LILCO, May 8, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322-OL-3
	)	(Emergency Planning
(Shoreham Nuclear Power Station, Unit 1)	)	Proceeding)

LILCO'S TESTIMONY ON CONTENTION 49
(NOMOGRAM FOR THYROID DOSE)

PURPOSE

This testimony shows that the procedures used in the LILCO Plan to calculate a thyroid dose provide a reliable basis for making protective action decisions. The assumptions and calculations used in the procedure are detailed for use in air sampling in documents published by the NRC, FEMA, and the Department of Health and Human Services. The nomogram used in the procedure is simply a mathematical tool to assist in the calculations.

The contention reflects two questions raised in the FEMA-RAC review. The first is that the nomogram is not always used to calculate the thyroid dose from radioactivity measured on the particulate filter paper. In response to this, the

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procedure has been modified so that the thyroid dose from the radioactivity on the particulate filter paper is always calculated. The second question is whether the thyroid dose determination might not be accurate due to filtration, moisture in the containment, and other removal processes. As shown in the testimony, these effects only reduce the amount of radioactive material released, and the air samples taken in the field can be remeasured in laboratories where no assumptions concerning the release need be made.

Thus, the procedure and the included nomogram are an effective means of rapidly determining a thyroid dose so that protective actions may be implemented.

Attachments

Attachment 1 LILCO Transition Plan OPIP 3.5.2, p. 56 of 56, Attachment 11, p. 1 of 1

2 FEMA-REP-2 Appendix B

3 LILCO Transition Plan OPIP 3.5.1 Section 5.3.7

4 LILCO Transition Plan OPIP 3.5.2, pp. 18 and 54 of 56

5 FDA 83-8211 Appendix H-4

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LILCO'S TESTIMONY ON CONTENTION 49
(NOMOGRAM FOR THYROID DOSE)

1. Q. Please identify yourselves.

A. My name is Matthew C. Cordaro. My address is Long Island Lighting Company, 1660 Walt Whitman Road, Melville, New York, 11747.

My name is Charles A. Daverio. My address is Long Island Lighting Company, 100 East Old Country Road, Hicksville, New York, 11801.

My name is Richard J. Watts. My address is Impell Corporation, 225 Broad Hollow Road, Melville, New York, 11747.

2. Q. Please state your professional qualifications.

A. [Cordaro] I am Vice President, Engineering, for LILCO. My professional qualifications are being offered into evidence as part of the document entitled "Professional Qualifications of LILCO Witnesses." I am sitting on this panel to provide the LILCO management perspective on emergency planning, and to answer any questions pertinent to management. My role in emergency planning for Shoreham is to ensure that the needs and requirements of emergency planning are being met, and that the technical direction and content of emergency planning are being conveyed to corporate management. I accomplish this by supervising the development and implementation of the offsite emergency response plan for Shoreham; the manager of the Local Emergency Response Implementing Organization (LERIO) reports directly to me.

[Daverio] I am employed by LILCO as Supervisor of Emergency Planning and Regulatory Services, and have been working on emergency planning for LILCO for over 4 years. I am also Assistant Manager of LILCO's Local Emergency Response Implementing Organization (LERIO). My professional qualifications are being offered into evidence as part of the document entitled "Professional Qualifications of LILCO

Witnesses." As Supervisor of Emergency Planning and Assistant Manager of LERIO, I am responsible for implementing LILCO's Local Emergency Response Plan. As such, I am familiar with the issues surrounding the calculation of thyroid dose using the nomogram which relates iodine to total fission products, as indicated in the LILCO Plan in OPIP 3.5.2, Attachment 11.

[Watts] I am the Health Physics Supervisor for the Radiological Services Section of Impell Corporation. My professional qualifications are being offered into evidence as part of the document entitled "Professional Qualifications of LILCO Witnesses." I have been retained by LILCO to serve as Radiation Health Coordinator of LERO and have participated in LERO drills in this capacity. As such, I am familiar with the nomogram which relates iodine to total fission products for the calculation of thyroid dose in OPIP 3.5.2, Attachment 11.

3. Q. What is Contention 49?

A. As rewritten by the Licensing Board in its April 20, 1984 order ruling on LILCO's motion for summary disposition of Contentions 24.B, 33, 45, 46, and 49, Contention 49 reads as follows:

> The nomogram which relates iodine to total fission products for the calculation of thyroid dose (OPIP 3.5.2 Attachment 11) is not realistic. Thus, there is no assurance that this procedure will provide reliable data for use in making protective action decisions. Accordingly, there is no compliance with 10 CFR Section 50.47(b)(9).

Q. 4. What is the legal standard cited in Contention 49?

A. The legal standard cited in Contention 49 is the following:

> <u>10 CFR Section 50.47(b)(9)</u>
>
> (b) The onsite and, except as provided in paragraph D of this section, offsite emergency response plans for nuclear power reactors must meet the following standards:
>
> . . . .
>
> (9) Adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use.

5. Q. Does the FEMA RAC review to the NRC on the status of offsite emergency planning at Shoreham, dated March 15, 1984, discuss the nomogram that is the subject of Contention 49?

A. Yes. The FEMA RAC review found the following:

> [T]he nomogram which relates iodine to total fission products for the calculation of thyroid dose (OPIP 3.5.2 Attachment 11) may not be realistic in this aspect [that "even without core damage, radioiodine may be collected on the particulate filter if the iodine is in elemental form. Therefore, one cannot rule out activity on the particulate filter as not being iodine.] Furthermore, the amount of fission products collected from a core damage accident are [sic] highly dependent on a number of parameters, such as moisture in containment, filtration of release, distance from the site, etc., and are [sic] not easily amenable to the nomogram assumptions.

FEMA Review at 29.

The Licensing Board in its April 20 order found that this comment from FEMA "clearly calls into question an important aspect of the entire system, viz, the reliability of the projected dose data available to decision makers when the calculations are being done in the manual backup mode."

6. Q. Where was this method for measuring radioactive iodine developed?

A. The method used in OPIP 3.5.2 (see Attachments 1 and 4 to this testimony) is described in "Guidance on Offsite Emergency Radiation Measurement Systems," FEMA-REP-2, September 1980, in Appendix B, entitled "An Air Sampling System Developed by Brookhaven

National Laboratory for Evaluation of the Thyroid Dose Commitment Due to Fission Products Released from Reactor Containment" (Attachment 2 to this testimony).

7. Q. Then the equipment and formulas used in OPIP 3.5.2 are the same as those recommended by FEMA in the above document?

A. Yes. The nomogram used is only a mathematical tool which assists in doing the calculation when a calculator or computer is unavailable.

8. Q. What is the nomogram that relates iodine to total fission products for the calculation of thyroid dose?

A. This nomogram is contained in OPIP 3.5.2 Attachment 11 (Attachment 1 to this testimony) and is identified as "TCS Air Sampler Offsite Thyroid Dose Nomogram - Shoreham Station." This nomogram compensates for four different variables within the sampling process: (1) the iodine to total fission product; (2) decay of isotopes after reactor shutdown; (3) any exposure that has taken place to the public prior to the actual field measurement; and (4) duration of exposure (the amount of time that the population would be inhaling radioiodine from the plume, contributing to a thyroid dose.)

9. Q. How is the nomogram used in calculating expected doses?

A. A nomogram is a graphic representation that consists of several lines marked off to scale and arranged in such a way that, using a straight edge to connect known values on two lines, an unknown value can be read at the point of intersection with another line. It is essentially a mathematical tool that is of assistance when used in a calculation methodology.

To calculate doses under the LILCO Plan, personnel go to the field and take measurements as described in OPIP 3.5.1 Section 5.3.7 (Attachment 3 to this testimony), and in OPIP 3.5.2. These measurements are used in a calculation worksheet that directs the person performing the evaluation to the nomogram. The nomogram is used in making a series of calculations resulting in a total thyroid dose for the area in which the air sample was taken.

10. Q. What is meant in the FEMA RAC review and the contention by the statement that the nomogram is "unrealistic?"

A. The FEMA review noted two areas in which FEMA thought the nomogram was unrealistic. First, FEMA commented that without core damage, radioiodines may be

collected on the particulate filter if the iodine is in elemental form. Therefore, it is conceivable that the activity measured on a particulate filter may be iodine. The second question in the FEMA comment notes that the amount of fission products collected from the core damage accidents is highly dependent on a number of parameters such as moisture, containment filtration of release, and other removal mechanisms that are not easily amenable to the nomogram assumptions. It is for these reasons that the FEMA review questions whether the nomogram is realistic.

11. Q. As to the first concern, does the nomogram account for particulate iodine that may be collected on the particulate filter paper?

A. Yes, the nomogram does account for particulate iodine collected on the filter paper. A radioactive plume released during an emergency could consist of gaseous and particulate material. Both of these types of emissions could include radioactive iodine, which, when inhaled, would result in a dose to the thyroid. The TCS Air Sampler System used in the LILCO Plan consists of an air pump and a sampler canister which is filled with absorbent material and surrounded by a particulate filter. The outside filter is a very fine paper which is designed to trap particulate

material. Particulate material present in a release could consist of radioactive iodine and other non-iodine particulates. The inner canister contains an absorbent material that collects radioactive iodine only in gaseous form. Thus, when the air sample collection is completed, the amount of radioactive iodine collected in the inner absorbent material and on the outer particulate filter must be determined. This is done in the field by use of a radiation survey instrument, or in the laboratory using radiation analysis equipment. The absorbent material in the inner canister would contain only radioactive iodine. This measurement would require only correction for radioactive decay of the iodine from the time of reactor shutdown to the time of sampling.

However, the outer filter paper may contain both iodine and non-iodine particulate material. The nomogram procedure assumes a certain mixture of iodine and non-iodine particulate material to be present on the filter paper; the radioactivity of this mixture is further assumed to vary as a function of time. Thus, the nomogram allows one to calculate how much of the measured radioactivity on the filter paper is due to particulate iodine at various points in time.

The nomogram procedure then allows the total thyroid dose from gaseous and particulate iodine to be calculated. This is accomplished by determining the gaseous and particulate components of the thyroid dose separately, and then adding them.

12. Q. What was the origin of the FEMA RAC review comment?

A. The LERO procedure OPIP 3.5.2 states in notes on pages 18 of 56 and 54 of 56 (Attachment 4 to this testimony) that unless there is core melt or fuel damage it is not expected that there will be any iodine released in particulate form and therefore no iodine radioactivity will be found on the filter paper. Thus, it is not necessary to calculate a thyroid dose from the filter paper measurement but only from the inner canister. Pursuant to FEMA's comment that even without core melt or fuel damage, radioiodine may be released and collected on the particulate filter paper, the procedure will be modified in future revisions to the LILCO Plan to remove the notes on pages 18 and 54. Thus, the radioactivity measured on the filter paper will always be included in the thyroid dose calculation.

Q. 13. As to the second concern, is the nomogram realistic?

A. Yes. The determination of the radioiodine fraction of the fission product release was based upon an analysis of different release scenarios for BWR accidents. The procedure uses a most probable iodine/total fission product ratio for the accident scenarios analyzed.

14. Q. Is the ratio used in OPIP 3.5.2 the same ratio recommended in the FEMA REP-2 report?

A. Yes, it is.

15. Q. Can valid thyroid dose determinations be made using this methodology?

A. Yes. As discussed above in this testimony, the particulate component of any accidental release will be accounted for by the TCS sampler method by always checking for the presence of radioactivity on the outer filter paper following sample collection.

