NRC FORM 313
(1-84)
10 CFR 30, 32, 33, 34, 35 and 40

APPLICATION FOR MATERIAL LICENSE

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED BY OMB
3150-0120
Expires: 5-31-87

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

FEDERAL AGENCIES FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS, IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIAL SECTION B
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
MATERIAL RADIATION PROTECTION SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
MATERIAL RADIATION PROTECTION SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [X] A. NEW LICENSE
- [ ] B. AMENDMENT TO LICENSE NUMBER _____
- [ ] C. RENEWAL OF LICENSE NUMBER _____

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip Code)*

Air Products and Chemicals, Inc.
P.O. Box 538
Allentown, PA 18105

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED.

Air Products and Chemicals, Inc.
Iron Run Facility
50 North Snowdrift Road
Fogelsville, PA

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Eugene I. Handwerk

TELEPHONE NUMBER: 215-481-8606

SUBMIT ITEMS 5 THROUGH 11 ON 8½ x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE.

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FACILITIES ANI

8505310414 850503
REG1 LIC30
37-05105-07 PDR

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*

FEE CATEGORY: 3.P.

AMOUNT ENCLOSED: $ 230

13. CERTIFICATION *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN, IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE–CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE
Brian M. Rushton	Brian M. Rushton	Vice President - R&D	

14. VOLUNTARY ECONOMIC DATA

a. ANNUAL RECEIPTS

- [ ] <$250K
- [ ] $250K–500K
- [ ] $500K–750K
- [ ] $750K–1M
- [X] $1M–3.5M
- [ ] $3.5M–7M
- [ ] $7M–10M
- [ ] >$10M

b. NUMBER OF EMPLOYEES *(Total for entire facility excluding outside contractors)*: 125

c. NUMBER OF BEDS: NA

d. WOULD YOU BE WILLING TO FURNISH COST INFORMATION *(Dollar and/or staff hours)* ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? *(NRC regulations permit it to protect confidential commercial or financial–proprietary–information furnished to the agency in confidence)*

- [X] YES
- [ ] NO

FOR NRC USE ONLY

TYPE OF FEE		FEE CATEGORY	COMMENTS	APPROVED BY
Dec 8 I	Appl.	3P	No Qual required	Frances Brown
AMOUNT RECEIVED	CHECK NUMBER			DATE
$230	485785			12/24/84

PRIVACY ACT STATEMENT ON THE REVERSE

DEC 13 1984 DJ 12/24/84

PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e)(3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on NRC Form 313. This information is maintained in a system of records designated as NRC-3 and described at 40 Federal Register 45334 (October 1, 1975).

1. **AUTHORITY:** Sections 81 and 161(b) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2111 and 2201(b)).

2. **PRINCIPAL PURPOSE(S):** The information is evaluated by the NRC staff pursuant to the criteria set forth in 10 CFR Parts 30, 32, 33, 34, 35 and 40 to determine whether the application meets the requirements of the Atomic Energy Act of 1954, as amended, and the Commission's regulations, for the issuance of a radioactive material license or amendment thereof.

3. **ROUTINE USES:** The information may be (a) provided to State health departments for their information and use; and (b) provided to Federal, State, and local health officials and other persons in the event of incident or exposure, for their information, investigation, and protection of the public health and safety. The information may also be disclosed to appropriate Federal, State, and local agencies in the event that the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding. In addition, this information may be transferred to an appropriate Federal, State, or local agency to the extent relevant and necessary for an NRC decision or to an appropriate Federal agency to the extent relevant and necessary for that agency's decision about you.

4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION:** Disclosure of the requested information is voluntary. If the requested information is not furnished, however, the application for radioactive material license, or amendment thereof, will not be processed. A request that information be held from public inspection must be in accordance with the provisions of 10 CFR 2.790. Withholding from public inspection shall not affect the right, if any, of persons properly and directly concerned need to inspect the document.

5. **SYSTEM MANAGER(S) AND ADDRESS:** U.S. Nuclear Regulatory Commission
Director, Division of Fuel Cycle and Material Safety
Office of Nuclear Material Safety and Safeguards
Washington, D.C. 20555

Air Products and Chemicals, Inc.

APPLICATION FOR MATERIAL LICENSE

Radioactive Material

a. Hydrogen 3

b. Titanium tritide deposited as a thin layer onto copper giving the appearance of a foil disc one quarter inch in diameter.

c. A maximum of 60 disks will be maintained in storage for uses described in this license. Also, foils which lose their efficiency, and are therefore replaced, will be retained in a suitable storage receptacle. The number of replaced foils will increase with time and will be stored until 100 to 120 are collected; at which time they will be disposed with a licensed disposal agent. Foil replacement occurs roughly on a three-year cycle. Each disc represents 50 millicuries of tritium. Therefore, a maximum of 9 curies of tritium will be possessed at any one time.

