ISOTEC, INC.

RADIATION SAFETY MANUAL

REVISED: NOVEMBER 1984

GENERAL EMERGENCY PROCEDURES FOR RADIATION ACCIDENTS

In the event of a radiation emergency, the prime concern must always be the protection of laboratory personnel from radiation hazards. Second, should be the confinement of the contamination to the local area of the accident (if this is possible) and contamination concentration does not impose undue hazard to personnel.

PROCEDURES FOR SPECIFIC EMERGENCIES ARE GIVEN ON PAGE 11-14 OF THIS MANUAL AND WILL BE POSTED IN THE PROCESSING AREA CONTROL ROOM.

IN THE CASE OF ANY EMERGENCY NOTIFY ROGER SCHWIND AS SOON AS POSSIBLE (435-4669 office or 433-9770 home). IF ROGER SCHWIND IS UNAVAILABLE, CALL VINCENT AVONA (435-4669 office or 848-2193 home) or KENNETH FRITZ, THE RADIATION OFFICER (1-825-9110).

ISOTEC OPERATING PHILOSOPHY FOR MAINTAINING OCCUPATIONAL RADIATION

EXPOSURE AS LOW AS IS REASONABLY ACHIEVABLE

The management of Isotec, Inc., is committed to operating its Tritium Removal Facility in the safest manner that is reasonably achievable. The management will welcome any suggestions on methods of reducing exposure to workers or the environment. These suggestions will be fully considered and implemented where practical.

Management will formally review this radiation safety manual and other written procedures at the end of each year of operation. Operation goals will be established for the upcoming year based on this review. These goals will include employee exposure action points and total environmental release goals which are substantially less than required by law.

The current action points have been established.

1. Operating procedures will be formally reviewed by management and the Radiation Safety Officer (RSO) if airborne concentrations exceed 2.5 X $10^{-6}\mu Ci/ml$ (2.5 $\mu Ci/m^3$).

2. Radiation exposure of any personnel at more than 50 millirems in any one week or 500 millirems in any quarter or 2 REM in a year will result in the formal review of operating procedures and equipment by management and the RSO.

3. The goal for tritium released to the environment from this facility is not to exceed 50 curies.

These action points should be considered as upper limits and not as permissible exposures or releases to the environment. Isotec will do whatever is reasonably achievable to have actual operating exposures significantly less than these action points. Isotec's objective is to lower future year action points to as low as is reasonably achievable.

Management gives the RSO authority to prevent unsafe practices and to communicate promptly with an appropriate level of management about an operation he deems to be unsafe. He also has the responsibility to suggest ways of reducing exposures.

RADIATION SAFETY CONSIDERATIONS

I. RESPONSIBILITIES:

Each person who has any contact with any source of ionizing radiation has the responsibility to:

1. Keep his exposure to radiation at the lowest possible value and specifically below the maximum permissible exposure listed in Part 20, Title 10, Code of Federal Regulations. Keep vigilant of ways to reduce exposure levels and suggest changes to his supervisor.

2. Wash hands thoroughly before leaving the processing area.

3. Use all appropriate protective measures such as protective clothing, remote pipetting devices, ventilated and shielded glove boxes and hoods.

4. Avoid eating or smoking in radioisotope laboratories.

5. Maintain good personal hygiene.

6. Check monitors and equipment to ascertain that tritium concentrations are within normal operating levels and equipment is operating satisfactorily.

7. Maintain good housekeeping practices in the laboratory.

8. Label radiation equipment and segregate radiation waste and equipment to avoid cross contamination.

9. Report immediatley to Dr. Roger Schwind the details of any significant spill or other accident involving radioactivity. Dr. Schwind should be notified if air concentrations exceed 2 x 10^{-}[illegible] µCi/ml (2 µCi/M^3).

10. Conduct significant decontamination procedures as supervised by Dr. Schwind or Kenneth Fritz.

II. STORAGE OF RADIONUCLIDES:

A. Solids

It is important that all stored radioactive samples be clearly labeled at all times giving isotope(s) chemical form, the activity and the date of activity.

II. STORAGE OF RADIONUCLIDES (cont'd):

A. Solids (cont'd)

Background radiation in unrestricted areas shall be such that individuals continuously in these areas will not receive a dose in excess of 2 millirems in any one hour, or 100 millirems in any seven consecutive days. Body exposure in unrestricted areas shall be such that any individual will not receive a dose in excess of 0.5 rems (500 mrem) in any one calendar year.

Storage place(s) will be chosen so as to minimize risk from fire and will be provided with a suitable means of exit. Storage areas will be well marked with "Caution Radioactive Materials" signs. The name, address and phone number of the responsible person (Dr. Schwind) SHALL be posted in a conspicuous place near the area.

B. Gases & Liquids

The storage requirements listed above in A apply as well as the following considerations:

Helium-3, other tritiated gases and all tritiated solutions (which should be assumed to emit tritium gas) should be labeled with, and kept in, an approved hood which has adequate ventilation. Only amounts of material necessary for immediate processing should be stored in the laboratory. For Maximum Permissible Concentrations (MPC) in air, the Federal Register, Appendix B; Chapter 1, Part 20, Table 1, Column 1, will be consulted. For tritium the MPC is 5×10^{-6} µCi/ml (in restricted areas).

III. RADIATION PROTECTION MEASURES:

A. External

The basic protective measures to reduce external radiation are time, distance and shielding. In every situation these three factors must be considered jointly. While shielding is desirable in reducing the exposure, it must not be overlooked that doing the job in one-half the time is just as effective as doubling the shielding. Working twice as far from a point source is as effective as using 4 times as much shielding. Continuous use of

III. RADIATION PROTECTION MEASURES (cont'd):

A. External (cont'd)

monitoring equipment is the best method of evaluating the hazard and reducing the exposure. Every user of radionuclides should have on hand adequate survey instruments to keep check on his operations.

Tritium is not an external radiation hazard. However, it can be rapidly absorbed through the skin into the body. Absorption of tritiated water into the body is especially fast. Therefore, protective clothing and equipment are necessary to keep tritium gas and liquids away from the skin. Special equipment is described in Section VI B, Page 16.

B. Internal

The prevention of internal exposure is more exacting and less easily performed than is that of external exposure. Continuous monitoring of the control room during the separation and release of tritium should indicate the presence of tritium in the air before the maximum permissible tritium concentration of 5×10^{-6} μCi/ml is reached. However, if a low level contamination is suspected, (any time there is a spill or the air concentration exceeds 2×10^{-6} μCi/ml) contact Dr. Schwind for a complete survey. The general policy in the use of tritium is to use such equipment and procedures which will most reduce the probability of contact with the body. Outlined below are general rules and procedures for this purpose:

1. Eating, drinking, smoking and use of cosmetics are not permitted in laboratories or rooms where radioactive materials are used or stored.

2. Solutions shall not be pipetted by mouth (for example, scintillation counter solutions).

3. Protective clothing appropriate to conditions shall be worn. A laboratory coat or shirt and pants, shoe covers and gloves are the minimum protective clothing to be worn. Protective clothing is not to be worn outside the laboratories. See Section VI B for other protective clothing to be used if the air concentration exceeds 5×10^{-6} μCi/ml or contact with tritiated liquids are probable.