Because radioactive material detected on the filter paper is likely to include a mixture of iodine and non-iodine particulates that varies with time, the nomogram includes a correction step to account for this variation. The nomogram correction reflects the most probable ratio of particulate iodine to total

particulates as a function of time. When filter canisters are later reanalyzed by a laboratory, the specific particulate mixtures present will be determined.

It should also be noted that the nomogram correction for particulate mixtures was based upon BWR accident scenarios, which predict significant releases of radioactivity in particulate form (known as dry release cases). However, when other parameters are considered, such as containment moisture, filtration, and other physical chemistry conditions, these influences would have the effect of suppressing the release of particulate material. Little, if any, iodine or non-iodine particulate material would therefore be likely to be detectable in the field. Accordingly, the particulate iodine component of any computed downwind thyroid inhalation dose would be greatly decreased in magnititude. This would also diminish the significance of any uncertainty associated with the mixture of iodine and non-iodine particulates assumed to be present.

Q. 16. Is this method (supported by the equipment, procedures, and calculations used in the LILCO Plan) recommended by any agency other than FEMA?

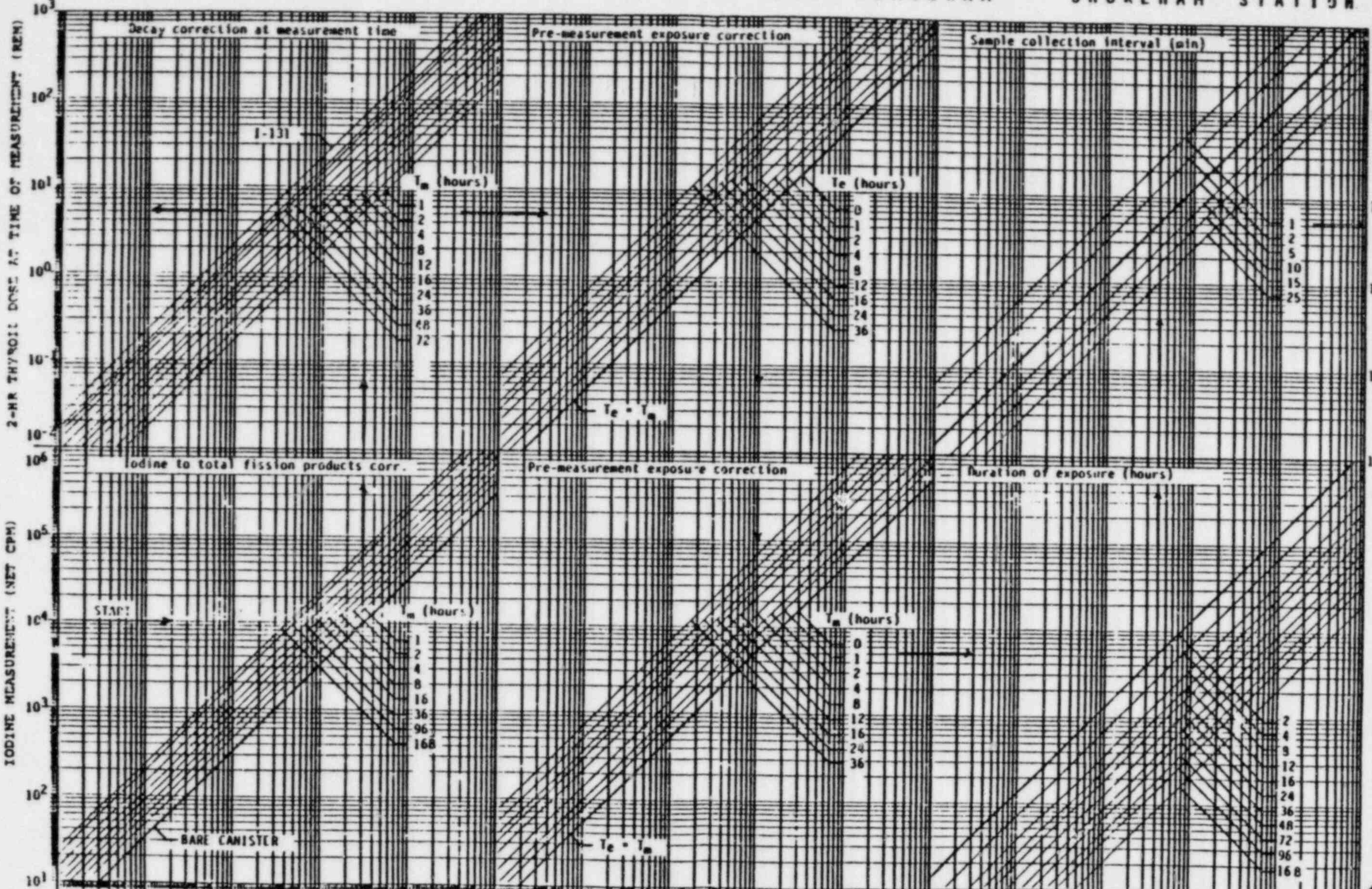
A. Yes, the same methodology and assumptions are detailed in Appendix H-4 of "Preparedness and Response in Radiation Accidents: U.S. Department of Health and Human Services," FDA 83-8211 (August 1983) (Attachment 5 to this testimony).

Q. 17. Will this method provide reliable data for use in making protective action decisions?

A. Yes. The method identified will provide an accurate and dependable means of determining the thyroid dose to the exposed population during the early stages of an emergency when the determination and implementation of protective actions are most critical. In a slowly developing emergency where there is the potential for a release or where a radiological release takes place over a given period of time after the reactor shutdown, protective actions would be recommended based upon factors that include plant conditions, in-plant radionuclide measurements, and environmental survey measurements.

Attachment 1

TCS AIR SAMPLER OFFSITE THYROID DOSE NOMOGRAM - SHOREHAM STATION



T_m = time interval between reactor shutdown and survey measurement

T_e = time interval between reactor shutdown and start of exposure

Rev. 0
5/11/83

Attachment 1 to
LILCO Testimony
on Contention 49

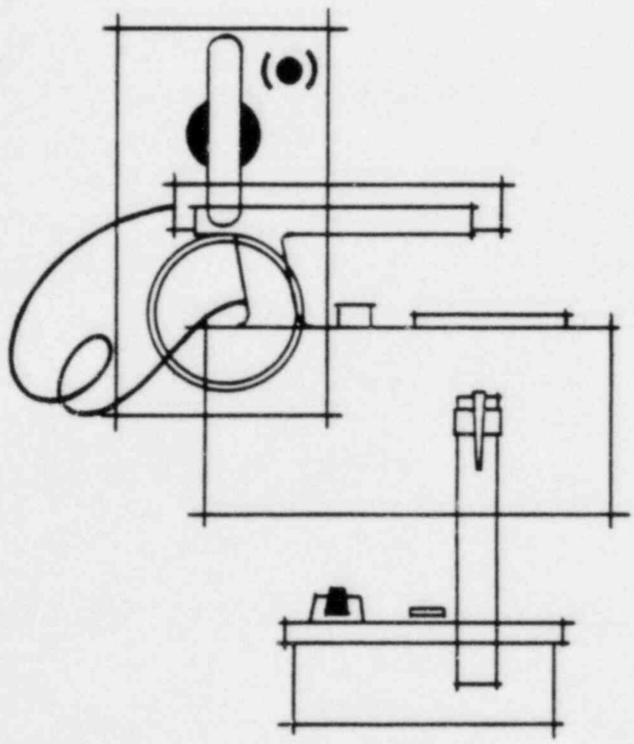
Attachment 2

Attachment 2 to
LILCO Testimony
on Contention 49

FEMA-REP-2
SEPTEMBER 1980

GUIDANCE ON OFFSITE EMERGENCY RADIATION MEASUREMENT SYSTEMS

Phase 1 - Airborne Release



Federal Emergency Management Agency

APPENDIX B

AN AIR SAMPLING SYSTEM DEVELOPED BY BROOKHAVEN NATIONAL LABORATORY FOR EVALUATION THE THYROID DOSE COMMITMENT DUE TO FISSION PRODUCTS RELEASED FROM REACTOR CONTAINMENT

B.1 Introduction

Inhalation of radioiodines is expected to be the most important initial pathway of human exposure in the event of a release of radioactivity during a nuclear power reactor incident. The thyroid gland will therefore be the critical organ and will receive the largest dose should an accident occur. Consequently, a method for monitoring for radioiodines, in the presence of fission gases (e.g., ^{133}Xe), which would be released in much larger quantities than radioiodines and particulate fission products, must be developed to provide a data base for exposure control.

Costly measurement methods using gamma analysis can be avoided by developing a sampler specifically for iodine, thereby permitting any beta or gamma detector to be used for measurement (Figure B-1). Particulate fission products include dozens of noniodine radionuclides. Use of a prefilter (Figure B-2) before the adsorber bed separates the activity into gaseous and particulate fractions, and allows a determination of gaseous radioiodine.

Figure B.1 Canister evaluation with a CD V-700 GM counter.

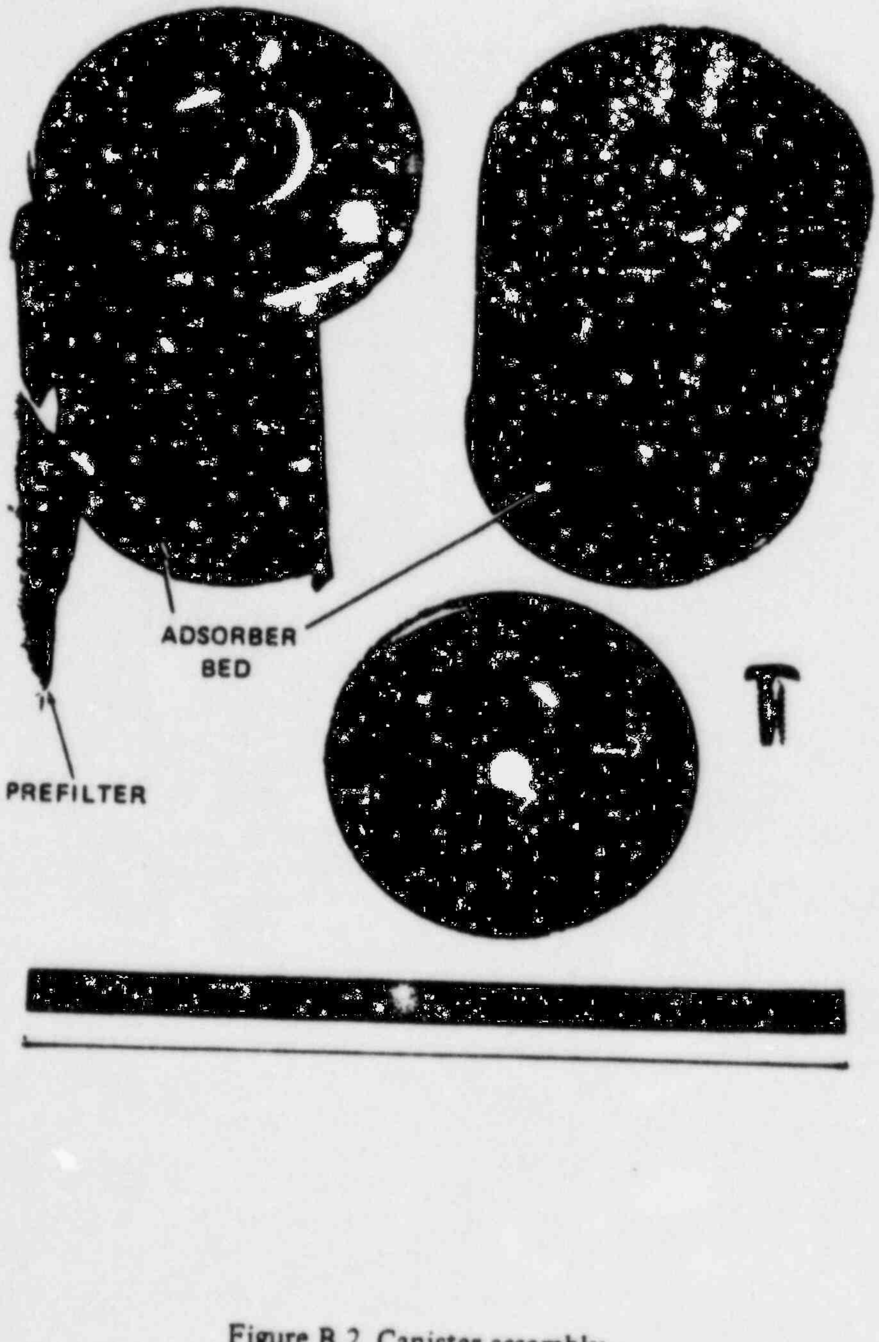


Figure B.2 Canister assembly.

