UNIVERSITY OF NORTH DAKOTA

Safety & Environmental Health Office

Standard Practice RSP 7	**Testing and Maintenance of Radioisotope Fume Hoods** **Effective Date January 31, 1999**

I. PURPOSE

The purpose of this Standard Practice is to ensure that radioisotope fume hoods on campus perform adequately; to establish a routine program for determining proper airflow for all air exhaust systems (laboratory fume hoods, machine shop exhaust hoods, etc.); and to locate and correct those hoods which are found to be operating incorrectly.

II. POLICY

Engineering controls will be used wherever possible to maintain a clean, healthful workplace atmosphere. The Safety office will review installation plans of new fume hoods, retrofit plans of existing hoods, and preventative maintenance procedures. To ensure the proper operability of fume hoods, they will be inspected and tested at least once per year according to the procedure contained in this standard practice. All fume hoods will also be tested following any major servicing. Any hood that does not meet UND's test criteria will receive priority maintenance, and be retested. Users of radioisotope fume hoods are responsible for the proper day to day usage.

III. SCOPE

This standard practice applies to all radioisotope fume hoods at the University or University-controlled sites.

IV. REFERENCES

A. American National Standard Institute, ANSI/AIHA Z9.5 - 1992, American National Standard for Laboratory Ventilation, American Industrial Hygiene Association, Fairfax, VA

B. Industrial Ventilation, A Manual of Recommended Practice, 23rd Edition, 1998, American Conference of Governmental Industrial Hygienists, Inc., Cincinnati, OH.

C. National Safety Council, Industrial Data Sheet 428

D. National Fire Protection Association (NFPA) Standard 90A

E. Hitchings Associates, PC World Wide Web site: www.safelab.com

V. DEFINITIONS

A. Face velocity: The air velocity at the plane of and perpendicular to the opening of an exhaust hood

B. Perchloric acid hood: A fume hood constructed with a water wash so it is safe for use with perchloric acid or other reagents that might form flammable or explosive compounds with organic materials of construction.

C. Radioactive material hood: A fume hood designated by the Safety Office for use of radioactive material. Hoods are designated to reduce the number of potentially contaminated equipment on campus. In the Edwin C. James Research Facility, only hoods that exhaust through the upper exhaust plenum may be used for radioactive material.

D. Setup work as used in this policy: placement and setup of equipment, apparatus and other material in the hood. Hazardous material must either not be present, or present only in a quantity or a manner that precludes the generation of hazardous airborne emissions. Only materials in quantities and/or forms that can be safely handled on an open lab bench can be present in a hood during setup work.

VI. RESPONSIBILITIES

A. The Safety and Environmental Health Office will:

1. Ensure that all fume hods are tested at least annually and following repair. The Safety Office will maintain records of all hood tests and will label hoods as they are tested.

2. Maintain a list of all fume hoods, and will designate which hoods are approved for specialized uses such as radioactive material or perchloric acid. Perchloric acid and radioactive material hoods will be clearly labeled by the Safety Office.

3. Evaluate the selection and design of all fume hoods before they are installed or retrofitted, and must test and certify all new or retrofitted hoods before they can be used.

4. Review and if necessary survey fume hoods, duct work, or equipment prior to servicing for the presence of hazards, chemicals, or radioactive substances that could pose a health threat.

B. Maintenance personnel are responsible for performing all maintenance on hoods. Prior to working on a radioisotope fume hood the Safety Office will be notified of the service to be performed.

C. Department Chair/Director or designee is responsible for assigning laboratories to researchers based on intended hood use. Radioactive material can only be used in hoods that are designated for radioactive material use by the Safety Office.

D. Each affected individual is responsible for adhering to the following work practices:

1. The individual shall not lean into the hood so that his/her head is inside the plane of the hood face without adequate respiratory and personal protection, except for setup work.

2. Equipment in the hood must not block air flow to the slots in the baffle.

3. Equipment that might be a source of emission should not be placed closer than 6 inches from the plane of the hood face. Workers should not stand closer than 6 inches from the face of the hood.

4. Flammable liquids should not be stored permanently in the cabinet under the hood unless that cabinet meets the requirements of ANSI/NFPA 30 and 45 for flammable liquid storage.

5. The hood sash or panels shall not be removed except for setup work.

6. The hood sash or panels must be closed to the maximum position possible while still allowing comfortable working conditions. The hood sash must not be opened beyond the tested maximum sash opening except for setup work.

7. A hood that has failed the annual hood test shall not be used for the control of airborne radioisotope contaminants unless it is repaired, and has passed an air flow test.

8. Fume hood users shall not conduct servicing of any kind unless authorized to do so, this includes scheduled, modified, or unscheduled maintenance. All servicing will be performed by maintenance or facility personnel.

VII. HOOD REQUIREMENTS

A. University Standards require all fume hoods to maintain an average linear face velocity between 80 and 125 feet per minute.

B. All new stacks should extend at least 10 feet above the roof line and no weather cap should be added.

C. No hood should be used for a function for which it was not designed, (e.g. perchloric acid, high pressure reaction, radioactivity).

D. For hoods rated for radioactive material use, means shall be provided to ensure that personnel entering any area where airborne radioactivity may be present will not be exposed to airborne radioactive material in excess of un-weighted DAC values as specified in Appendix B of Chapter 33-10-04.1 in the North Dakota Radiological Health Rules.

VIII. SAFETY OFFICE INSPECTIONS

The Safety Office schedules and performs annual inspections of all fume hoods on campus. The inspections include:

A. Air flow surveys following the test procedure in Section IX.

B. A check on proper hood usage. During the inspection hoods are checked for improper use such as perchloric acid, improper chemical storage, excessive clutter, large equipment blocking air flow, book or paper storage in hoods, etc.