RADIATION PROTECTION MEASURES (cont'd):

B. INTERNAL (cont'd)

4. Wash hands thoroughly when leaving the laboratory processing area.

5. If contamination is suspected or if a concentration exceeds 2 $\mu Ci/M^3$, all work should be stopped immediately and Dr. Schwind shall be contacted to evaluate the condition and give advice.

6. All injuries shall be monitored to determine possible contamination.

7. Special protection is required for wounds in order to prevent the entry of radioactive materials. Waterproof adhesive tape should seal any other bandaging. Do not enter radiation area with a wound without special permission from Dr. Schwind or the RSO.

8. Everything in the laboratories or room is considered contaminated and anything to be removed from the laboratory should be monitored.

9. All persons working with radioactive material shall be aware of radiation safety procedures. Dr. Schwind is responsible to see that his personnel have been properly trained and have read this "Radiation Safety Manual" (see Section VII of this manual).

10. Radioactive material shall be used and stored in a manner which restricts unauthorized access to radioactive materials.

11. All containers for radioactive material shall be properly labeled (per 10 CFR, Part 20).

C. Handling Procedures

1. Radioactive materials are to be handled only by persons aware of the hazards of the material.

2. The shipping container shall be opened and treated as though it were contaminated inside until monitored to prove differently.

C. Handling Procedures (cont'd)

3. When handling radioactive material (except when < 100 μCi/liter or in a shipping container) personnel shall wear a laboratory coat or shirt and pants, shoe covers and gloves. See Section VI B for other protective clothing and procedures to be used if the air concentration exceeds 5×10^{-6} μCi/ml or contact with tritiated liquids are probable. One layer of plastic is NOT adequate protection from tritiated liquids since absorption through most plastics is rapid.

D. Good Housekeeping Habits

Much of the job of preventing the spread of contamination is a matter of good housekeeping.

1. Keep the laboratory neat and clean. Keep the work area free of equipment and material not required for the immediate procedure.

2. Wash hands and arms thoroughly before handling any object which goes to the mouth, nose or eyes. Monitor the hands* whenever contamination is suspected and decontaminate immediately.

3. Keep fingernails short and clean. Do not work with radioactive material if there is a break in the skin below the wrist unless the wound is so protected that radioactive materials can not gain access to the body. Cover the break with tape (waterproof) and wear a rubber glove(s). Obtain permission from Dr. Schwind before entering the radiation area.

E. Restrictions and Labeling of Radiation Areas

All radiation areas are to be properly labeled and as such are to be restricted from entrance by unauthorized personnel. The design of the Radiation Symbol is given in Section 20.203 of the Federal Register, Chapter 1, Part 20. A sign bearing the radiation caution symbol and the words "Caution High Radiation Area" will be posted when the level

*Wipe surface of hands with moistened cotton applicator or filter paper and submit for scintillation counting.

E. Restrictions and Labeling of Radiation Areas (cont'd)

in such an area is such that a major portion of the body could receive in any one hour a dose in excess of 100 millirem. The hood in the processing area will therefore be labeled "Caution High Radiation Area" when tritium has been placed in this hood. A sign bearing the radiation caution symbol and the words "Caution Radiation Area" will be posted when the level in such an area is such that a major portion of the body could receive in any one hour a dose in excess of 5 millirem. The processing area control room will be labeled "Caution Radiation Area". A sign bearing the radiation caution symbol and the words "Caution Airborne Radioactivity Area" will be posted when any room, enclosure or operating area in which airborne radioactive materials exist in concentrations in excess of the amounts specified in Appendix B of the Federal Register, Chapter 1, Part 20, Table 1, Column 1 (5×10^{-6} µCi/ml for tritium). A sign bearing the radiation caution symbol and the words "Caution Radioactive Materials" will be displayed on each container in which it is transported, stored or used for a quantity of any licensed material greater than the quantity of such material specified in Appendix C of the Federal Register, Chapter 1, Part 20 (1000 microcuries for tritium).

Form NRC-3 "Notice to Employees" will be posted in a sufficient number of places in the Tritium Removal Facility to permit employees to observe a copy on the way to or from this building.

F. Monitoring and Survey

Each person is responsible for being aware of and making use of the monitoring equipment provided by Isotec in the building.

1. Personnel Monitoring

Film badges, pocket dosimeters, etc., are useful only for the measurement of doses from external radiation hazards such as radionuclides emitting x-rays, gamma rays and "hard" betas. They are of no value for "soft" betas emitting from such radioisotopes as tritium and Carbon-14. Personnel monitoring devices will be issued only if conditions are such that these devices are required pursuant to 10 CFR, Part 20, Sections 20.101 and 20.202.

F. MONITORING AND SURVEY (cont'd)

2. Laboratory Monitoring and Survey

There will be continuous monitoring for tritium in the effluent air during any week in which more than 25 millirems in one day or 100 millicuries in one month are processed. The location and purpose of the various monitors are described in the "Tritium Removal Facility Description". The stack air will be monitored for total tritium and a differential tritium air sampler will be used to determine the amounts of tritium gas (HT) and tritium oxide (HTO) released to the environment. The process area control room will be continuously monitored for total tritium while tritium processing is being carried out. The control room monitor will also be available for monitoring the air in the rest of the building or surrounding area as may be warranted.

Swipe tests will be taken from at least two locations in each adjacent room of the building each week while tritium is being processed in the building. These wipes will be made with a piece of moistened cotton applicator or filter paper. Wipe tests for tritium contamination will be counted by a liquid scintillation counter.

If tritium processing is to be stopped for a period of over two weeks, the continuous monitoring, as described above, can be phased out as follows. The process equipment will be placed in a standby condition and all tritium containing equipment will be depressurized. Any waste tritium will be packaged and removed from the building when possible (see Page 9 of this manual). Continuous monitoring may be ceased if, under these conditions, the stack effluent releases remain less than 25 millicuries per day for one week after tritium processing has been completed.

Air monitoring, as stated above, and swipe tests will also be taken on a quarterly basis in the waste storage area if any pressurized vessels are present during this time. Air monitoring and swipe tests, of course, will be taken if a leak or other contamination is suspected. Base line measurements will be taken before any tritium separations are conducted.

F. Monitoring and Survey (cont'd)

3. Bioassays

All potentially exposed personnel involved in the Tritium-Helium-3 Feed Gas Facility will be subjected to a regular program of urinary monitoring as follows if more than 25 mCi of tritium is being separated or used. The current bioassay procedure is attached at the end of this manual (see Page 22).

a. Bioassay samples will be taken one day after initial exposure.

b. If processing continuously, subsequent bioassays will be performed at weekly intervals.

c. If smaller quantities of tritium are processed batchwise, bioassays will be performed the day of and the day after processing.

d. If the air concentration is 20% of the MPC as determined by tritium in air monitoring, bioassays will be performed.

e. A base line urine sample will be taken not more than one month prior to beginning work with tritium.

f. Action points and corresponding actions listed in NRC's Tritium Bioassay Guideline (which is on file at Isotec) will be followed.