Adsorption of fission gases relative to iodine can be reduced by using an appropriate inorganic adsorber. Several commercial inorganic adsorbers were tested, but were too expensive or inefficient for the organic or hypoiodous acid forms of iodine. A silver impregnated silica gel adsorber was developed that has over 90% efficiency for collection of radioiodine for sampling times of several minutes. The material provides corresponding xenon efficiencies of less than 0.04% at temperatures above 7°C.

The air sample size needed for reliable detection of a given air concentration depends on detector sensitivity, flow rate, and sampling time. Field monitoring under accident conditions requires prompt measurements for proper use of time, equipment, and operator exposure. For these reasons, the Federal Interagency Task Force on Offsite Emergency Instrumentation for Nuclear Incidents set a maximum of 5 minutes for air collection. Two degrees of freedom remain: detector sensitivity and flow rate.

Flow rate is governed, in part, by the power available for air movement. Air sampling away from power lines requires portable generators or power derived from automotive electrical systems. Battery power supplies are inappropriate due to excessive weight and expense. As mentioned earlier, the desirable solution is a significant number of inexpensive air sampling apparatus. Thus, use of automotive electrical systems is the least expensive solution (Figure B-3). Two power connections to automotive batteries are economically possible: direct clamping or use of cigar lighter sockets. The safer and generally better solution is the latter.

Figure B.3 Sample collection utilizing 12V d.c. power from an automobile cigar lighter socket.

Factory installed wiring limits this source to about 150 watts. Vacuum motors of this size can move 4 to 7 cfm through the pressure drop of an adsorber-filter thereby setting the flow rate at 5 cfm.

For operational flexibility, the air sampler can also be used on standard 110V a.c. power. Air flow regulation and control assures a uniform sampling rate for either power source.

The remaining variable is detector sensitivity. Economy and long-term calibration stability make Geiger-Mueller detectors desirable. GM detectors are known for high beta and low photon efficiency. However, photon sensitivity can be increased by changing the standard GM tubes, with stainless steel cathodes, to ones with higher Z cathodes. Therefore, a CD V-700 GM instrument, used with a high Z cathode Victoreen 6306 tube, may be used to provide the sensitivity desired for this sampling system.

B.2 The Air Mover

The air mover housing, shown on Figures B-4 and B-5, consists of a tubular support structure, a front and back plate, and a perforated motor impeller safety guard. The tubular structure contains a handle, two plate mounting rings and a switch mounting hole.

The front plate is shown on the lower right on Figure B-4. The filter adsorber canister is placed on the central suction tube and retained with

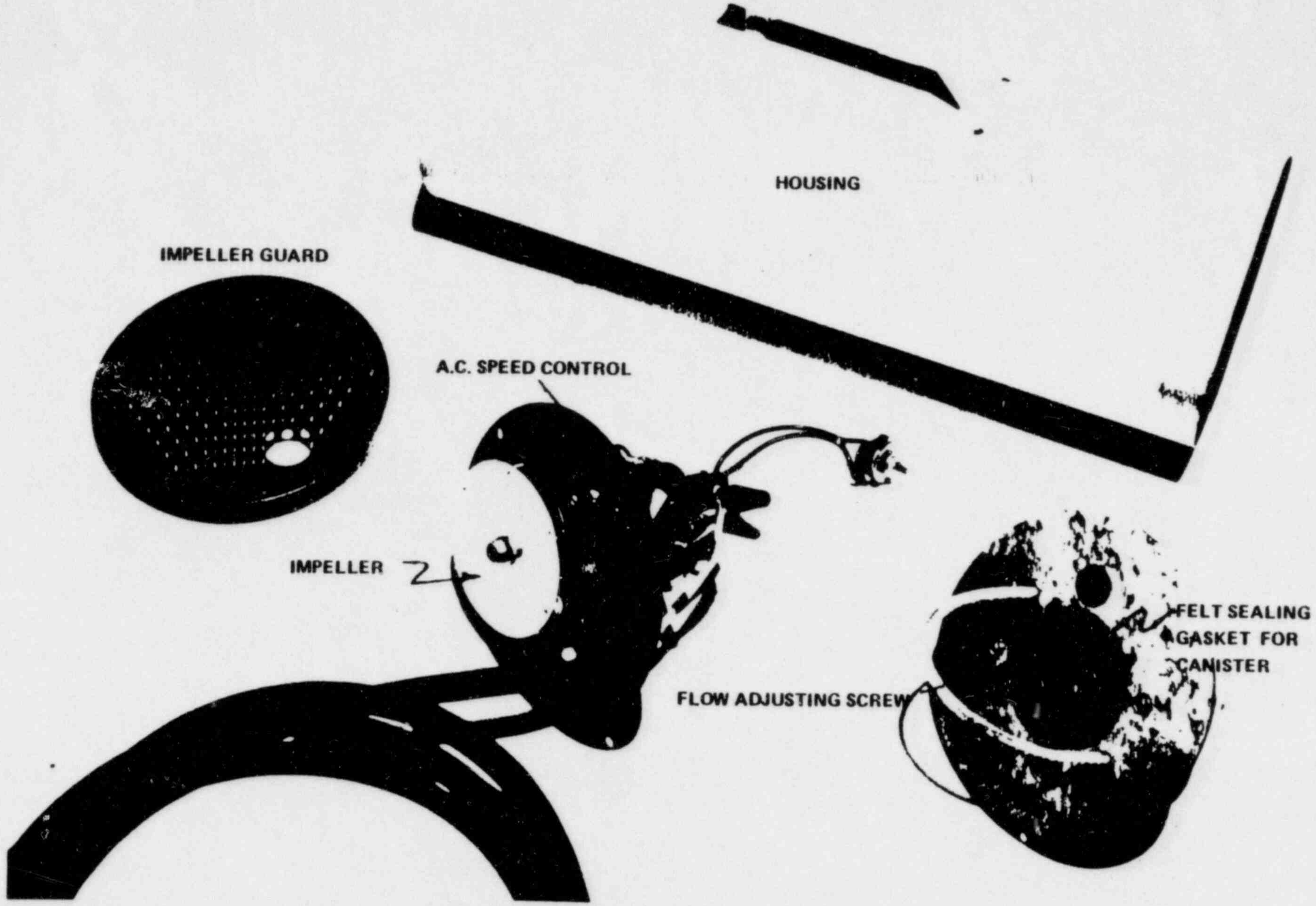


Figure B.4 Air mover components: Exterior view of vacuum bulkheads.

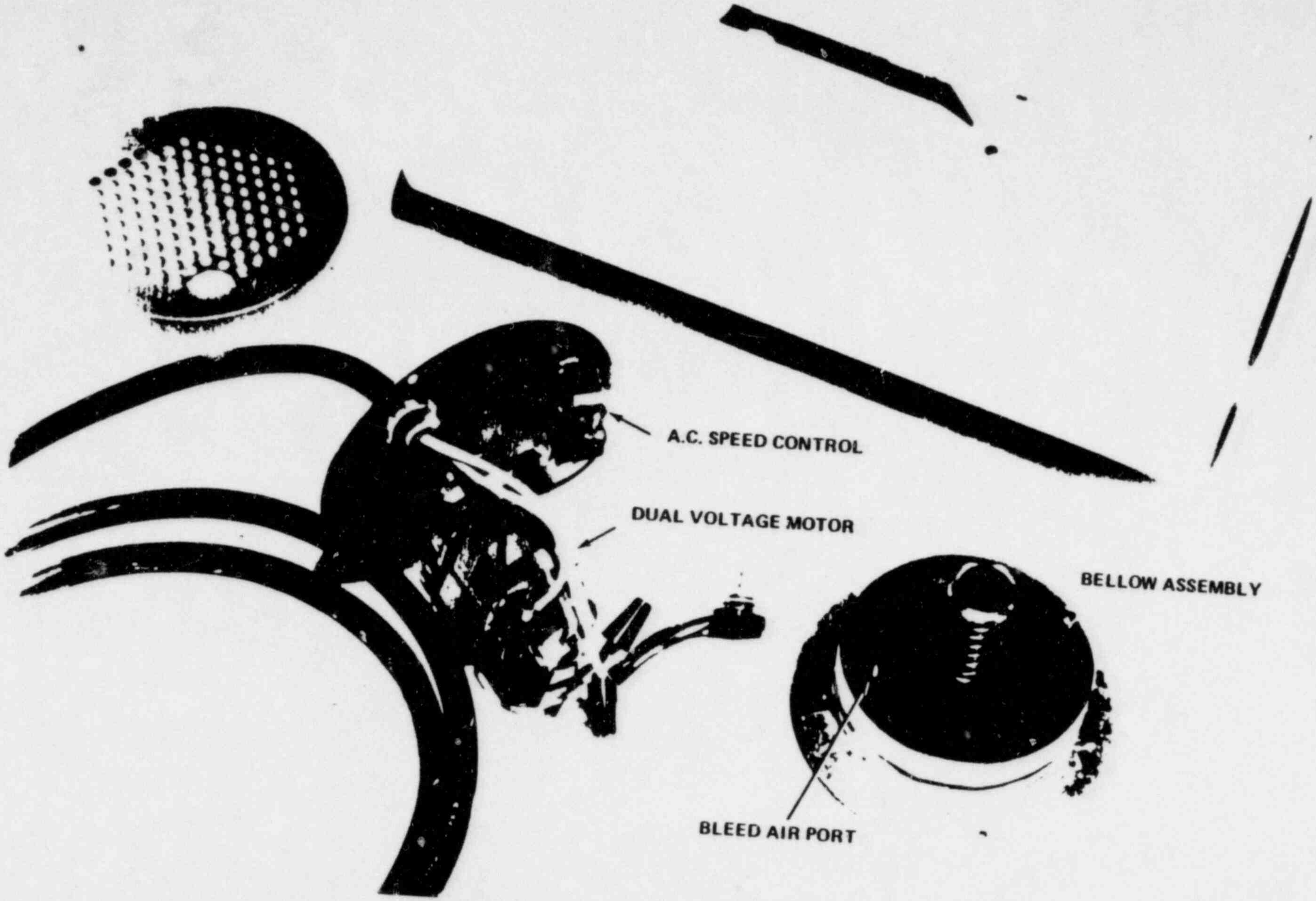


Figure B.5 Air mover components: Interior view of vacuum bulkheads.

the rubber cord. The flow rate control screw is located in the central suction tube and is used to adjust spring tension on the bellows. The remaining two holes ventilate the interior of the bellows to maintain normal atmospheric pressure within the bellows. A rear view of the bellows is shown on Figure B-5. The bellows consist of two metal cups, one attached to the front plate and the other capable of longitudinal movement. The flow rate control screw is used to adjust the spring loading. This tends to direct the movable bellows half toward the front plate, closing the air bleed port shown to the left of the spring. During motor operation, the reduction in atmospheric pressure will counteract the loading spring, opening this port. Thus, spring adjustment controls the pressure inside the air mover. The difference between ambient pressure and pressure in the air mover governs the flow rate through the filter adsorber. Dust loading is not a problem for the 5 minute, 5 cfm sample.

