Spilled gas clearance times are calculated as described in this appendix.

OR

☐ Spilled gas clearance times are calculated *other* than as described in this appendix and are attached for review.

SPILLED NOBLE GAS CLEARANCE TIME CALCULATION

Occupational DAC-hour values are found in the ALIs, DACs, and effluent concentrations, Table I, Occupational Values, Col. 3

Use DAC values to determine when the NMT or authorized user may return to the spill area.

- The Xe 133 DAC-hour value is 1×10^{-4} uCi/ml in restricted areas.
- The Xe 127 DAC-hour value is 1×10^{-5} uCi/ml in restricted areas.

The non-occupational (MOP) values are found in the ALIs, DACs, and effluent concentrations, Table II, Effluent Concentrations, Col. 1.

Use the Effluent Concentrations levels to determine when a MOP may return to the spill area.

- The Xe-133 non-occupational or effluent concentration value is 5×10^{-7} uCi/ml.
- The Xe-127 non-occupational or effluent concentration value is 6×10^{-8} uCi/ml.

Determine "A" The highest activity in microcuries in a single container of noble gas.

Determine "Q" The total room air exhaust measured in milliliters per minute. Measure the airflow (cfm) of each exhaust vent in the room and find the sum. Exhaust may be either the normal air exhaust or a specially installed gas exhaust system.

Determine "C" The allowable air concentrations for occupational exposure in restricted areas (derived air concentration-hour or DAC-hour) - *or* - the air concentration (effluent concentration) limits for member of the public dose.

Determine "V" The volume of the room in milliliters, [$1 ft^3 = 28,317$ ml -*or* - $28,317 ml/ft^3$].

Determine "t" The calculated evacuation time.

"ln" Is the Natural log

$$t = \frac{-V}{Q} \times \ln (C \times V/A)$$

Sample Calculation

Evacuation time $t = \frac{-V}{Q} \times \ln (C \times V/A)$

Volume of room in milliliters $V = 12' \times 30' \times 8' = 2880\ ft^3 \times 28,317\ ml/ft^3 = 81,552,960\ ml$

Room exhaust ml/minute $Q = 900\ cfm \times 28,317\ ml/ft^3 = 25,485,300\ ml/min$

Effluent concentration limit $C = 5 \times 10^{-7}$ uCi/ml (Xe-133)

Activity in microcuries A = 10 mCi = 10,000 uCi

$$t = \frac{-81,552,960}{25,485,300} \times \ln (5 \times 10^{-7} \times 81,552,960 / 10,000)$$

$$t = -3.2 \times \ln (0.0040776)$$

$$t = -3.2 \times -5.50$$

t = 17.6 minutes