Calibration of Survey Meters

All survey meters used routinely must be calibrated at least once every six months using appropriate standards. The tritium calibration procedure is attached at the end of this manual (Pages 20 & 21).

Permissible Exposures

The maximum permissible radiation dose for personnel occupationally exposed is 100 millirems per week. Isotec plans to control radiation dosage to as low as

Permissible Exposures (cont'd)

possible and to undertake a formal review of procedures and methods if any personnel are exposed to more than 50 millirems in any one week. This dose may be from external sources or from radionuclides deposited within the body. One millicurie of tritium present in the body for one week will result in a radiation dose of 100 millirems. The Maximum Permissible Body Burden (MPBB) for tritium is one millicurie.

Contaminated Equipment

Radioactive contamination is defined as the deposition of radioactive material in any place where it is not desired. Contaminated equipment no longer of any use may be discarded in a radioactive waste can or disposal drum.

The U.S. NRC Guideline for Decontamination of Facilities and Equipment prior to release for unrestricted use will be followed. For tritium, the following surface contamination levels are acceptable:
Average: 5000 dpm/100 cm^2; Maximum: 15,000 dpm/100 cm^2; and Removable: 100 dpm/100 cm^2. Approval must be obtained from Dr. Roger Schwind or the RSO (who will check for complete compliance with the above guidelines) prior to release of any equipment from the Tritium Removal Facility for unrestricted use.

All protection measures pertinent to personnel safety mentioned above apply to all visitors. No visitors are permitted where a radiation source is being used unless accompanied by a qualified individual familiar with the hazards involved. All visitors shall be issued protective clothing when they enter an area in which radioactive materials are located in such amounts that they constitute a potential personnel hazard or increase the possibility for spread of contamination.

IV. DISPOSAL

Records of the amounts, in microcuries, of all radioisotope disposals must be maintained.

Radionuclides are disposed of in the following manner:

A. Solid Disposal

Radioactive solid wastes not held until radioactive decay is down to background levels, will be shipped for burial to a firm that is NRC authorized to handle such wastes. All applicable burial ground regulations will be followed.

B. Liquid Disposal

1. Sewer Disposal

If the radionuclide such as tritium, is readily soluble in water, it may be flushed down the drain providing the concentration is below the maximum permissible levels. An assay may have to be made to determine the exact amounts present and the dilution necessary. Tritium may be disposed in the sewer if the concentration does not exceed 100 µCi/liter of water. If is anticipated that only millicurie amounts will be disposed of in this manner. Under no circumstances will more than 1 curie per year be disposed of in this manner.

2. Non-Sewer Disposal

If a liquid waste can not be disposed by the sewer method, it may be placed in a disposal drum if it is in an inner container. No liquids shall be poured directly into a disposal drum. The drum is eventually sent to a NRC authorized commercial firm such as U.S. Ecology for burial as radioactive waste. Drums containing radioactive liquids must also contain enough absorbent material present to absorb twice the amount of the liquid present to be "solidified" or in a manner acceptable to the approved burial site.

V. EMERGENCY PROCEDURES

Emergencies resulting from accidents in laboratories working with radioactive materials could range from simple spills of small amounts of radioactive materials, where no serious contamination problem results, to major disasters occurring from explosions, fires or natural phenomena. Correspondingly, the hazards resulting from such accidents might cover the range of situations from no hazard whatsoever to very serious situations involving extreme radiation hazards and bodily injury or both. In review of the complicating factors that may arise during such emergencies, simple rules of procedure can not be set down covering all situations of radiation danger. However, in any emergency, PRIMARY CONCERN MUST ALWAYS BE THE PROTECTION OF LABORATORY PERSONNEL FROM RADIATION HAZARDS. Second, should be the confinement of the contamination to the local area of the accident, if this is possible, and contamination concentrations do not impose undue hazard to personnel.*

A. Whom to Call and When

In the event of an emergency or suspected emergency, e.g., spills, bodily injury, fire, etc., Dr. Schwind shall be notified immediately. In addition, the lab should have posted the location of the nearest fire alarm or phone number of the fire department and the home phone number of Dr. Schwind (433-9770) and Vincent Avona (848-2193).

B. Loss of Tritium Containing Material

In the event of a loss of any radioactive material, notify all personnel in the lab area or building, if necessary. Evacuate the area if necessary and take, where applicable, the appropriate steps listed below.

Contact Dr. Schwind at once for consultation and survey if concentration on any of the monitors reaches 2.0×10^{-6} μCi/ml (2.0 μCi/M^3).

* If contamination can be released to an unrestricted area in concentrations below the MPC value of 2×10^{-7} μCi/ml, this alternative should be considered.

C. Minor Spills Involving No Radiation Hazard to Personnel (Room tritium concentration $<5 \times 10^{-6}$ μCi/ml).

1. Notify all other persons in the room at once and retain them nearby.

2. Attempt to localize the leak or spill by closing valves.

3. Notify Dr. Schwind as soon as possible.

4. Permit only the minimum number of persons necessary to deal with the spill into the area.

5. Decontaminate (see Section VI A and B for procedure).

6. Monitor via swipe and bioassays all persons involved in the spill or clean-up.

7. Permit no persons to resume work in the area until a survey of air monitors is made and approval of Dr. Schwind is secured. Air concentrations should be < 2 $\mu Ci/M^3$ before normal operations are resumed.

8. Prepare a complete history of the accident and subsequent activity related thereto for the laboratory records.

D. Accidents Involving Tritium Gas (Room tritium concentration is $>5 \times 10^{-6}$ μCi/ml).

1. Notify all other persons to vacate the room immediately.

2. Hold breath and close escape valves and other valves which may localize the leak and minimize the source, if time permits (see footnote Page 11).

3. Vacate the room.

4. Notify Dr. Schwind at once.

5. Ascertain that all doors giving access to the room are closed and post conspicuous warning or guards to prevent accidental opening of doors.

D. Accidents Involving Tritium Gas (Room tritium concentration $\geq 5 \times 10^{-6}$ μCi/ml).

6. Report at once all known or suspected inhalations of radioactive materials.

7. If the spill is on the skin, flush thoroughly with cold water.

8. If the spill is on the clothing, discard outer or protective clothing at once.

9. Evaluate the hazard and the necessary safety devices for safe re-entry. If air concentration is above 5×10^{-6} μCi/ml, a bubble suit should be used as discussed in Section VI B.

10. Determine the cause of contamination and rectify the condition.

11. Decontaminate the area under supervision of Dr. Schwind or Ken Fritz.

12. Perform air survey of the area before permitting normal work to be resumed. (Air concentrations should be < 2 μCi/M³ before normal operations are resumed).

13. Monitor all persons suspected of contamination via wipes and bioassay.

14. Prepare a complete history of the accident and subsequent activity related thereto for the laboratory records.

F. Injuries to Personnel Involving Radiation Hazard

1. Wash minor wounds immediately under cold running water while spreading the edges of the wound.

2. Report all radiation accidents to personnel (wounds, overexposure, ingestion, inhalation, etc.) to Dr. Schwind and the attending physician.