The rear plate serves as a vacuum bulkhead and as a mounting plate for the dual voltage motor and a.c. speed control. The impeller and a.c. speed control adjusting stub are shown in Figure B-4. The remaining perforated plate protects the operator.

The dual voltage motor is designed for about 240 watts on alternating current, nearly double the d.c. power value. A 600 watt household lamp dimmer is used to reduce the a.c. power for the proper flow rate.

Direct current power is derived from the cigar lighter socket of any 12 V vehicle. An adapter plug provides for d.c. operation.

B.2.1 Initial and Periodic Flow Rate Adjustment

The air mover is operated at 12.8 V d.c. measured at the cigar lighter socket. A filter canister is connected to a venturi flow rate meter which in turn is connected to the air mover suction tube with Tygon tubing. A venturi flow meter is a straight through flow device that operates with an acceptable pressure drop of about 0.25 inches of water. The flow rate is adjusted to 5 cfm by alternately disconnecting, adjusting the flow adjusting screw shown on Figure B-4, and reconnecting the Tygon tubing to the air mover suction tube.

The dual voltage motor develops about twice as much power on a.c. as it does on d.c. For proper balance the a.c. voltage must be reduced.

After d.c. adjustment, the adaptor plug is removed and the air mover is operated on 110 ±1 volt a.c. power. The a.c. speed control stub shown on Figure B-4 is turned to provide an indicated flow of 5 cfm.

Air flow control characteristics for a.c. and d.c. power are shown on Figure B-6. The regulated d.c. flow rate change is less than 0.4% per 1% voltage change, while the regulated a.c. flow rate change is about 0.8% per 1% voltage change.

B.3 An Inorganic Adsorber with Low Noble Gas Retention

A silver loaded silica gel has been developed as an adsorber for air monitoring subsequent to a release from containment power reactor accident.

FIGURE B-6

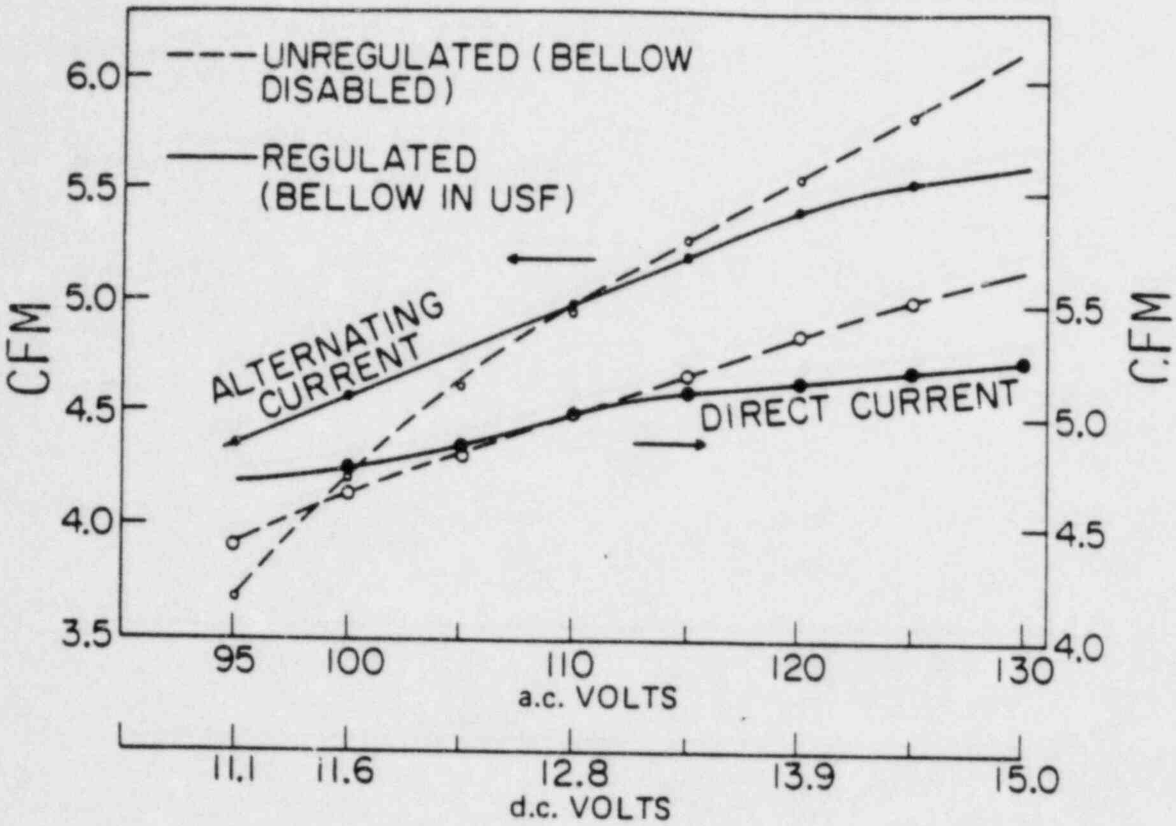


Figure B.6 Flow rate regulation.

Requirements of high efficiency for known radioiodine species under wide ambient conditions of humidity and temperature and low noble gas adsorption efficiency are satisfied by the material.

Silver loadings from 2 to 24% by adsorber weight have been tested against organic radioiodine, hypoiodous acid, elemental radioiodine, and noble fission gases. Relative humidity was varied between 5 and 99%, and stay times of 0.11, 0.073, and 0.055 seconds were used.

Silver loading requirements depend on sampling duration and relative humidity. Environmental monitoring requires about 25 ft^3 of air be sampled and analyzed for a dose projection. The proposed analysis system consists of an air mover, an adsorber and a civil defense readout instrument fitted with a special 6306 probe which is discussed in Section 4. This combination provides adequate sensitivity for dose predictions. A silica gel adsorber can be used with a 4% silver loading for an efficiency of better than 93% with a 0.11 second stay time, and for all ambient conditions tested. Similar tests using 4% silver loaded 13X molecular sieve or about 60% silver zeolite yielded lower efficiencies.

Xenon adsorption was less than 5×10^{-3}% at 50°C with no post-release flushing. This value was about 1/20 of the value for charcoal under the same conditions.

B.4 High Photon Sensitivity GM Tubes

Geiger-Mueller detectors are sensitive to ionizing events initiated by energetic charged particles within the active volume.

To increase photon sensitivity, GM detectors should have high Z materials within the active volumes. Bismuth is the optimum material since it is the highest Z non-radioactive element.

Victoreen 6306 GM detectors contain bismuth coated wire mesh screens positioned around the cathodes. Wire screening is used to increase the cathode surface to volume ratio and thereby increase sensitivity. Organic quenching must be used due to the chemical reactivity of bismuth with the halogens.

TGM Detectors, Inc. supplied a number of halogen quenched counters with platinum plated cathodes. Type NP 358 detectors, with an inside diameter of 15.2 mm, were shortened by TGM to 9.8 cm. All of the GM tubes were operated with a standard CD V-700 instrument adjusted to 900 volts.

B.5 Energy Response Measurements

GM detector energy responses were measured with heavily filtered x-rays and isotope sources. Some of the isotope sources used to determine detector energy response were ^{131}I (365 keV), ^{137}Cs (662 keV) and ^{60}Co (1250 keV). X-rays from 74 to 200 keV effective energy were also used.

The measured energy responses of four bare Victoreen detectors are shown in Figure B-7. Good agreement between measurements and sales literature exists below 365 keV, while a sensitivity more constant with energy was measured above. GM detector filter calculations were made to design a shield to attenuate the principal xenon decay photons more than the iodine, where the calculated and measured response is shown in Figure B-7 for a two element concentric filter of 0.127 cm Pb adjacent to the GM tube followed by 0.08 cm Cu. The shield and 6306 tube are shown in Figure B-8. A comparison of the bare tube ^{135}Xe to ^{131}I ratio of 350/185 ≅ 1.9 to the filtered tube ratio of 123/125 ≅ 1 indicates that the shielding reduced the xenon to iodine response ratio by a factor of approximately 1.9. The remaining xenon isotopes have lower energy decay gamma rays and are reduced by much larger factors.

Air sampling for iodine involves adsorption of gases and filtration of particles on a cylindrical canister. Readout requires the insertion of a shielded GM detector into the axial suction hole in the canister, as shown in Figure B-2. The energy response of the 6306 probe within a canister with 4% by weight silver loaded on silica gel is shown in Figure B-9. Calculations indicate that approximately 50% of the adsorbed organic iodine is in the first 0.4 cm of adsorber. To better account for photon attenuation, a 0.4 cm void is placed in the periphery of the adsorber bed and oriented normal to the photon beam.

