

RINSC OPERATING PROCEDURES

Emergency Air Filter Efficiency Test

I. SCOPE:

The purpose of this procedure is to provide guidance for determining the efficiency of the Emergency Exhaust System (EES) for the removal of iodine, which is required to be tested annually by Technical Specification 4.4, 4.5, 4.6 item 4. Technical Specification 5.4 requires that the minimum removal efficiency be 99.97% for the charcoal filter in the system.

II. DISCUSSION:

Under emergency conditions, the air in the main reactor room is diverted to the EES filter bank located in a shielded basement area beneath the main reactor building. The filter bank is composed of a roughing filter, a HEPA filter, and an activated charcoal filter followed by another HEPA filter. The activated charcoal section of this filter is engineered to remove 99.97% of any airborne radioactive iodine present in the reactor room air during emergency conditions prior to its discharge to the stack. With the reactor secured and the EES in operation, the iodine removal efficiency test is conducted by sampling the inlet and outlet air of the ESS Filter Bank using small activated charcoal filters while introducing iodine vapor to the EES duct intake. Refer to Attachment A "Efficiency Test Set-Up Diagram". The samples are taken, packaged and stored for subsequent irradiation and gamma analysis during a day when the reactor is in operation. The charcoal filter samples are analyzed by Instrumental Neutron Activation Analysis (INAA); the samples are irradiated in the reactor and analyzed for I-128 (half-life = 25 minutes) using a GeLi detector/analyzer system.

III. REFERENCES:

- A. RINSC Technical Specification 4.4, 4.5, 4.6 item 4
- B. RINSC Technical Specification 5.4

IV. PRECAUTIONS:

- A. Do not breath the Iodine vapors that are introduced into the emergency exhaust system.

Revised by/Date

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Approved by/Date

NRSC

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V. PROCEDURES:

A. Set up the sampling equipment :

1. Obtain the following equipment :
 - A. Two air sampling pumps
 - B. Two air flow meters
 - C. Two air filter holders
 - D. Three fresh activated charcoal filters
 - E. Tygon tubing
2. Heat seal one fresh charcoal filter into polyethylene sleeve, trim sides and label as **Blank**. Leave in 305 lab.
3. Load the two filter holders with the remaining charcoal filters (rough side of charcoal filter is the collection side).
4. Assemble Group 1 Equipment List items in vicinity of the EES Filter Bank located in the basement area.
5. Connect equipment items to inlet and outlet of the EES Filter Bank as shown in diagram. NOTE: be sure filter holders are oriented properly with the "in" side towards the filter bank and the "out" side towards the pump.
6. Open tube clamps on each sampling system, run pumps and adjust flow rate of each sampling system so that the airflow of each is 20 liters per minute.

B. Set up the Iodine Vapor Generator :

1. Obtain the following equipment :
 - A. Screw Driver
 - B. Tweezers
 - C. Hot Plate and wood paddle
 - D. Leveling blocks and lead brick
 - E. Electrical extension cord
 - F. Pyrex Petri Dish
 - G. 10 grams resublimed iodine crystals
2. Assemble Group 2 equipment list items in vicinity of the EES intake grill located on the main floor of the reactor near the reactor room hood.
3. Remove grill on the intake duct.

4. Install hot plate and wood paddle as shown in diagram. Level wood paddle at opposite end using borrowed blocks and/or bricks. Place lead brick on wood paddle at end above leveling block(s) to steady paddle.
5. Place Pyrex petri dish on top of hot plate and add the 10 grams of resublimed iodine crystals.

C. Collect the Sample :

1. Turn on emergency exhaust blower by using the evacuation button. Announce test of evacuation system over the P.A. System.
2. Plug extension cord into outlet and heat up hot plate; leave it on until iodine vapor is vigorous, then turn off hot plate [by unplugging extension cord] and let it cool down. Evolution of vapor should continue for several minutes during cool down period. NOTE: Do not breathe iodine vapors.
3. When the hot plate and Pyrex petri dish are cool to the touch, go to basement and turn off the sampling pumps [inlet first and outlet second] and constrict the tubing with tube clamps.
4. Remove petri dish and place any remaining crystals back into the iodine crystal stock bottle.
5. Remove hot plate and wood stand from intake duct. Turn off the emergency exhaust system.
6. Replace the grill on the intake duct.
7. Reset the Stack Monitor Actuator Valve so that the monitor samples from the "Normal" side of the valve.

D. Package the Charcoal Filters :

1. Put new gloves on before opening charcoal sample filters to eliminate possibility of iodine cross-contamination of filter samples from hands during iodine vapor generation step.
2. Collect the outlet charcoal filter holder first and transport to 305-lab. Open holder and remove charcoal filter using tweezers. Transfer to inside corner of polyethylene sleeve and heat seal sleeve. Trim excess plastic on outside of seals and label as **Outlet**.

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Note - The collection of the Outlet filter first eliminates the possibility of cross-contamination of this filter following processing of the iodine laden inlet filter.