3. Call a physician qualified to treat radiation injuries at once.

F. Injuries to Personnel Involving Radiation Hazard (cont'd)

4. Permit no person involved in a radiation injury to return to work without the approval of Dr. Schwind and the attending physician.

5. Prepare a complete history of the accident and subsequent activity related thereto for the records.

G. Fires or Other Major Emergencies

1. Notify all other persons in the room and building at once.

2. Attempt to put out fires if radiation hazard is not immediately present.

3. Notify Dr. Schwind.

4. Notify the fire department and other local plant safety personnel.

5. Govern fire-fighting or other emergency activities by the restrictions of Dr. Schwind.

6. Following the emergency, monitor the area and determine the protective devices necessary for safe decontamination.

7. Decontaminate under supervision of Dr. Schwind.

8. Permit no person to resume work without approval of Dr. Schwind.

9. Monitor via swipes and bioassays all persons involved in combating the emergency.

10. Prepare a complete history of the emergency and subsequent activity related thereto for the records.

VI. DECONTAMINATION PROCEDURES

A. General Considerations

1. Prevent Spread of Contamination

The radiation officer should be called for assistance as soon as possible whenever a spill occurs. The first consideration, AFTER PERSONNEL SAFETY, is the confinement of radioactivity and decontamination. Many factors must be considered, including tracking by persons, movement by air currents (hoods, fans, etc.), water, dusting, mopping and other physical actions. To minimize spreading, decontaminate the spill from the outside toward the center.

2. Radiation Protection Guide Levels of Contamination

The maximum limits of contamination generally allowable are:

Skin & Hands:	Tritium *1000 dpm/100 cm
Clothing:	The maximum limits are the same as those for the skin and hands.
Glassware:	The maximum limits for glassware that is handled with bare hands are the same as those for skin and hands.
Laboratory Tools:	The maximum limits for laboratory tools that are handled with bare hands are the same as those for skin and hands.
Process Equipment:	See Page 9 of this manual.

* Tritium will not be detected with a γ & β- type survey meter, so wipe tests and liquid scintillation counting followed by bioassay is necessary.

2. Radiation Protection Guide Levels of Contamination (cont'd)

There may be some instances when these levels can not be attained using routine decontamination procedures. In these cases, the Radiation Safety Officer (RSO) should be consulted.

3. Develop a Plan

Successful decontamination calls for planned action. Although speed is desirable, a spur of the moment action at decontamination can cause more harm than good. After a spill has been confined, make a thorough plan of the steps to be taken in the decontamination procedure and obtain plan approval from Dr. Schwind or the RSO.

4. MONITORING
Make full use of instruments and available assistance.

Each step of decontamination should be monitored. One person should be kept clean (not contaminated) to operate the instruments and aid in monitoring. When the instruments become contaminated, it is impossible to obtain additional accurate information. Protective clothing, footwear, gloves and respiratory masks should be used as needed.

B. Use an air supplied bubble suit for maintenance work or decontamination work of (1) air concentration is $\geq 5 \times 10^{-6}$ μCi/ml or (2) contact with tritiated liquid is probable. Use all of the following gloves with the air supplied bubble suit:

1. Cotton glove liner taped to wrist.

2. Surgeons rubber glove taped to wrist.

3. Surgeons rubber glove attached to bubble suit cuff (replace this glove with a butyl rubber glove if contact with tritiated liquid is likely).

4. Buna-N or butyl rubber glove and;

5. Natural rubber glove.

Change gloves immediately if glove comes in contact with tritiated liquid.

Exit area immediately if tritiated liquid comes in contact with bubble suit or if bubble suit is pierced.

Have second person present to watch, monitor and provide emergency assistance at all times when person is in bubble suit.

Hold pre-job conferences with personnel before any modifications or maintenance work is performed on tritium containing equipment or lines to expose potential hazards and to prepare a plan of action and ensure availability of proper tools, waste containers, liquid absorbents, etc...

All lines should be treated as containing tritiated liquids unless it can be proven otherwise.

C. <u>Special Precautions for Breaching of Tritium Lines</u>

1. Release pressure in lines and, if possible, flush and evacuate before opening to atmosphere.

2. Enclose joint to be opened with a plastic bag containing vermiculite, molecular sieve (or similar absorbent) and any tools required.

3. Put paper on floor and have adequate supply of dry rags nearby.

4. Use of plastic tent may be necessary if a large portion of hood front must be opened to perform maintenance on equipment.

5. If hood or tented area must be entered, lay paper down and establish a second shoe change area at entry point.

VII. TRAINING

Workers in the tritium processing area (control room) will be required to read and understand the contents of the Radiation Safety Manual and will receive instructions pursuant to 10 CFR, Part 19, Section 19.12 entitled "Instructions to Workers" and pertinent to the use, processing and handling of tritium and related hazards. They will be advised of the necessity of bioassays, will be informed of the Maximum Permissible Body

Burden (MPBB) limits as determined by tritium concentration (μCi/liter) in the urine and the proper course to be taken (Item V, Guidelines for Bioassay Requirements for Tritium). They will have available to them 10 CFR, Parts 19 and 20 and will receive instructions of their responsibility to report promptly to their supervisor any conditions which they consider to be unsafe or out of the ordinary.

Extent of on-the-job training will, of course, depend upon the training and experience with radioactive materials already possessed by the employee. Dr. Schwind will be present during all tritium processing operations until another employee is completely trained. An attempt will be made to hire a person who has had several years of experience in tritium processing similar to that which will be done by Isotec. If such a person is hired, the on-the-job training can be reduced but not eliminated. The first week will be spend becoming familiar with Isotec's equipment and reviewing safety procedures as discussed above. The new employee will then observe Dr. Schwind perform the processing operation. The next time this processing operation is carried out, the new employee will then perform some of the less critical operations under Dr. Schwind's direct supervision. The new employee will gradually take over the processing operation until he can do the entire operation independently, but with Dr. Schwind present.

After performing the operation independently in Dr. Schwind's presence (at least two times), the new employee will then be allowed to do the processing without Dr. Schwind being present. However, supervision will be available for advice should it be required. Two people will be in the building at all times during tritium processing. It is anticipated that an employee with previous experience will get to this stage after six batch processes.

New employees with less experience will require longer periods of on-the-job training and more formal training. Isotec will require that tritium processing personnel have two years of college education or the equivalent of on-the-job experience. Employees will be required to attend a formal radiation safety course offered by a university or professional organization at least once every five years. A new employee with little or no experience will not be allowed to independently perform the tritium processing operation during his first nine months of work in the Tritium Removal Facility. Independent processing after this nine month period will depend on the employee's competency.