Purposes For Which Licensed Material Will Be Used

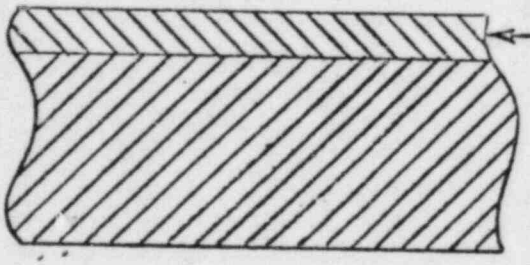
Air Products and Chemicals, Inc. (hereafter referred to as Air Products) manufactures high purity argon gas. For several years, Air Products has purchased Argon Purity Analyzers from Com Sip, Inc. Delphi Instrument Division, 3030 Red Hat, Whittier, CA 90601 under an instrument design licensing agreement between Com Sip and Air Products. See attached Patent and Know-How License Agreement and Instructions for Model D Ion Mobility Detector.

The argon purity analyzer uses a tritium source identified in the U.S. Radium Corporation drawing number 508-3 within a sealed cell to ionize argon and nitrogen molecules passing through the cell. Differences in the two ions mobility can be measured electronically and interpreted in terms of the nitrogen concentration in the argon gas. Since the Air Products' demand for analyzers will continue, and those analyzers currently in use will eventually require replacement of the sealed source material, Air Products plans to build and maintain argon purity analyzers. (See Exhibit I - Operating and Maintenance Manual.)

The argon purity analyzers built and maintained by Air Products will be solely for company use and are not intended to be distributed commercially.

REV.	BY	APP'D	DATE	REVISION

DWG. NO.



BACKING FOIL,
ONE OF:
302 STAINLESS STEEL .002"-.010" THICK
OF HC COPPER .005"-.030" THICK
HASTELOY "C" .002" -.010 THICK

NUCLEAR PRODUCTS DEPT.

UNITED STATES RADIUM CORPORATION

MATERIAL	TOLERANCES		
SPEC. AS NOTED	FRACTIONS ± 1/64" ANGLES ±	DWN BY ja	TITLE
	DECIMALS UNLESS OTHERWISE NOTED ±	CK'D BY	TRITIUM FOIL
THICKNESS	DECIMAL DIMENSIONS TO 5" ±	APP'D BY	
	DECIMAL DIMENSIONS 5" TO 10" ±	DATE 12-15-75	
FINISH	DECIMAL DIMENSIONS 10" AND UP ±	SCALE —	
	THREADS CLASS ___ FIT	REF. DWG.	DWG. NO. 508-3 REV.
	DO NOT SCALE DWG.		MATERIAL 508-1 REV. B

Radiation Safety Officer

Mr. Eugene I. Handwerk is the Radiation Protection Officer for Air Products and Chemicals, Inc. He will be responsible for insuring the safety of the personnel handling the tritium foil which is the subject of this notice.

Air Products has contracted a consultant, Dr. Walter S. Vincent, a professor at the University of Delaware, to assist and advise in radiation safety matters.

RPO Resume

EUGENE I. HANDWERK
COORDINATOR, TOXICOLOGY AND REGULATORY COMPLIANCE
AIR PRODUCTS AND CHEMICALS, INC.

Mr. Handwerk holds the position of Coordinator of Toxicology and Regulatory Compliance. This is a corporate staff function within the Corporate Safety and Environmental Activities Department. Mr. Handwerk reports to Mr. A. J. Diglio, Director of Corporate Environmental Activities, who in turn reports to Mr. J. M. Norwood, Corporate Director of Safety and Environmental Activities. Mr. Handwerk has responsibility for the Corporation's product stewardship programs and compliance with the Nuclear Regulatory Commission, Food and Drug Administration, and the Environmental Protection Agency regulations.

Mr. Handwerk has been employed in this position with Air Products and Chemicals, Inc. since January 1982. Prior to that, he was assigned this responsibility for the Chemicals Group Division of Air Products and Chemicals, Inc. beginning in January 1977.