3. Collect the inlet charcoal filter holder and transport to 305-lab. Open holder and remove charcoal filter using tweezers. Transfer to inside corner of polyethylene sleeve and heat seal sleeve. Trim excess plastic on outside of seals and label as **Inlet**.
4. Save packaged and labeled charcoal filter samples for later irradiation and gamma analysis. Return all equipment to its proper storage location. Wash filter holders with tap water and allow them to dry before returning to storage.

E. Perform NAA on the Charcoal Filters :

1. Perform an operational check of the gamma detector / analyzer system.
2. Check out RINSC Isotope Library to be sure that the I-128 isotope data is present and that the data processing algorithm references the RINSC Isotope Library.
3. Prepare irradiation form for irradiation of the three-charcoal filters in one rabbit. Refer to previous irradiation forms for details. Irradiation is conducted under Reactor Experiment No. 004. Check for presence of personal monitors [badge and ring].
4. Group individually packaged filters together and place in rabbit.
5. Set pneumatic rabbit system timer for 2 minutes. Introduce rabbit into system such that samples are at the rear of the rabbit in order to obtain maximum flux.
6. Following irradiation and return of rabbit to receiver, leave rabbit in receiver for 30 minutes for decay. Record time of end of irradiation: this time will be used as the reference time for back decay correction during counting.

F. Perform gamma spectroscopy on the filters :

1. Transfer rabbit to reactor room hood, open rabbit and remove samples. Place Inlet and Outlet samples behind lead shielding bricks in hood.
2. Place the blank filter sample in plastic bag, take and record contact dose rate using the survey meter and remove to 305-lab. Note: Contact dose rate should be typically ~25 mR/hr gamma.

3. Carefully repackage and heat-seal the blank filter into new polyethylene sleeve. Trim sleeve and label as **Blank**. Place RAM sticker on outside of sleeve. Place on detector shelf position, check for dead time [typically ~ 7%] and count for 600 seconds using the “filter paper on det. shelf” geometry.
4. While the Blank filter is counting, retrieve the Outlet filter from the rabbit hood, take and record dose rate readings [typically ~20 mR/hr gamma @ contact] as before and remove to the 305 lab. Repackage and label as **Outlet**.
5. As soon as the Blank filter has completed counting, remove and store behind lead shielding in the 305 lab.
6. Place Outlet filter on detector shelf position and count for 600 seconds using the “filter paper on det. shelf” geometry.
7. After 2 to 3 hours of decay in the rabbit hood, retrieve the Inlet Filter from the rabbit hood, take and record dose rate readings [typically ~75 mR/hr gamma @ contact] and remove to the 305-lab. Repackage and label as **Inlet**.
8. Place Inlet filter on detector shelf position, check for dead time [typically ~ 7.5%] and count for 600 seconds using the “filter paper on det. shelf” geometry.

G. Determine the Iodine removal efficiency :

1. The iodine removal efficiency of the EES Filter is calculated as follows :

$$\text{Efficiency} = [1 - \{\text{I-128 activity of outlet}\} / \{\text{I-128 activity of inlet}\}] \times 100$$

Note 1 - The charcoal filters used for sampling contain some target material [I-127] therefore a small I-128 activity in both Blank and Outlet filters is expected. Comparison should be made between the I-128 activities of the Blank and Outlet filters. Observation of the 1 sigma uncertainty of the activity of each of these filters should show an overlap, indicating that the activity in the Outlet filter is due to the blank.

Note 2 - If the activity in the Outlet filter is slightly higher, statistically, than the Blank, the activity of the Blank should be subtracted from the

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Outlet activity and this blank corrected Outlet activity used in the efficiency calculation.

Note 3 - In the event that the final count data and resulting efficiency calculations are unsatisfactory due to possible timing and counting errors, the packaged charcoal filters should be saved, re-irradiated and counted on a later day when the reactor is in operation. If the filters are not saved for re-irradiation and counting, the sample collection procedure will need to be repeated in order to obtain new samples.