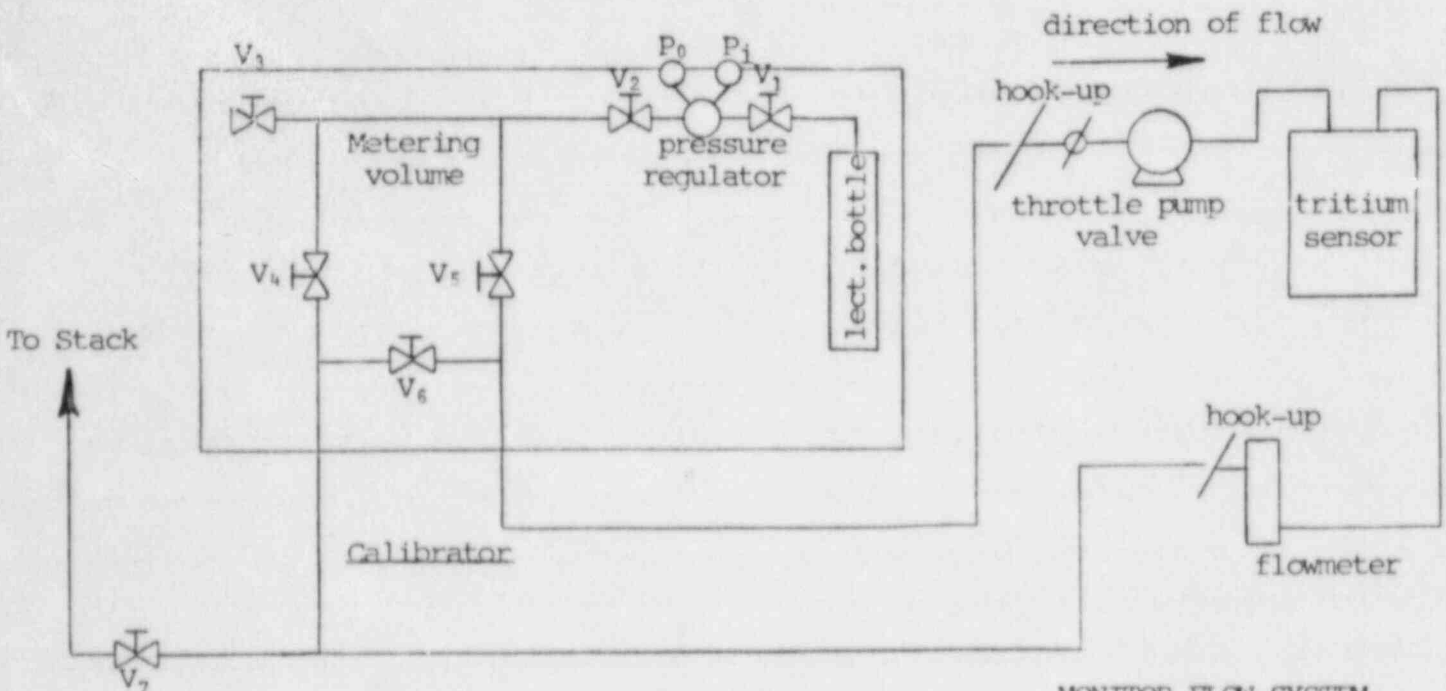
VII. <u>TRAINING (cont'd)</u>

Competency will be determined by his ability to follow give instructions and produce a finished product or task in a safe and efficient manner as judged by Dr. Schwind or the RSO.

Quarterly safety meetings will be held as training aids ɪor all workers in the Tritium Removal Facility.

VIII. TRITIUM MONITOR CALIBRATION PROCEDURES

1. Connect the calibrator to the tritium monitor as shown:



MONITOR FLOW SYSTEM

2. With all other valves CLOSED, open valve V_6 and recirculate the entrapped air until the monitor reads a steady value. That is the monitor zero.

3. Close V_6 and open valve V_1. Check the pressure regulator - pressure gauge P_0 should read 30 psig. Open valve V_2 to fill the metering volume. Close valves V_2 and V_1 and open valves V_4 and V_5. Recirculate the calibration gas until the monitor reads a steady value. Compare this reading, corrected for the monitor zero from Step 2, to the value listed below (in $\mu Ci/m^3$).

JAN 1984	9.2	JUL 1986	8.0	JAN 1989	7.0
JUL 1984	9.0	JAN 1987	7.8	JUL 1989	6.8
JAN 1985	8.8	JUL 1987	7.6	JAN 1990	6.6
JUL 1985	8.4	JAN 1988	7.4	JUL 1990	6.4
JAN 1986	8.2	JUL 1988	7.1	JAN 1991	6.2
				JUL 1991	6.1

4. Close valve V_4 and open valves V_7 and V_3 to vent calibration loop. When the monitor again reads zero, close valves V_3 and V_7, open valve V_4 and recirculate the air about five minutes. Then close V_4 and open V_7 and V_3 again and vent the loop another fifteen minutes.

5. Disconnect the calibrator and resume normal operation.

FREQUENCY:

Monitors are calibrated at least every six months.

STANDARDS:

A Johnston Laboratory Calibration Gas cylinder (#504) having an assayed tritium level of 4.24 μCi/liter on 02/20/81 is used in this procedure.

ACCEPTANCE CRITERIA:

If this calibration indicates the instrument reading to be within 30% of the value determined from the standard, the instrument will be accepted and a correction chart will be posted to correct readings obtained. If the instrument deviates from the standard by more than 30% the manufacturer will be consulted for repairs. This calibration procedure will be repeated after repairs are completed. An equivalent procedure will be used if the manufacturer recommends.

IX. H^3 IN URINE BIO-ASSAY PROCEDURE (Revised 11/05/84)

1. Materials

   a. Cocktail - N.E.N. Atom light or equivalent.

   b. Vial - C.M.S. 20 ml scintillation vial or equivalent.

   c. Spike - Dilution of N.E.N. Tritium Standard traceable to NBS.

2. Sample Preparation and Counting

   a. Background - 17ml of cocktail (one per batch).

   b. Sample - add 3ml of unknown urine to 17ml of cocktail.

   c. Standard - add 1ml of spike and 3ml of the unknown urine to 17ml of cocktail.

   d. Count all vials.

3. Data Analysis

   a. Subtract the cpm of the background from the gross cpm of the standard and sample to get their net cpm's.

   b. Calculate the efficiency.

$$\text{Efficiency} = \frac{\text{net cpm of standard}}{\text{dpm}}$$

where dpm = 108 on 04/03/81

   c. Calculate µCi/ml of H^3 in urine.

$$\mu\text{Ci/ml} = \frac{\text{net cpm of standard}}{(\text{eff})\ (3\ \text{ml})\ 2.2 \times 10^6\ \text{dpm}/\mu\text{Ci})}$$

NOTE: MPBB = 0.028 µCi/ml
REPORT EXPOSURES OVER 0.014 µCi/ml.

If urine count values are > 0.028 µCi/ml, additional bioassays will be performed. If projected dosage is greater than 5 REM, procedures pursuant to NRC 10 CFR, 20.403, will be followed.

TRITIUM REMOVAL FACILITY

DESCRIPTION

NOVEMBER 1984

TRITIUM REMOVAL FACILITY

Description

Purpose

The purpose of this facility is to remove tritium from Helium-3 feed gas so that the purified Helium-3 can be sold by Isotec, Inc. as a non-radioactive gas ($<1 \times 10^{-11}$ mole% tritium). The partially purified Helium-3 gas is obtained from the U.S. DOE through its Mound Facility in Miamisburg, Ohio. By purchasing this partially purified feed gas, Isotec is able to provide "non-radioactive" ($<1 \times 10^{-11}$ mole % tritium) Helium-3 product gas to the end user.