FIGURE B-7

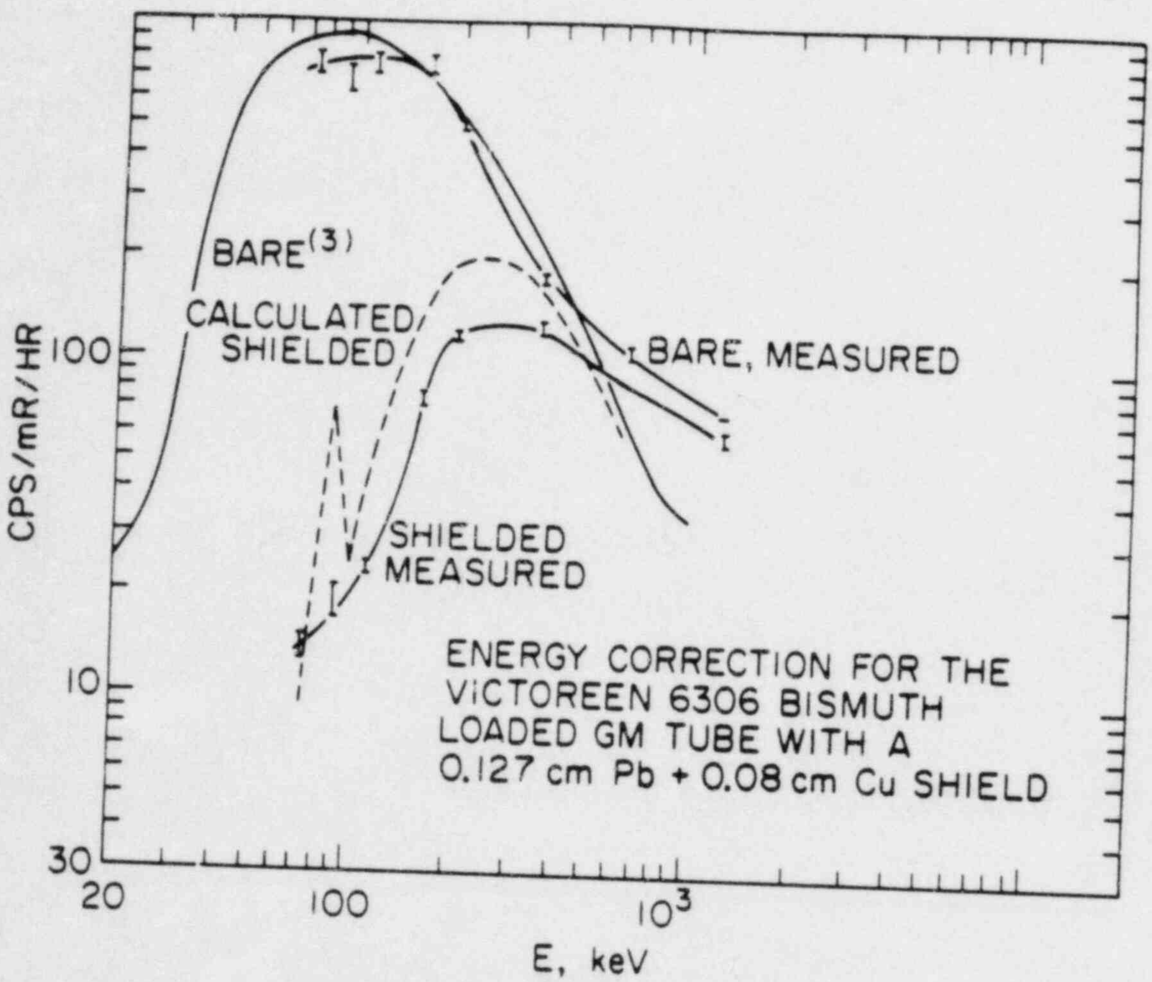


Figure B.7 Energy response of bare and shielded 6306 GM detectors.

FIGURE B-8

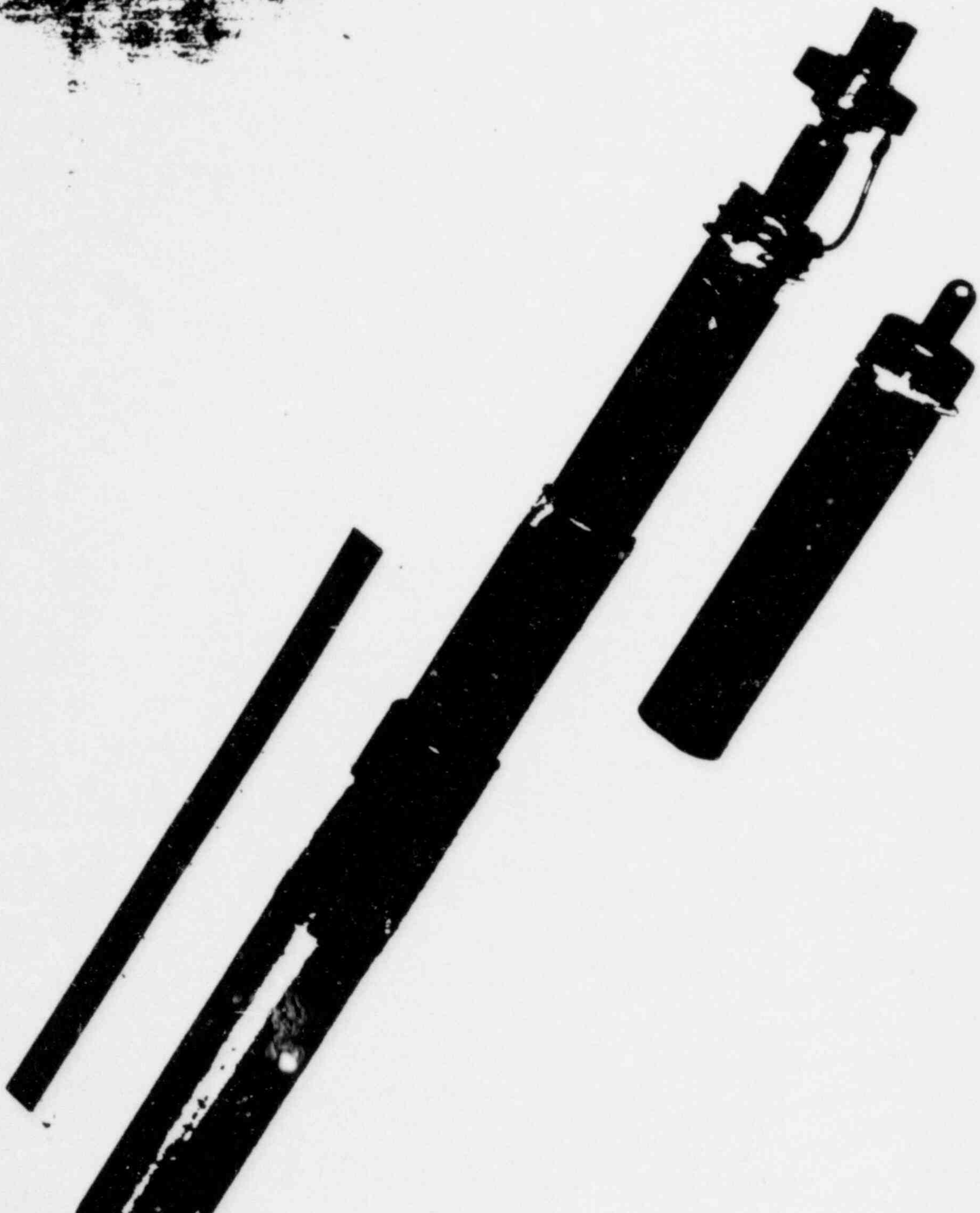


Figure B.8 6306 GM detector and shield assembly.

FIGURE B-9

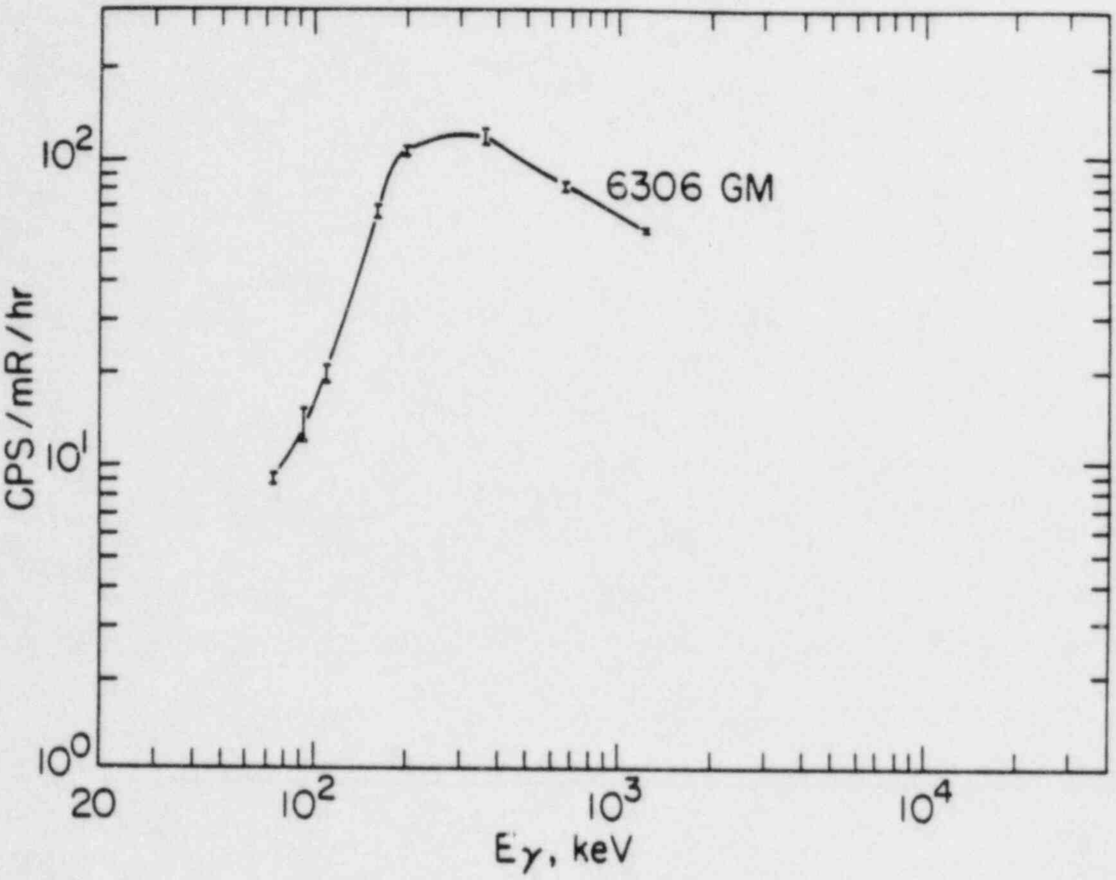


Figure B.9 Shielded probe exposed in 4% Ag-gel canisters.

B.6 Summary of Results

a. The critical GM detector requirement was taken to be the evaluation of air samples containing mixed fission products.

b. A filter was designed to attenuate the xenon decay photons more than ^{131}I photons.

c. The energy response for a probe having a filtered 6306 detector was measured. The energy response was also determined with a 6306 GM tube in a 4% Ag-gel loaded canister.

d. In general, the 6306 GM tube was found to be more sensitive for photons from 0.25 to 0.5 MeV than the CD V-700 GM instrument with its standard GM tube.

AIR SAMPLING PROCEDURE

Procedures are given for equipment check and field air sampling, evaluation of the exposed filter-adsorber canisters, and internal thyroid dose equivalent predictions for the people living in the measured area. In order they are:

I. Equipment Check and Field Air Sampling

A. The air sampling system

1. Air mover.

2. Automobile, 12 volt cigar lighter adapter.

3. One or more quart cans each containing one filter-adsorber canister. Take one can for each location you are to measure and one spare.

4. CD V-700 GM counter modified with a 6306 GM tube.

5. Screwdriver or 25 cent coin to open the quart can lids (immediately before use).

6. Pocket or wristwatch to time the 5 minute ±6 second sampling period.

7. Respirator, one per person, optional.

B. Equipment checkout

1. Turn on the modified CD V-700 and test for an on-scale meter deflection of about 50 to 100 counts per minute on the X 1 range. The meter will jitter around on an average reading. Read the midpoint value within the jitter band.

2. Test the air sampler for operation with normal household a.c. electric power. Plug cord into a wall outlet and push the start switch near the handle. For proper operation, the sampler will sound and feel like a small vacuum cleaner.

3. Take all of the 7 items of part A plus a map and/or route instructions to a car or truck.

4. Plug the d.c. adapter on the end of the sampler power card into the cigar lighter or using the adapter make contact across the battery terminals and test sampler operation using the car

electrical systems with the engine running. Turn the sampler off.