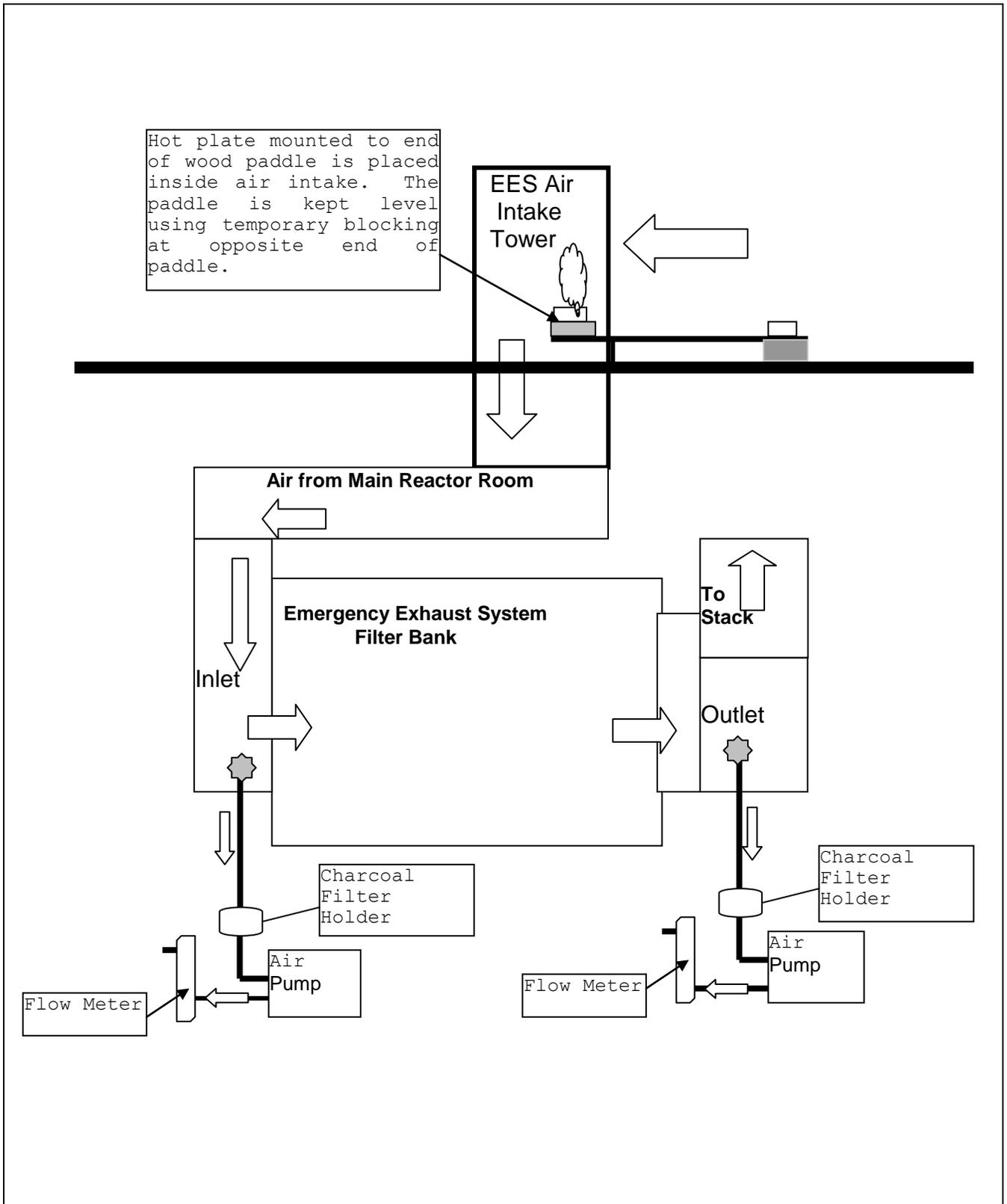
2. The test must show an efficiency for removal of iodine of at least 99.97%.

H. Record the results on Form NSC - 19 Emergency Exhaust System Iodine Filter Efficiency Test, and file it in the "Emergency Exhaust Filter System Efficiency for Iodine" notebook.

VI. ATTACHMENTS:

A. Efficiency Test Set-Up Diagram

B. NSC - 19 Emergency Exhaust System Iodine Filter Efficiency Test



Efficiency Test Set-Up Diagram

EMERGENCY EXHAUST SYSTEM
IODINE FILTER EFFICIENCY TEST

Date : _____

If the analysis for I-128 performed by one of the GeLi detectors has not taken decay into account, the initial activity must be back calculated from the activity reported in the Gamma Spectrum Analysis Report. The calculations are as follows :

$$A_o = \frac{A}{e^{-\lambda t}}$$

Where :

$$\lambda = 0.0277 / \text{min}$$

Filter	Count Time (s)	Detector	Shelf	Decay Corrected Activity (Ci / filter)
Blank				
Outlet				
Inlet				

The quantity of Iodine on the outlet and inlet filters prior to the filtration process is assumed to be the same as that for the blank filter. Consequently the activity of I-128 found on the blank filter after irradiation, is assumed to be the same activity that would be found on the outlet and inlet filters after irradiation, if they had not been subjected to the filtration process. Therefore, the activity of I-128 due to the filtration process is :

$$A_{\text{Out}} = A_{\text{Outlet}} - A_{\text{Blank}}$$

$$A_{\text{In}} = A_{\text{Inlet}} - A_{\text{Blank}}$$

The Emergency Exhaust System Iodine Filter efficiency is determined by looking at the ratio of I-128 activity on the Outlet Filter (A_{Out}), to that of the Inlet Filter (A_{In}) :

$$\text{Efficiency} = \left[1 - \left(\frac{A_{\text{Out}}}{A_{\text{In}}} \right) \right] \times 100$$

Efficiency = _____ Technical Specification 5.4 requires $\geq 99.97\%$ efficient