Education

B.S., Muhlenberg College, Allentown, PA, 1963-1967
Major: Natural Sciences - prime emphasis in chemistry

M.S. degree credits: 27 in biochemistry and genetics
Lehigh University, Bethlehem, PA, 1975-1980

Radiation Safety Training - 7 hours lecture
Instruction by Dr. Walter Vincent, University of Delaware, 1984

Basic Training and Hospital Corp. School, U.S. Navy, 1967-1968
Included first aid, triage and protection from radiation exposure

Isotope Use

Life Science Laboratory, Air Products and Chemicals, Inc.,
Trexlertown, PA, 1975-1976

Isotope	Max. Amount	Type of Use
C^{14}	<25 uC	Label biological material.
H^{3}	<25 uC	Label biological material.

*Resume of Consultant to RPO

Walter S. Vincent, Ph.D.

Dr. Vincent has signed an agreement with APCI to serve as an on-call consultant to APCI for radiation safety matters.

Academic Positions:

AEC Pre Doctoral Fellow,
U. of Pennsylvania, 1949-1950

Instructor, Assistant Professor, Dept. of Anatomy,
Upstate Medical Center, NY, 1952-1961

Associate Professor, Dept. of Anatomy and Cell Biology,
University of Pittsburgh Medical Center, 1961-1971

Professor and Chairman, Dept. of Biological Sciences,
University of Delaware, 1971-1976

Professor of Cell and Molecular Biology,
University of Delaware 1976-present

Summer Investigator, Marine Biological Laboratory (MBL), 1949-present
Member, Radiation Committee, 1958-1963, 1977-1984
Chairman, Radiation Committee, 1977-1983
Radiation Protection Officer, 1977-1984
(Trustee, 1967-1975, Member Executive Committee, 1972-1975)
Chairman, Biohazards Subcommittee, 1978-present

B.S., M.S. - Oregon State University, 1946-1948
Ph.D. - University of Pennsylvania, 1952

Field: Cell and Molecular Biology

a. Training in Radiation Physics, Isotope Handling, etc.

Biophysics, Oregon State University, 1948, 3 months, lecture and Lab: radiation, isotopes, radiation measurement, health physics.

Isotope Handling and Safety, MBL, summer 1954, isotope handling, measurement, safety and use. 10 hours, lecture and demonstration.

Health Physics for Investigators, University of Pittsburgh, 1963, 9 - 1 hour lectures on radiation and isotopes as related to health safety.

b. Courses taught: Use and Handling of Radioisotopes in Biological Experimentation. University of Pittsburgh Medical Center, 1963-1968. 20 lectures, 60 laboratory hours on use, handling, safety, laboratory techniques, calculations, measurements relating to design of experiments using radioisotopes.

Isotope Use: See following page.

Experience with Radiation -- Walter S. Vincent, Ph.D.

Isotope	Maximum Amount	Where	Duration	Type of Use
H^3	100 uC	Upstate Medical Center Pittsburgh Medical Center University of Delaware MBL	1960-1961 1961-1971 1971-present 1958-present	Labeling Biological Materials
C^{14}	20 uC	Upstate Medical Center Pittsburgh Medical Center University of Delaware MBL	1956-1961 1961-1971 1971-present 1956-present	do.
p^{32}	10 mC	Upstate Medical Center Pittsburgh Medical Center MBL University of Delaware	1954-1961 1961-1971 1953-present 1971-present	do.
S^{35}	1.0 mC	Upstate Medical Center Pittsburgh Medical Center MBL	1960-1961 1961-1971 1960-1975	do.
Na^{24}	1.0 mC	MBL	1960-1965	do.
Ca^{45}	10 uC	MBL	1960-1970	do.
Co^{60}	1 uC	MBL	1955-1957	do.
I^{125}	5 mC	MBL	1973-1978	do.
I^{131}	10 uC	MBL	1970-1971	
Cs^{137}		MBL	1964	Irradiation of biological material

Employee Training

The following Air Products and Chemicals, Inc. employees will have basic training in radiation safety including instruction on:

a. Principles and Practices of Radiation Protection

b. Radioactivity Measurement

c. Math Basic to Radioactivity Measurement

d. Biological Effects of Radiation

Mr. Charles Ackerman is the supervisor of the instrument pool section of Corporate Research Services Department.

Mr. William Bechtel is a Senior Instrument Engineer in Corporate Research Services and provides oversight to all department activities from the point of view of an engineer.

Randolph M. Weber is an electronics technician in the instrument pool of the Air Products and Chemicals, Inc. Corporate Research Services Department. Mr. Weber has had formal training in electronics and TV repair. Mr. Weber will assemble the argon purity analyzer cells in the laboratory supervised by Mr. Charles Ackerman. A condition of Mr. Weber's performance of this work will be training in radiation safety and on-the-job familiarization with techniques in handling radioactive materials directly applicable to the construction of analyzer cells.

Assemblage of cells will be on an intermittent basis. It is anticipated that Mr. Weber would assemble a maximum of 20-40 cells within a 5-day period. Six months might lapse before additional cells would be assembled.