Process Description

Feed Supply

Partially purified Helium-3 gas is obtained from Mound Facility in compressed gas containers. This gas may have concentrations of tritium ranging from 10^{-1} to 10^{-10} mole percent. After receiving detailed analysis of the contents of the container from the DOE, Isotec purchases a quantity of up to several thousand liters which it then processes in this facility to separate the tritium from the Helium-3. The quantity of gas received by Isotec is adjusted so that Isotec never has more than 1000 curies of tritium in its possession at any one time.

Location

Isotec's tritium removal facility is located on a 5 acre plot of land in Miami Township in Montgomery County, Ohio. This is a remote site that is zoned, I-2, light industry. The site plan is shown in Figure 1. The facility occupies 290 sq. ft. in a steel building. The building is surrounded by a perimeter fence. The distance from the stack to the fence surrounding the building is 210 feet on the West side, 190 feet on the East side, 201 feet on the South side, and 199 feet on the North side. Access within the tritium processing area is restricted to occupational workers and authorized visitors.

A lay-out of the processing building is shown in Figure 2. The inside building air is released to the atmosphere through a stack with a blower having a minimum capacity of 1100 cfm. The ventilation system is designed so that the processing hood will be at a negative pressure compared to the locker and rest room area of the building. Air flow is from "cold" non-processing areas into the processing hood and then up the building stack. The stack is twenty-four feet above ground level and away from the building air intake. A fenced-in, covered storage area is located adjacent to the control room for temporary storage of burial drums prior to shipping to an approved burial site such as the one in the State of Washington, operated by the State of Washington Department of Social and Health Services.

The tritium removed from the Helium-3 feed gas is converted to water and absorbed on a molecular sieve or similar absorbent. The tritium will be packaged in the burial drums so as to satisfy all the requirements of the State of Washington or a similar burial site.

A schematic of the ventilation system is also shown in Figure 2, A 1350/2700 cfm two-speed fan will be used to insure that the linear air velocity at the processing hood openings are maintained at 130 ft/minute or greater. Differential pressure monitors are readily visible to the process operator(s) in the control room. These differential pressure monitors are marked so that the operator(s) can easily verify that the ventilation system is operating properly.

The ventilation blower has dual capacity of 1350 cfm and 2700 cfm. Processing is not conducted when the air speed is less than 1100 cfm. The high blower speed is used whenever the hood opening exceeds 7 sq.ft. (157 ft./min. @ 1100 cfm) and when processing more than 1 millicurie. The maximum hood opening will be 20.4 sq. ft. (which corresponds to 132 ft./min. @ 2700 cfm).

The location of the air monitoring points within the building is also shown in Figure 2. Air from monitor point A will be radiocounted for total tritium concentrations by an ionization chamber such as those sold by Johnston Laboratories or Overhoff and Associates. An Overhoff and Associates monitor is currently used. The sensitivity range of these instruments is 0.1 $\mu Ci/M^3$ to 1000 $\mu Ci/M^3$. The volumetric air flow in this duct is measured by a standard pitot tube located at Point C (see Figure 2), and the differential pressure reading is visible in the process area control room.

Routine monitoring of effluent releases will be conducted whenever tritium is processed in quantities greater than 25 millicuries in one day or 100 millicuries in one month. Monitoring will be conducted as soon as practical after the release; immediately, if possible, and in all cases no later than 24 hours after the release.

Air from monitoring point B (see Figure 2) will be passed through a glycol bubbler system such as that shown in Figure 3. All six bubblers (HTO and HT) are replaced and measured with a scintillation counter within 24 hours after any day in which processing of >25 millicuries has taken place or any unusual occurence. The total tritium released to the environment is determined by the product of the volumetric flow rate and the tritium concentration from the bubbler system.

The air in the process area control room is continuously monitored at point D (see Figure 2) while tritium is being processed. Monitoring is done by an ionization type monitor located in the process area control room. The room monitor is available for monitoring the air in the rest of the building or the surrounding area as needed. The process operator(s) therefore have continuous monitoring of the air they are breathing and the air going up the building stack.

In addition, surface wipes are taken from at least two locations in each adjacent room of the building each day tritium is processed within the building. Accurate records are maintained of the surface wipes and the stack glycol bubbler system.

Process Schematic

A schematic of the process equipment and piping that is to separate the tritium from the helium is presented in Figure 4. The feed gas is passed through an absorbent (for example, charcoal or molecular sieve) filled cold trap.

The quality of the helium gas in the process and product cylinder(s) is monitored using a liquid scintillation counter or a mass spectrometer. The tritium absorbed on the absorbent traps at cryogenic temperatures will be processed by the following process.

A helium/oxygen/water gas mixture is metered into the waste stream to provide enough oxygen so that the tritium can be oxidized to its water form in the oxidizer. The oxidizer consists of a catalyst bed (for example, a platinum or palladium catalyst such as Engelhard No. A16648) at elevated temperature.

The water formed in the oxidizer is absorbed in the dryer which is composed of a molecular sieve or similar absorbent. The "solid" tritium waste is removed, packaged, and sent to burial when the molecular sieve absorbent capacity is used up. A sample of the gas in the storage tanks is then radioassayed. If the tritium contained in these tanks is less than 1 curie, it is released up the building stack to the atmosphere over a period of at least one hour and not more than one curie per week. If the tritium contained is higher than 1 curie, this gas is recycled through the process until the tritium is collected on the molecular sieve and/or reduced below 1 curie.

Release of Tritium Gas from Storage Tank

No more than 1 curie of tritium per week will ever purposely be vented through the building stack. It is anticipated that less than 10 curies per year would be disposed of in this manner. The stack height is at least twenty feet. Accessibility will be limited to twenty feet or closer to the stack exhaust. This area can be considered to be enclosed by a sphere with a 20 foot radius. The volume of this sphere is $3.35 \times 10^{+4}$ ft^3 or 9.45×10^8 cc. Using the maximum permissible concentration for a restricted area (5×10^{-6} μCi/cc), a volume of 9.45×10^8 cc can accommodate (5×10^{-6} μCi/cc) (9.45×10^8 cc), or 4725 μCi on a 40 hour/week basis (13 week avg., 10CFR, 20.103). This also assumes no air exchange.

The stack air flow will be at least 1100 cfm, or 1.87×10^9 cc/hr. One curie of tritium in a restricted area needs

$$\frac{10^6 \mu Ci}{5 \times 10^{-6}} \mu Ci/cc = 2 \times 10^{+11} \text{ cc of air.}$$

This can be supplied by our stack air flow in less than 5 days. 2×10^{11} cc/1.87×10^9 cc/hr = 107 hrs. (about 4.5 days).

Similar calculations will be made to determine the minimum amount of time needed for the blower to operate if millicurie amounts of tritium are released to the atmosphere.

System Start-Up and Quality

The complete system was helium leak tested and a test run was made with Helium-4 and normal hydrogen before the system was started up with tritium. The system is completely made out of metal and all fittings and valves are specially purchased for reliability in tritium environments. Welded connections are made where possible. The tritium monitors provide a sensitive test for any leaks that may develop in the system after it is used for a period of time.