C. A check for condition that may compromise the operation of the hood such as drafts or air currents that could upset the flow into the hood, equipment outside of the hood such as gas bottles that may restrict air flow into the hood, etc.

D. The results of the inspection will be recorded on the "UND Fume Hood Test Form". A copy of the form is included at the end of this Standard Practice.

IX. AIR FLOW SURVEY PROCEDURE

A. All hoods will be tested in an as used condition at maximum sash height.

1. The test will consist of determination of average face velocity and flow visualization following procedures in Subsections B and C. In addition, **variable air volume or VAV** hoods will be tested for approximate face velocity at a sash height of 8 inches following the procedure in Subsection D.

2. Fume hoods that appear to meet the flow visualization test criteria, but that have visible anomalies will also undergo a face velocity variation test (a quantitative turbulence measurement) following procedures in Subsection E.

3. If a hood in the as found condition fails to pass any of the requisite tests, adjustments will be made to the cabinet and the hood will be retested. Possible adjustments include but are not limited to:

   a. lowering the hood sash to no less than 10 inches.

   b. adjusting the baffles or dampers.

   c. rearranging or removing some of the equipment in the hood.

4. Labels will be applied to all hoods at the completion of the tests.

   a. For hoods that pass all requisite test criteria a label will be affixed to the hood sash and a corresponding arrow will be affixed to the outside edge of the hood indicating maximum safe operating height of the hood sash. The label will include the test date, average face velocity, maximum safe operating height in inches, and initials of the individual completing the test.

   b. If the hood fails to meet all of the requisite criteria a label will be affixed to the hood sash indicating that the hood failed, and that it should not be used to provide control of airborne contaminants until it is repaired. A memo will be sent to the Department notifying them that the hood failed, and they are responsible for having it repaired.

B. Average Face Velocity:

1. Procedure for vertical sash hoods:

   a. The hood face is divided into three horizontal rows, one approximately 6 inches from the top, one approximately 6 inches from the bottom, and one approximately in the middle of the sash. Additional rows must be established if the space between the rows is more than 12 inches (applies to hoods with greater than 36 inch sash height). Each row is divided into at least six equidistant test locations starting approximately 6 inches from the edges of the hood face. Test locations cannot be separated by more than 12

inches.

b. Velocity is measured at each of the test locations. The probe is held at a test location until the reading is stabilized, and then the reading is taken, Individual velocity values are recorded and an average value is determined. Results will be recorded on a "UND Fume Hood Test Form". A copy of the form is included at the end of this Standard.

2. Criteria: The average face velocity must be between 80 and 125 feet per minute. (Reference 2 states that for radionuclide hoods, "Control velocity must not exceed 125 fpm. Air velocities higher than this value will create eddies in front of the operator which may pull contaminants from the hood"). Individual velocity readings must not vary from the mean face velocity by more than ∓20%.

C. Flow Visualization

1. Procedure: A small amount of smoke is produced using a smoke tube/bottle arrangement, titanium tetrachloride ($TiCl_4$) in a squeeze bottle, or other available method. The smoke source is moved around the perimeter of the sash opening and around any equipment in the hood, while the flow patterns are observed. The completion of the flow visualization smoke test will be noted on the "UND Fume Hood Test Form".

2. Criteria: the hood passes this test if no flow-reversals or eddy currents were detected and if no smoke escaped from the hood into the laboratory.

D. Lowered Sash, Face Velocity Test for VAV Hoods

1. Procedure for vertical sash hoods:

a. The sash is lowered to a height of 8 inches. A single row of readings is made horizontally, in the middle of the opening. The row is divided the same as it was for the Average Face Velocity test from Subsection B. Each row is divided into at least six equidistant test locations starting approximately 6 inches from the edges of the hood face. Test locations cannot be separated by more than 12 inches.

b. Velocity is measured at each of the test locations. The probe is held at a test location until the reading is stabilized, and then the reading is taken, Individual velocity values are recorded and an average value is determined. Results will be recorded on a "UND Fume Hood Test Form". A copy of the form is included at the end of this Standard.

2. Criteria: The average face velocity should remain between 80 and 125 feet per minute.

E. Face Velocity Variation (Turbulence Measurement)

1. Procedure: Test locations are the same as those used for determination of average face velocity. Five velocity measurements approximately one second apart are taken at each of the test locations. The anemometer probe must be held as still as possible and the reading must be allowed to stabilize before taking the 5 measurements. The data will be recorded on the "UND Fume Hood Test Form: Supplementary Sheet". A copy of the sheet is included at the end of this Standard. The data is used to calculated a Coefficient of

Variation (COV) of velocity over time (a measure of turbulence) using the following method:

$$COV = \frac{\left(\frac{\sum \sigma_n}{n}\right)}{\overline{V}}$$

Where:

σ_n	=	standard deviation of velocity at test location *n*
n	=	number of test locations
$\overline{V}$	=	mean face velocity of the fume hood (average of <u>all</u> velocity readings)

$$\sigma = \left[\frac{\sum (x_i - \overline{x})^2}{i}\right]^{\frac{1}{2}}$$

Where:

σ	=	standard deviation for a single location (5 readings at a single spot)
x_i	=	an individual reading (1 through 5 at a single location)
$\overline{x}$	=	mean velocity reading at a single location
i	=	number of readings taken at a single location

2. Criteria: the hood passes if the COV value is 20% or less.