C. Air sampling procedure

1. Drive to the first location, keeping vehicle windows closed.
2. Park at the first location, leave engine running, open the first quart can, and remove the filter-adsorber canister.
3. Mount filter-adsorber canister over central suction tube and stretch rubber retainer over the outer end of the canister.
4. Check to see that the air sampler is plugged into the cigar lighter socket and step out of the vehicle to the relaxed extent of the power cord. Keep vehicle door closed to the extent possible while allowing the power cord outside vehicle.
5. While holding the sampler about 4 feet above the ground, turn on for 5 minutes ±6 seconds.
6. While the sample is being taken, mark the location code of this first location on the can using a two-part peel-away label similiar to Figure B-13. After filling out both parts of the label, remove the peel-away part and mount on the page of the data notebook. Include any supplementary information on the sample next to the label in the notebook. During this sampling period a team member will make gamma measurements at 6 inches and 4 feet above the ground and inside the vehicle. These readings will be added to both parts of the label with any supplementary notes added in the notebook.

7. When the air sample is completed, carefully remove the canister from the sampler and insert the modified CDV-700 probe into the air suction tube of the canister. This measurement will be made at either 4 feet above the ground or inside the vehicle (depending on which location has the lowest reading). Record which location is used, the reading obtained and the reading of the canister on the part of the label marked Evaluation, as illustrated in Figure B-13.
8. If the reading at 4 feet or inside the vehicle is greater than 10% of the count rate obtained from the canister, the measurement should be performed at another location where these readings are below this level. For example, if the canister count rate is 2,000 c/m, then the reading at either 4 feet or inside the vehicle should be less than 200 c/m.
9. Locate the tape on the outside of the canister. Pull the tape and remove the glass fiber cloth. Return the filter into quart can using a paper tissue for handling.
10. Read the bare adsorber canister and record this final entry and date on the label.
11. Return the canister to its quart can containing the filter cloth and reseal with the correct lid.
12. Report data to EOC by radio or whatever communications system has been made available.
13. Drive to the next location and using a new canister repeat steps C2 through C12. If previous canisters have indicated high activity, stack them away from a newly measured one.

II. Internal Dose Predictions

The following calculations should be made at the EOC as the data is received from the monitoring teams in the field.

A. Glass filter cloth evaluation

1. Use Figure B-10 to account for the radioiodine on the glass filter cloth for each set of measurements received. Note the type of reactor (BWR or PWR), and determine the number of hours between shutdown and time of measurement.

2. Find the iodine to total released fission products correction factor (CF) on the vertical axis and calculate the difference in filter-adsorber and adsorber readings. This difference (D) is due to total fission product activity on the filter. The product CF x D is the corrected filter reading (F) at the time of the measurement due to iodine on the filter.

B. Filter-adsorber evaluation

1. The adsorber net counting rate (N) is determined by subtracting background (B) from the bare adsorber measurement (G), i.e., the adsorber with a glass fiber cloth removed.

$$N = G - B$$

Figure B-10

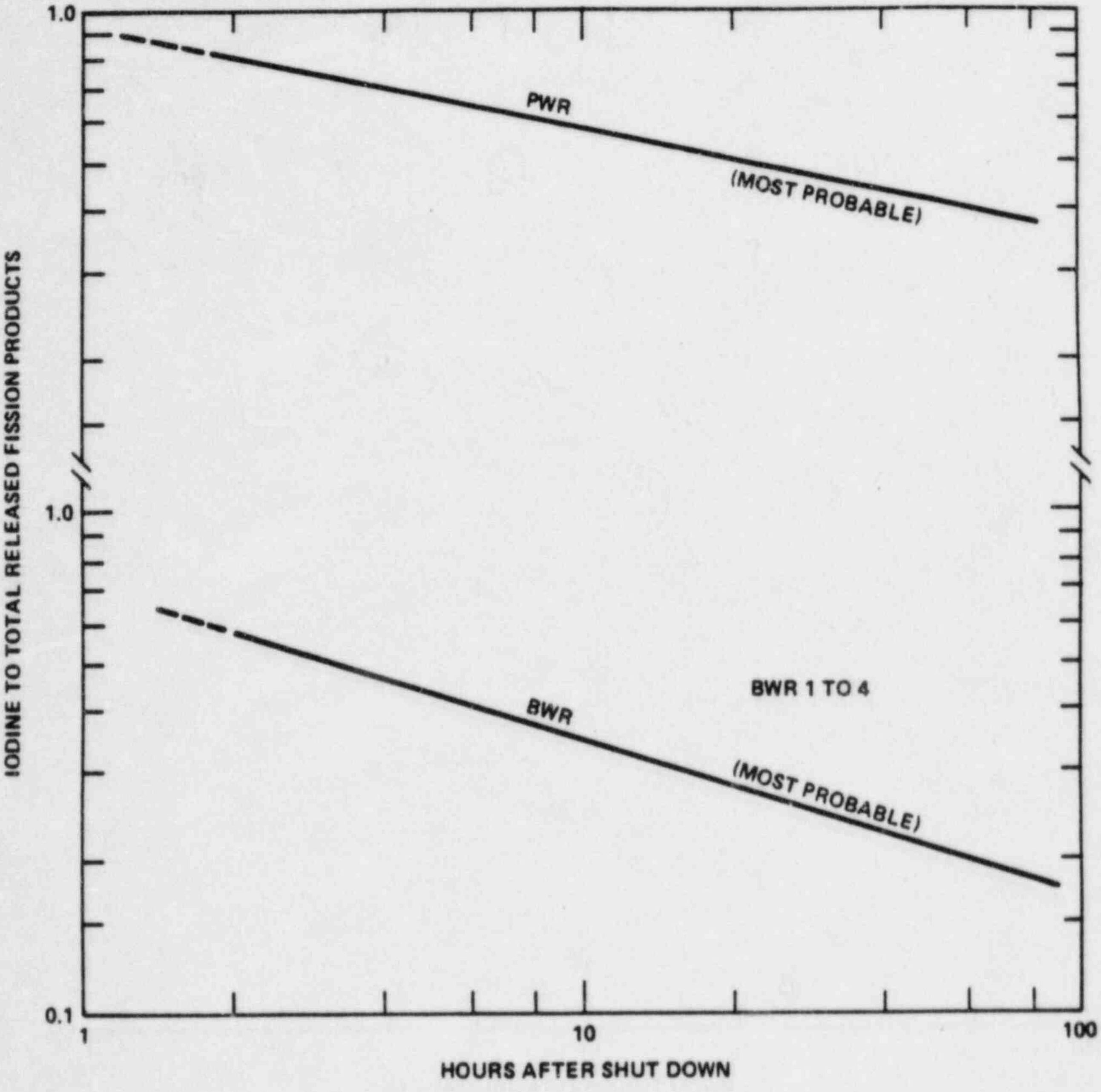


Figure B.10 Iodi 1e to total fission products correction factor for shielded CD V-700 instruments.

2. Add the corrected filter reading (F), step 2 of Section A, to the net adsorber reading to obtain the total iodine counting rate (R).

$$R = F + N$$

3. Enter on your label the total iodine counting rate found in step 2, on Section B. From Figure B-11 follow a vertical to the number of hours after reactor shutdown that the bare reading (G) was made. The ordinate is the predicted thyroid dose commitment to a 5 year old child at the site of the air sample for a 2 hour immersion.

4. If the immersion time is greater than 2 hours, then Figure B-12 can be used for the dose commitment to the 5 year old child. For example, where the dose commitment (H_∞) for a 2 hour immersion is 1 rem, and the anticipated immersion time is 5 hours, multiply 1 rem x 2.5 = 2.5 rem.

C. Evaluation of results

The projected dose commitment values can be posted on a map corresponding to their locations. If sufficient measurements were made, the location of the plume should be defined by significantly higher readings.

Predictions can be made of the dose commitment along the plume pathway. This should improve the data base so that decisions can be made about stable iodine feeding, evacuation of exposed persons to reduce exposure to resuspended radioactive particles, and designations of contaminated pasturage.

FIGURE B-11

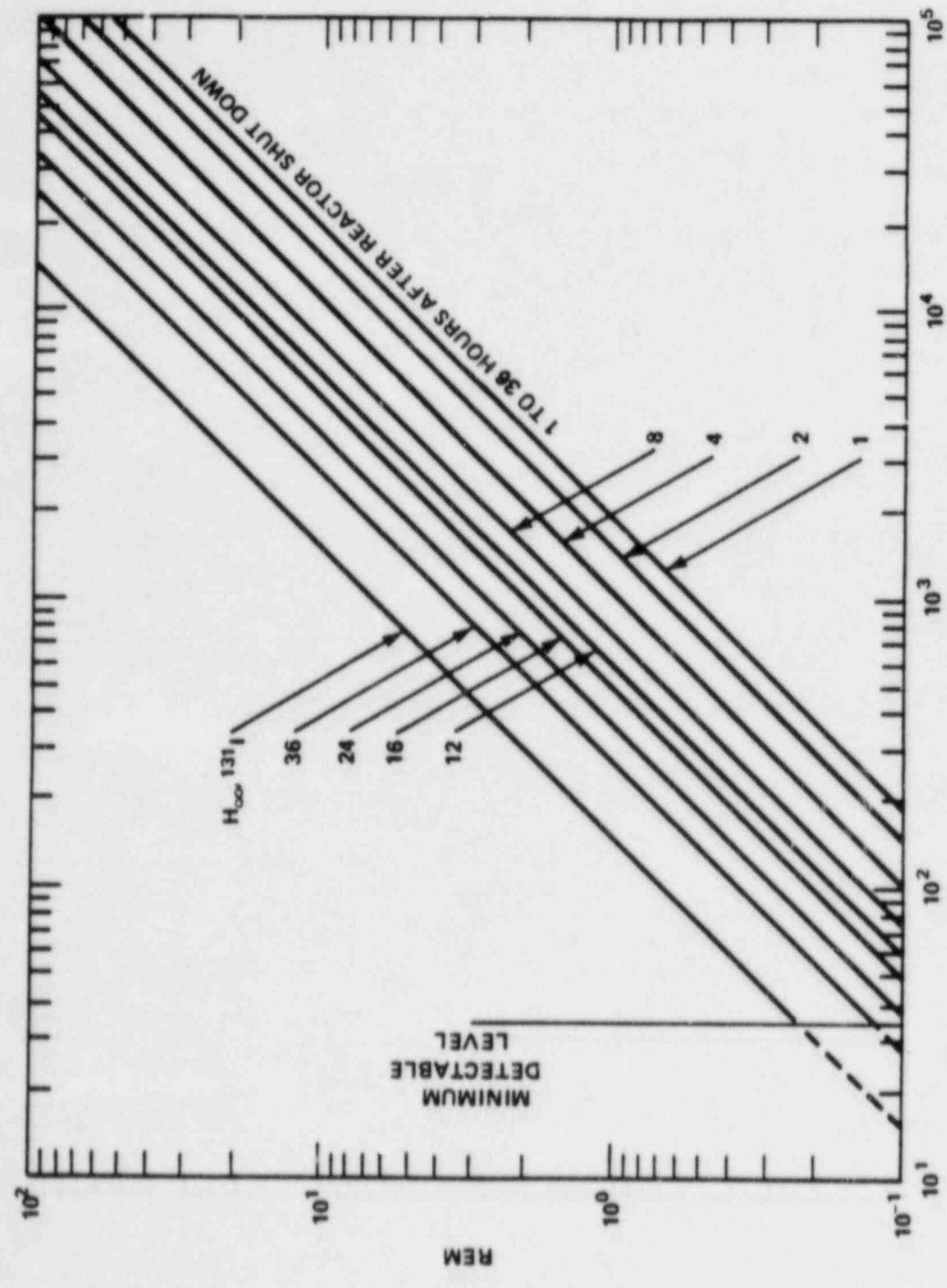


Figure B.11 Conversion of 6306 probe response to 5 year old child thyroid dose commitment for 2 hr immersion.