All of the methods of gas separation and tritium removal in this process have been used for many years at Mound Facility and other DOE locations. Isotec personnel are well acquainted with these methods.

Maximum Allowable Tritium in Separation Building

Building 960 ft^2 floor area x 9 ft. ceiling 8640 $ft.^3$ = 2.45×10^8 cm^3.

Assuming no exchange of air:

(2.45×10^8ml) (5×10^{-6}μCi/ml) = 1225 μCi for 40 hour week
Assuming 1100 cfm blower (continuously on during separation process)

1100 cfm = 1.87×10^9 cm^3/hr.

$1.87 \times 10^9 / 2.45 \times 10^8$ = 7.63 air exchanges per hour

(1225 μCi) (7.63) = 9.35 mCi/hr = Maximum allowable tritium leakage rate in building with blower operating at 1100 cfm.

Design Basis Accident

The worst possible radiological accident that could conceivably happen in this facility would be the rupture of the transfer line leading to the venting of the contents of the feed gas cylinder and cold trap. This would be less than 1000 curies, but for the purpose of analysis, the effects of a 1000 curie release over a two-hour period will be calculated.

Using Gaussian distribution atmospheric dispersion calculations suggested in the HEW "Workbook of Atmospheric Dispersion Estimates", 1967, the maximum off-site ground level concentration (at the fence line) during this two hour release is given by X where:

$$X = \frac{Q}{\pi \sigma_y \sigma_z \mu} \quad \exp. \left[-1/2 \left(\frac{H}{\sigma_z}\right)^2\right]$$

where:

Q = emission rate, curies sec -1

σ_y = horizontal dispersion coefficient, meters

σ_z = vertical dispersion coefficient, meters

μ = average wind speed, meter sec^{-1}

H = stack height plus plume rise, meters

For Isotec's location and average atmospheric conditions (class D) these variables are as follows:

Q = 0.317×10^{-4} curies/sec. (released averaged over 1 yr., i.e., $3.1536 \times 10^{+7}$ sec, pursuant to 20.106 (a), 10CFR20).

σ_y = 4.8 (at closest fence, 200 feet)

σ_z = 2.8 (at closest fence, 200 feet)

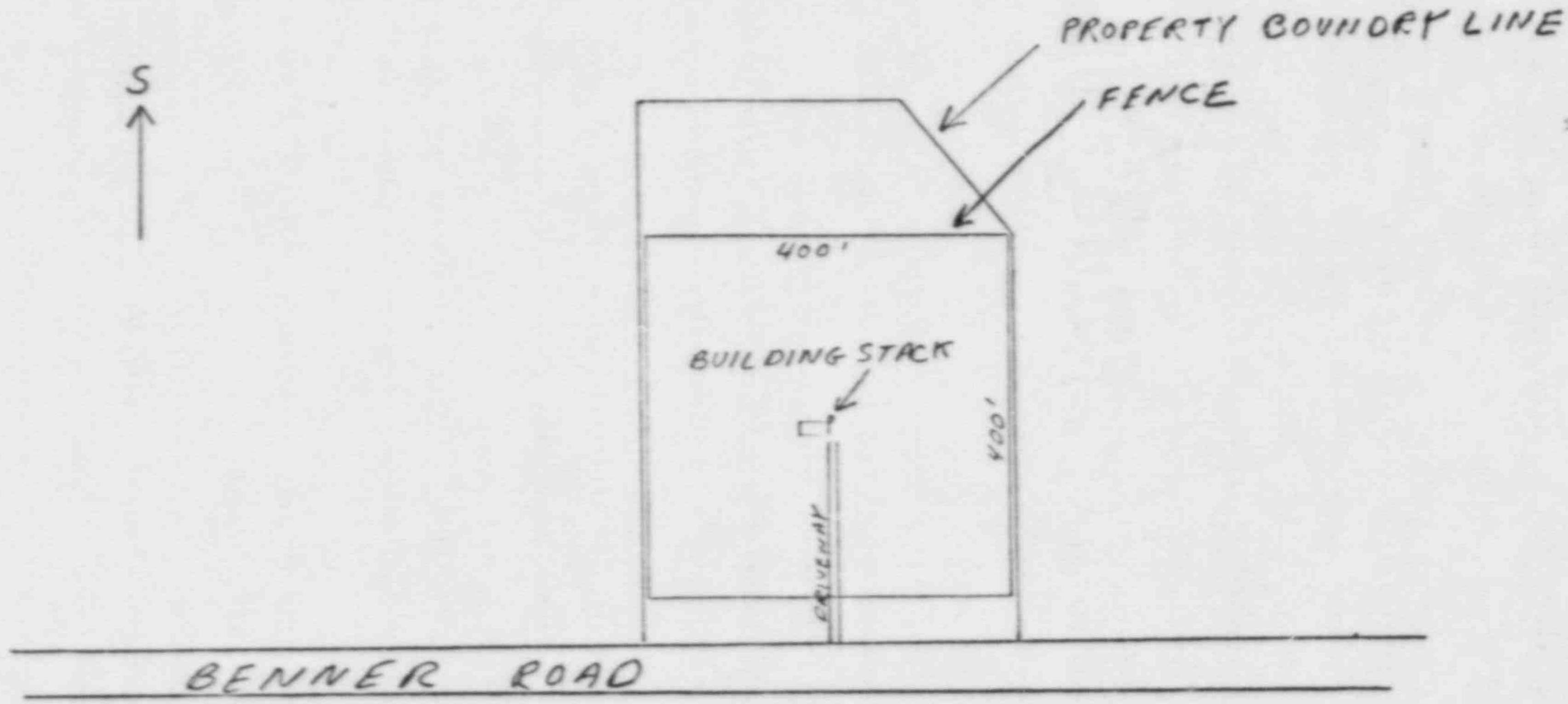
μ = 5 m/sec. (average for area)

H = 6 meters

$\therefore X = 1.5 \times 10^{-8}$ µCi/ml

Therefore even the most severe accident would lead to tritium concentrations less than those allowable for unrestricted areas (2×10^{-7} µCi/ml per part 20, Appendix B, Table 1). In addition, a release of 1000 curies is extremely unlikely.

FIGURE 1 SITE PLAN



SCALE : 1/1" = 25'

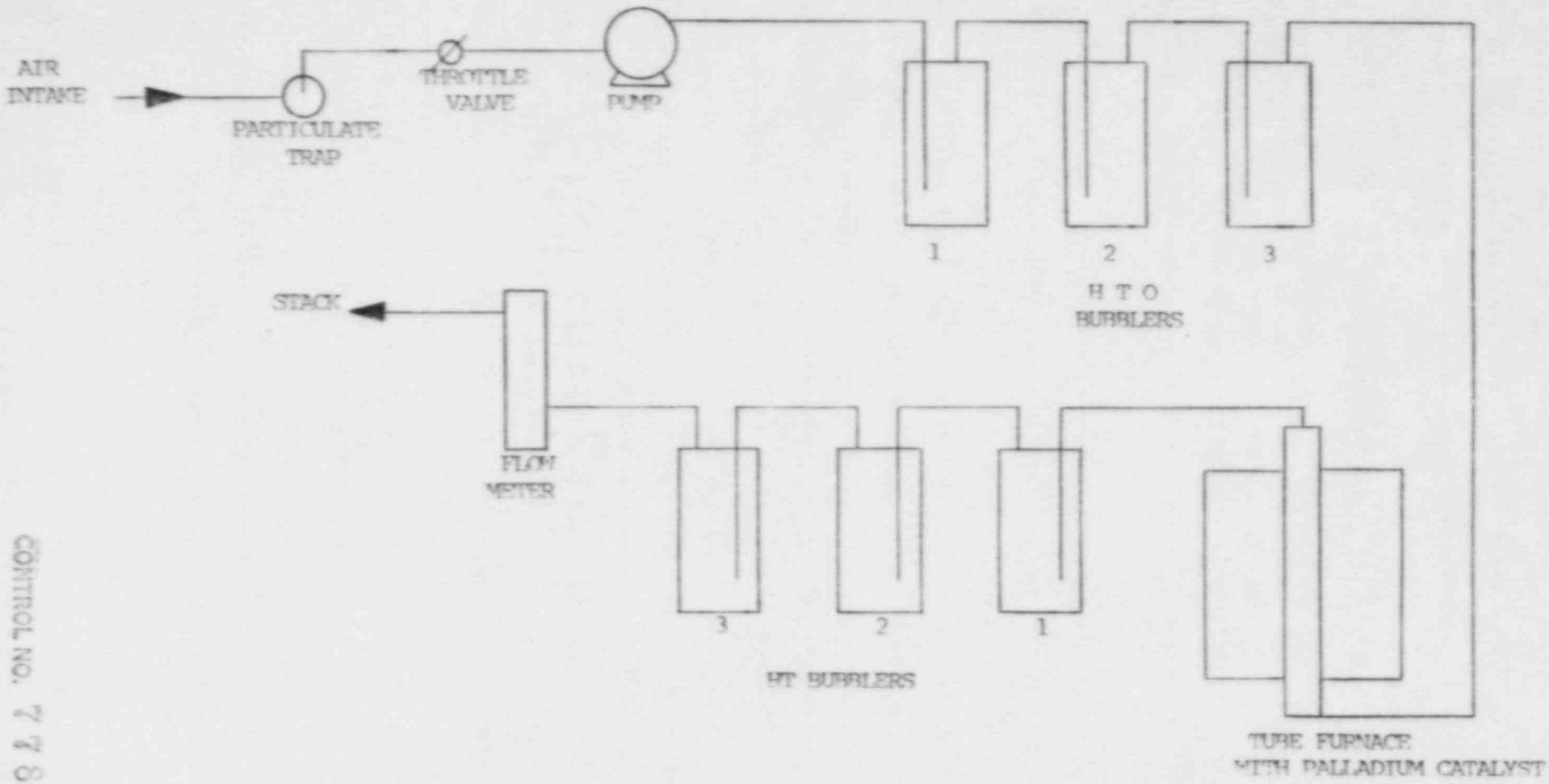


FIGURE 3: DIFFERENTIAL TRITIUM AIR SAMPLER

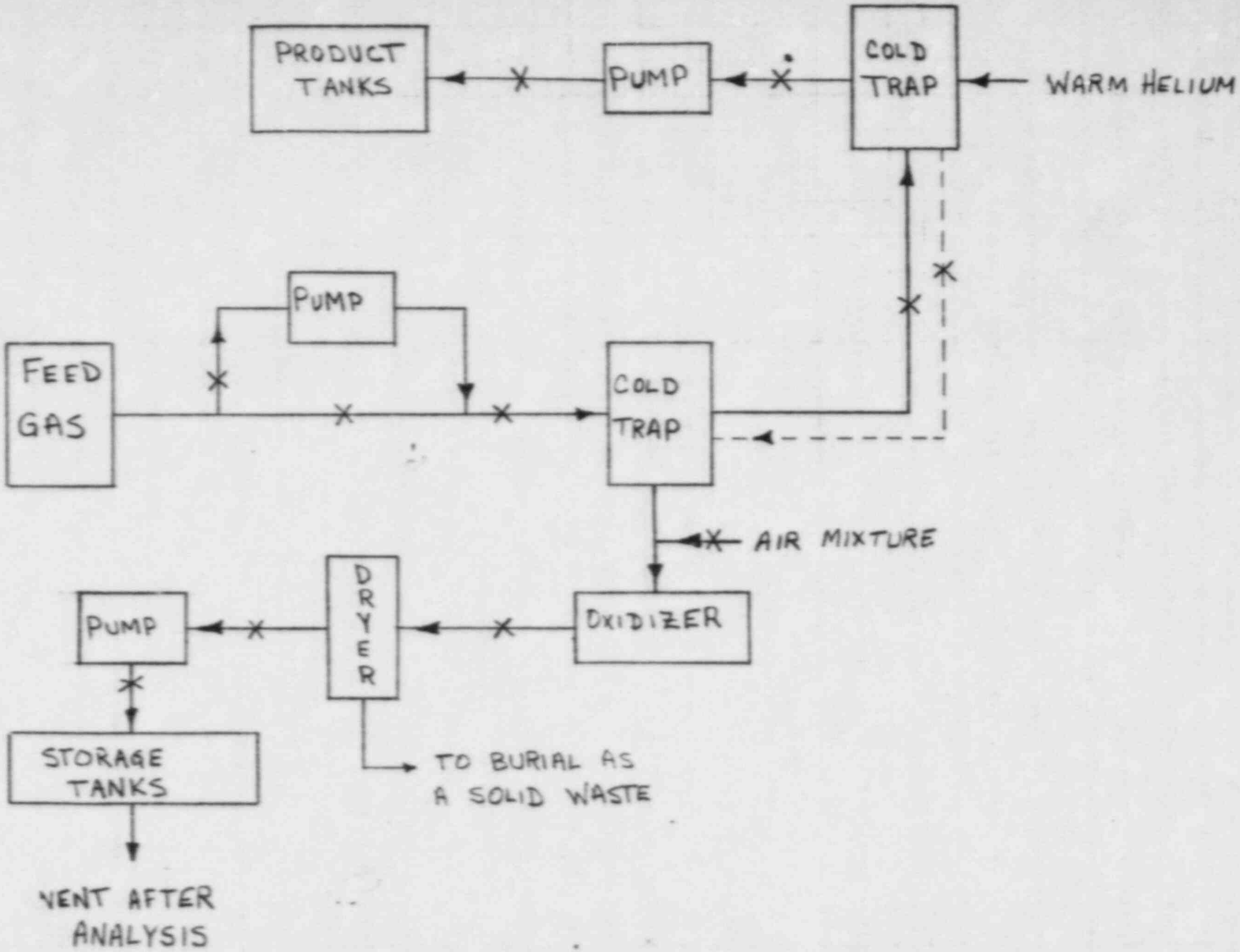


FIGURE 4: PROCESS SCHEMATIC

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