FIGURE B-12

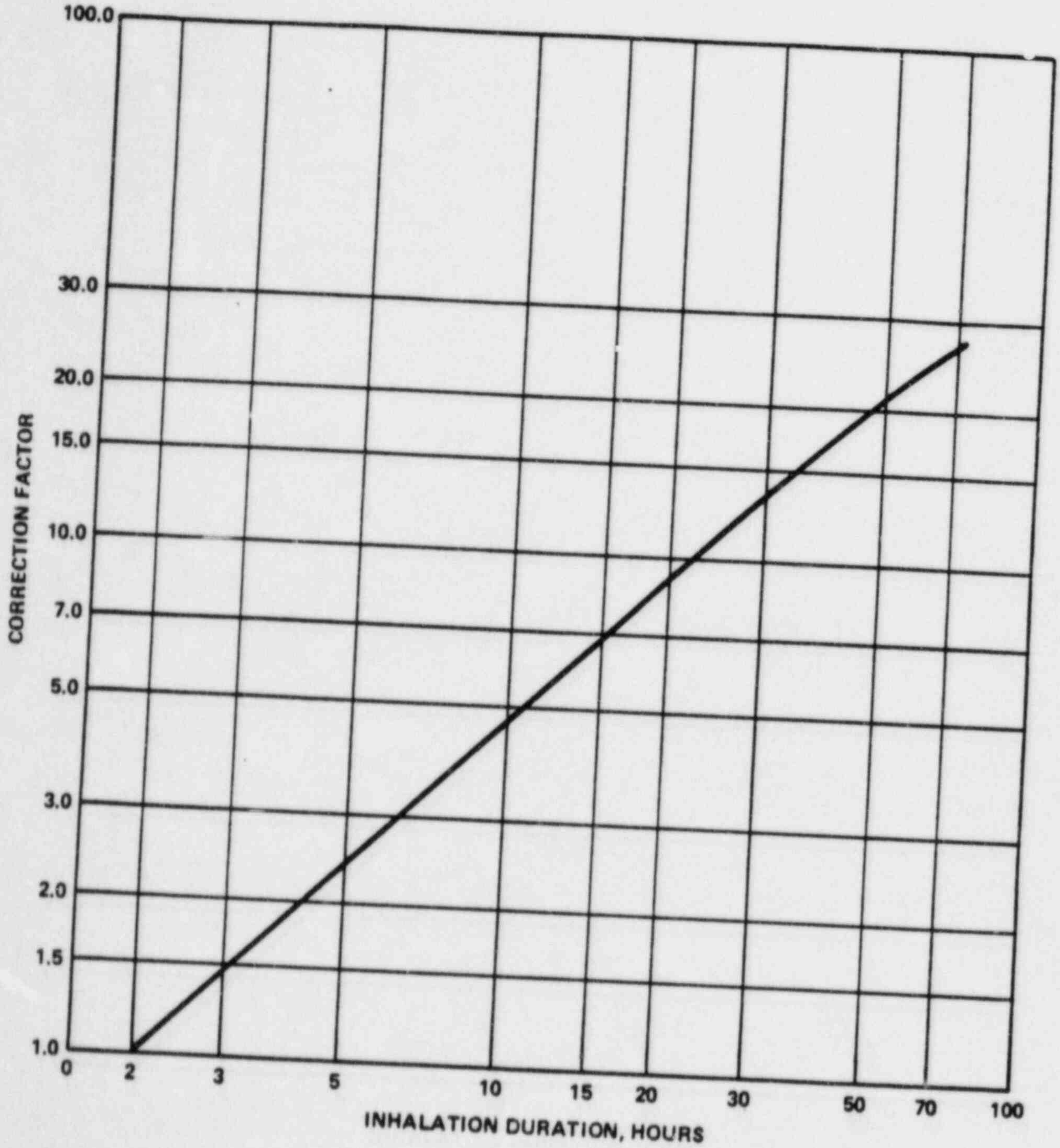


Figure B.12 Correction factors for cloud immersion times longer than 2 hours.

Figure B-13

Location ________________

____

____

____

____

Time (Air Sample) ________

Date ________________

Area Reading at 4' ______ c/m

Area Reading at 6" ______ c/m

- -

EVALUATION

Location ________________

Reading (at______) ______ c/m

Canister ______________ c/m

Adsorber ______________ c/m

Canister-particulate filter

Time ________________

Date ________________

Figure B.13 Sample filter-adsorber canister label.

Appendix B. Bibliography

1. U.S. Nuclear Regulatory Commission. · Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, WASH-1400 (NUREG-75/014), U.S. Nuclear Regulatory Commission, Washington, D.C. 20555 (October 1975).

2. C. Distenfeld and J. Klemish, An Air Sampling For Evaluating The Thyroid Dose Commitment Due To Fission Products Released From Reactor Containment, NUREG/CR-0314, BNL-50881 (November 1978).

3. C. Distenfeld and J. Klemish, Environmental Radioactive Moitiroing To Control Exposure Expected From Containment Release Accidents, NUREG/CR-0315, BNL-50882 (November 1978).

Attachment 3

and record these readings on Attachment 2. (If the 4 foot reading is noticeably higher than the 3 inch reading, it should be assumed that the predominant gamma source is the airborne plume).

b. If readings increase with decreasing height above the ground, assume that the source is on the surface. In this case, take several smear samples (with gloves) over a 4" x 4" area of the ground and/or a soil sample when conditions permit.

c. Use a plastic bag for the soil sample and fill out a label to tag the bag. Label all samples with proper ID information: sample number, sample location, initials, date, time, and team ID.

d. When monitoring, periodically check beta (open window of RO-2A) reading at 3 inches and 4 feet above ground. Record any readings significantly different from the window-closed readings.

5.3.7 At the survey location, take an air sample, as required by the Radiological Survey Briefing Form, Attachment 1, Item 10 (2), as follows:

a. Leaving the vehicle engine running, plug in the TCS-EAS-1 air sampler. Run it for about a 1/2 minute, warm-up period without the filter/canister installed.

b. Open the TCS EAS-1 one quart can containing the canister. Inspect the canister for visible defects; the canister is not acceptable for use if the moisture check dot is blue.

c. Turn off the warmed-up sampler, center the canister over the suction opening on the side of the sampler. Stretch the elastic retainer over the outer end of the canister, making sure the fit is tight.

d. Position the air sampler 4 feet above the ground, as far away from the vehicle exhaust pipe as the cable will allow.

e. Adjust the flow rate to approximately 5 CFM. Set the timer to $\frac{25}{CFM}$ = 5 minutes. (Rotate dial past the 5-minute mark, then turn back.)

f. Start the sampler and record the starting flow rate on the ORS Data Sheet, Attachment 2. Use a stop watch to verify the run time.

g. When the air sample time is completed, record the final flow rate reading on the ORS Data Sheet, Attachment 2. Carefully remove the canister from the sampler and put it in a plastic bag. Avoid contact with the white filter cloth wrapped around the outside and the bare filter. Be sure to record start/stop times and flow rates on the ORS Data Sheet, Attachment 2.

h. Connect the brass-shell GM-1 probe cable to the RM-14 count rate meter to "DETECTOR" input connection (see Attachment 5, Operation of Eberline Model RM-14). Switch "RESPONSE" to "SLOW". In this position, allow 20 seconds meter response time for each measurement.

i. Using the above setup, measure the background at 4 feet above the ground or inside the vehicle. Record this background cpm on the ORS Data Sheet, Attachment 2.

j. Insert the GM-1 probe into the center hole of the canister and adjust the scale of the RM-14 as necessary. Record the stabilized filter/canister reading (cpm) on the ORS Data Sheet, Attachment 2. Remove the GM-1 probe.

k. Carefully remove the white fiber cloth which is wrapped around the canister by pulling the red tape on the top rim of the canister. Hold the canister in the plastic bag while doing this to avoid contacting the cloth and to prevent silver zeolite crystal bits from falling out after the cloth wrapping is removed. Return the fiber cloth to the quart can.

l. Insert the GM-1 probe into the center hole of the canister and record the stabilized bare canister reading and time of measurement on the ORS Data Sheet, Attachment 2.

m. Place the bare canister with the plastic bag into the quart can and label the can with the following information:

Date and time of sample
Map location
Start and stop time
Starting and ending flow rate
Sample number (sequential)
Team ID

n. Place the quart can inside a plastic sample bag and ensure that a label is attached.

o. Report the ORS Data Sheet information for the air sample to the ESF.

5.3.8 Report dosimeter readings to the ESF at regular intervals (see OPIP 3.9.1, Dosimetry and Exposure Control).

5.3.9 Immediately report any equipment or supply shortages to the ESF.

5.3.10 Repeat Steps 5.3.2 through 5.3.8 as necessary for other survey locations.

5.3.11 When all survey and sampling activities are completed and the team receives no further requests from the ESF or the team is relieved by a second team, return to the Emergency Worker Decontamination Center, in Brentwood, unless instructed otherwise by the ESF or the RAP Team Captain.

5.3.12 Do not remove protective clothing or respirator until instructed by Emergency Worker Decontamination Facility personnel (see Attachment 6, Section 5.5, Removing Protective Clothing; Attachment 6, Section 5.7, Step-off Pad Use; Attachment 7, Section 5.5, Removing Respirator).

Attachment 4

d. Move vertically down until the time between reactor shutdown and time of measurement, item 8, is intercepted; if the start of radiation exposure coincides with the time of measurement, move to the line marked Te = Tm.

e. Move horizontally to the right until duration of exposure, item 13, is intercepted.

f. Move vertically up until the sample collection interval, item 2, is intercepted.

g. Move horizontally to the right to read off the thyroid dose commitment for the bare canister. Record this in item 14a on the Thyroid Dose Commitment Worksheet, Attachment 9.

5.6.7 Filter Component

NOTE: If core or fuel damage has not occurred, no iodine release in particulate form is expected and any filter radioactivity will be void of iodine. The total dose commitment value, item 15, will be the bare canister component only. Otherwise, complete the steps below.

a. Locate the net filter adsorber reading, item 5, on the lower left-hand axis of the Thyroid Dose Commitment Nomogram, Attachment 11. Move horizontally to the right until the slanted line corresponding to the number of hours between reactor shutdown and time of measurement, item 8, is intercepted.

b. Move vertically up until the time between reactor shutdown and measurement, item 8, is intercepted; for time values greater than 72 hours, use the line marked I-131.

c. Move horizontally to the right until the time between reactor shutdown and start of exposure, item 12, is intercepted; if the start of radiation exposure coincides with the time of measurement, move to the line marked Te = Tm.

THYROID DOSE COMMITMENT WORKSHEET
(continued)

6. Has core or fuel damage occurred? (yes or no) ______

7. Time of reactor shutdown ______ hours

8. Time between shutdown and measurement (item 7 - item 1n) ______ ______ ______ ______ hours

9. Time release started ______ hours

10. Plume travel time (item 1c/ground or elevated windspeed (mph)) ______ ______ ______ ______ hours

11. Time exposure started (item 9 + item 10) ______ ______ ______ ______ hours

12. Time after shutdown exposure started (item 11 - item 7) ______ ______ ______ ______ hours

13. Release duration ______ hours

14. Thyroid Dose Commitment

    a. Bare canister component ______ ______ ______ ______ rem

    b. Filter/canister component ______ ______ ______ ______ rem

    NOTE: If item 6 is "No," then filter/canister component is zero.

15. Total thyroid dose commitment (item 14a + item 14b) ______ ______ ______ ______ rem

Attachment 5

Attachment 5 to
LILCO Testimony
on Contention 49

HHS Publication FDA 83-8211

Preparedness and Response in Radiation Accidents

Bernard Shleien, Pharm.D.
Certified Health Physicist, ABHP
•
Office of Health Physics

WHO Collaborating Centers for:
- Standardization of Protection Against Nonionizing Radiations
- Training and General Tasks in Radiation Medicine
- Nuclear Medicine

August 1983

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Food and Drug Administration
National Center for Devices and Radiological Health
Rockville, Maryland 20857

APPENDIX H-4

AIR SAMPLING PROCEDURE

(from Distenfeld & Klemish, NUREG/CR-0314, USNRC, December, 1978)

Procedures are given for three phases of the task. They are equipment check and field air sampling, evaluation of the exposed filter-adsorber canisters, and internal thyroid dose equivalent predictions for the people living in the measured area. In order they are:

I. Equipment Check and Field Air Sampling

A. The air sampling system

1. Air mover, similar to a vacuum cleaner

2. Automobile, 12-volt cigar lighter adapter

3. One or more quart cans each containing one filter adsorber canister. Take one can for each location you are to measure and one spare.

4. CDV-700 G-M counter

5. Pocket ionization chamber

6. Screwdriver or 25-cent coin to open the quart can lids (immediately before use).

7. Pocket or wristwatch to time the 5-minute ± 6-second sampling period.

8. Respirator, one per person, optional.

B. Equipment checkout

1. Turn on the CDV-700 and test for an on-scale meter deflection of about 10 to 30 counts per minute on the times 1 range with probe shield closed. The meter will jitter around on an average reading. Read the midpoint value within the jitter band. Reject an instrument for zero reading or too high a reading in place where other CDV-700's read much lower. Twist metal shield open on probe and move toward the test spot on right side of instrument. Meter should go upscale as probe moves toward spot. Close the probe shield and allow the instrument to remain on.

2. Test the air sampler for operation with normal household AC electric power. Plug cord into a wall outlet and push the start switch near the handle. For proper operation, the sampler will sound and feel like a small vacuum cleaner.

3. Rezero pocket ionization chamber.

4. Take all of the seven items of Part A plus a map and/or route instructions to a car or truck that has a working cigar lighter.

5. Plug the DC adapter on the end of the sampler power cord and test for sampler operation using the car electrical system with the engine running. Turn the sampler off.

C. Air sampling procedure

1. Keeping vehicle windows closed, drive to the first location.

2. Arriving at the first location, leave engine running, open the first quart can, and remove the filter-absorber canister.

3. Mount filter-absorber canister over central suction hole and stretch rubber retainer over the outer end of the canister.

4. Check to see that the air sample is plugged into the cigar lighter socket and step out of the vehicle to the relaxed extent of the power cord.

5. Turn on the sampler for exactly 5 minutes ± 6 seconds.

6. During this period, the other team member will measure the general area outside of the vehicle with the CDV-700 and will record the time of day, location, and general area reading on the empty quart can top label similar to Figure A-4.

7. When the air sample is finished, remove the cannister, replace in its quart can, and reseal can. Note: The canister may be warm to hot due to adsorption of moisture from the air, NOT radioactivity.

8. Go to the next location and use a new canister.

9. After the last measurement return promptly to the center for analysis of the filter-adsorber canisters.

II. Evaluation of the Filter-Adsorber Canisters

A. Filter-adsorber readout can be accomplished by the measurement team or by another designated person.

1. First check out a special modified CDV-700 instrument for operation. This instrument should have a background reading of 50 to 100 cpm on the times 1X range. The probe does not open so the instrument will not respond to the test spot. Reject instruments that do not have on-scale readings.

2. Locate a measurement place where the modified CDV-700 will have a background reading of 50 to 70 cpm. A basement location near the floor and in a corner may be suitable. If the recommended sandshield was constructed, use this device for all measurements including background.

3. Stack used canister assemblies within their quart cans several yards away from the measurement point.

4. Open the first quart can and take the filter-adsorber out with a paper towel or facial tissue.

5. Insert the special CDV-700 probe into the air suction hole of the filter-adsorber.

6. Record the time of day, background reading, and the filter-adsorber reading on the quart can label.

7. Locate the rip cord-like thread on the outside of the canister and pull to remove the glass fiber filter cloth. Using facial tissue for handling, return the filter into its quart can at the storage point.

8. Read the bare adsorber canister and record this final entry and date on the label.

9. Return the canister to its quart can containing the filter cloth and reseal with the correct lid.

10. Start on the next measurement.

B. Upon conclusion of the measurements, mark the location code on each can with a felt marking pen and remove the peel-away labels. The labels should be mounted on pages of a school notebook or composition book in measurement sequence for each team. The location information should be checked and supplemented, if necessary, with additional information. The data should then be taken or phoned to the local emergency coordination center.

III. Internal Dose Predictions

A. Glass filter cloth evaluation

1. Use Figure H-5 to account for the radioiodine on the glass filter cloth for a set of measurements noted on a transfer label. Enter the curve for the type of reactor and the number of hours between shutdown and time of measurement.

2. Find the iodine to total fission products correction factor, CF, above the vertical axis and calculate the difference in filter-adsorber and adsorber readings. This difference, F, is due to total fission product activity on the filter. The product CF x F is the corrected filter reading due to iodine at the time of the measurement.

B. Filter-adsorber evaluation

1. The adsorber net counting rate is determined by subtracting background from the bare adsorber measurement.

2. Add the corrected filter reading, step A2, to the net adsorber reading.

3. Select the appropriate curve that corresponds to the total inhalation time in the clouds for the people in the area.

4. Enter Figure H-6 with the total iodine counting rate found in step B2. Follow a vertical to the number of hours after reactor shutdown that the bare reading was made. The ordinate is the predicted thyroid dose commitment to a 5-year-old child at the site of the air sample.

5. Correct the dose commitment for the part that could have been received prior to the time of the prediction. Figure H-7 can be used to make the correction by following instructions included on the Figure.

6. Multiply the correction factor obtained in step 3 by the dose commitment found earlier in step 4.

7. Figure H-8 is a sample canister label.

C. Evaluation of result

The projected dose commitment values can be posted on a map corresponding to their locations. If sufficient measurements were made, the path of the cloud should appear as significantly higher readings.

Predictions can be made of the dose commitment along the cloud track. This should improve the data base so that decisions can be made about stable iodine feedings, evacuation of exposed persons to reduce exposure to resuspended radioactive particles, and designations of contaminated pasturage.

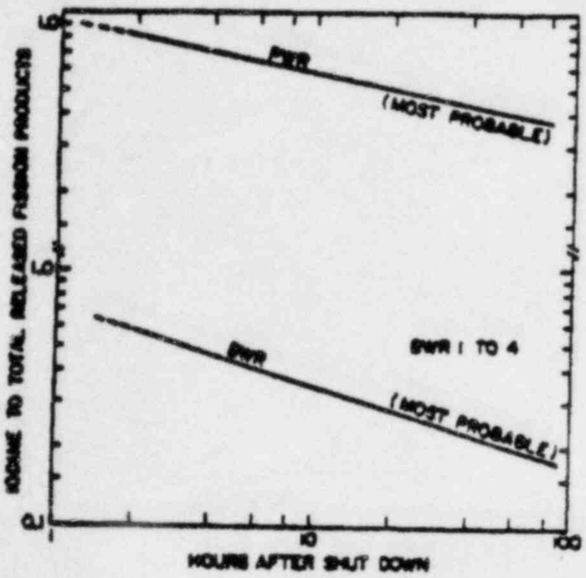


Figure H-5. Iodine to total fission products correction factor for shielded CDV-7000 instruments.

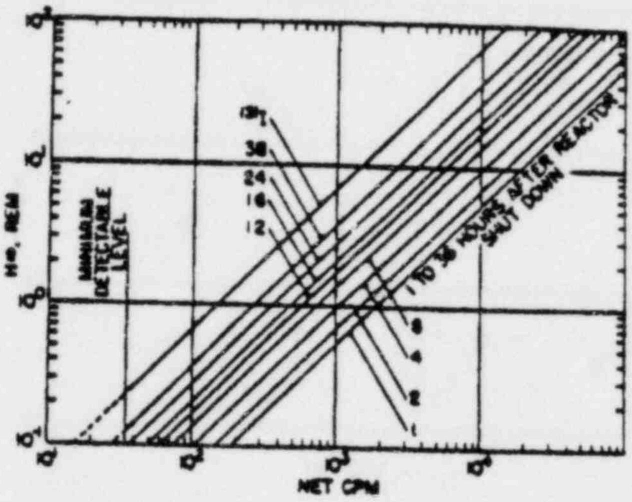


Figure H-6. Conversion of 6306 probe response to 5-year-old child thyroid dose commitment for 2-hour immersion.

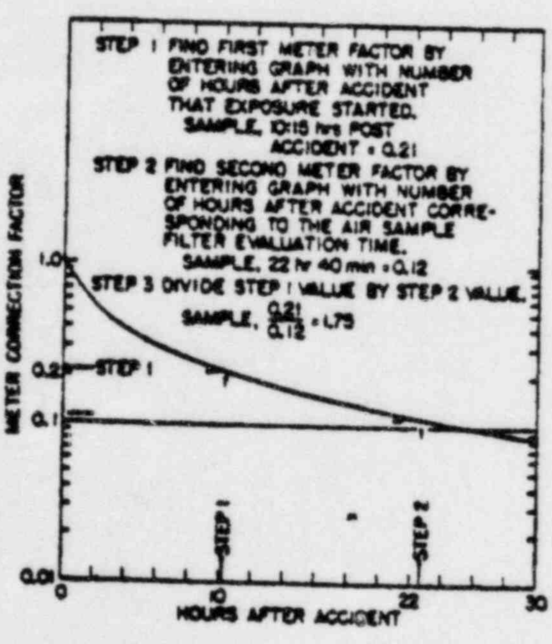


Figure H-7. Correction for iodine isotope composition.

Location________________

Time (Air Sample)________

Date__________________

Area Reading__________cpm

EVALUATION

Background____________cpm

Filter-Adsorber_______cpm

Adsorber______________cpm

Time__________________

Date__________________

Figure H-8. Sample filter-adsorber canister label.

CERTIFICATE OF SERVICE

In the Matter of
LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Power Station, Unit 1)
(Emergency Planning Proceeding)
Docket No. 50-322-OL-3

I certify that copies of TESTIMONY OF MATTHEW C. CORDARO, CHARLES A. DAVERIO, AND WILLIAM F. RENZ ON BEHALF OF LONG ISLAND LIGHTING COMPANY ON PHASE II EMERGENCY PLANNING CONTENTION 33 AND LILCO'S TESTIMONY ON CONTENTION 49 (NOMOGRAM FOR THYROID DOSE) were served this date upon the following by first-class mail, postage prepaid, or (as indicated by one asterisk) by hand, or (as indicated by two asterisks) by Federal Express.

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