Facilities and Equipment

Titanium tritide foil storage and assembly into analyzer cells will be in the Calibration Room (Room No. 63) of the Air Products and Chemicals, Inc. Iron Run Facility.

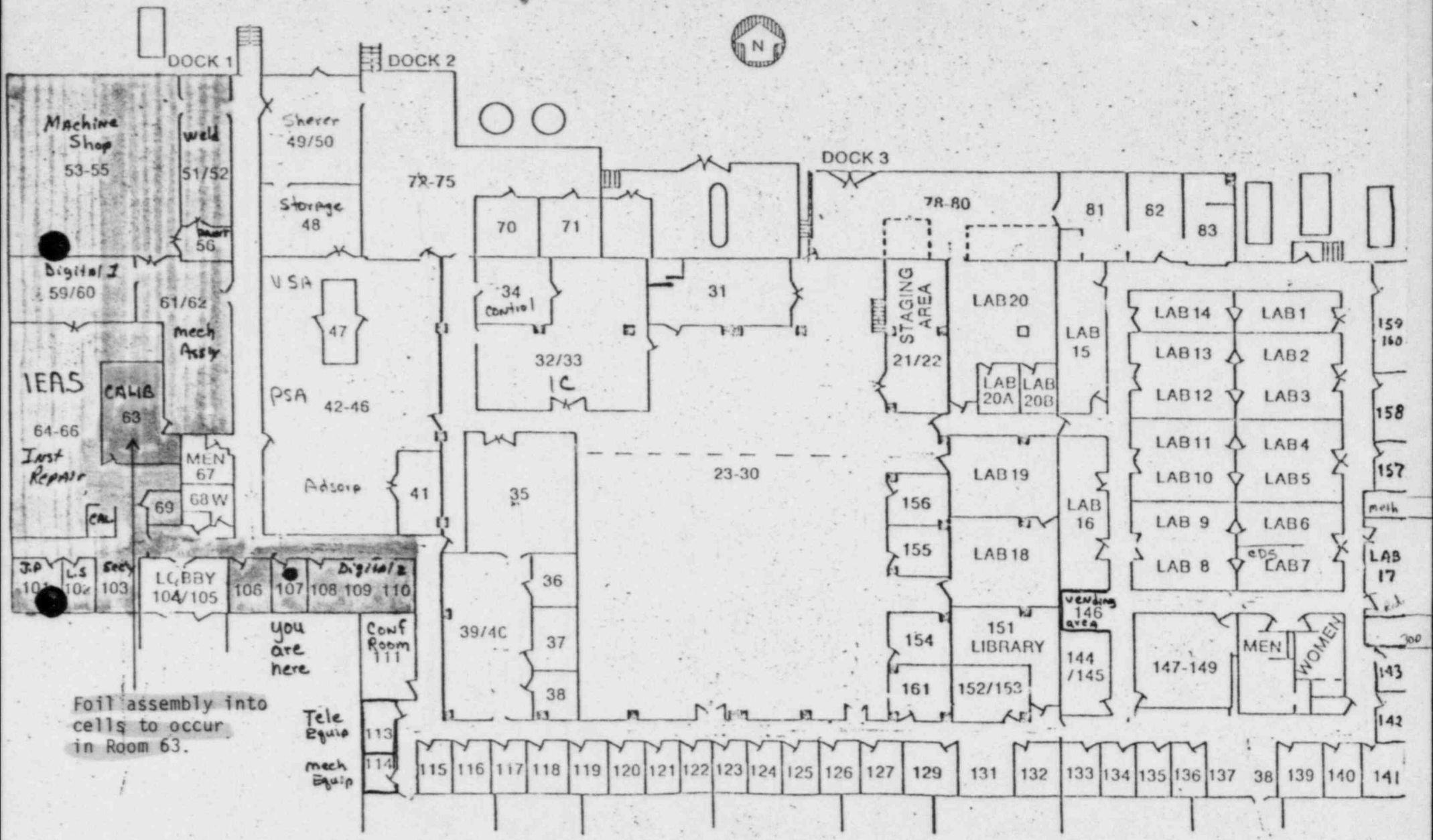
Assembly work will be conducted within a ventilated hood designated solely for this work during the time frame needed to assemble a sufficient number of cells to maintain an inventory for 6-12 months, i.e., 20-40 cells. Dedicated tools will be stored in a closed container when not in use.

Tritium foils will be stored within the glass jars in which they are received from the supplier. The jars will be maintained in a locked storage cabinet labeled CAUTION! RADIOACTIVE MATERIALS.

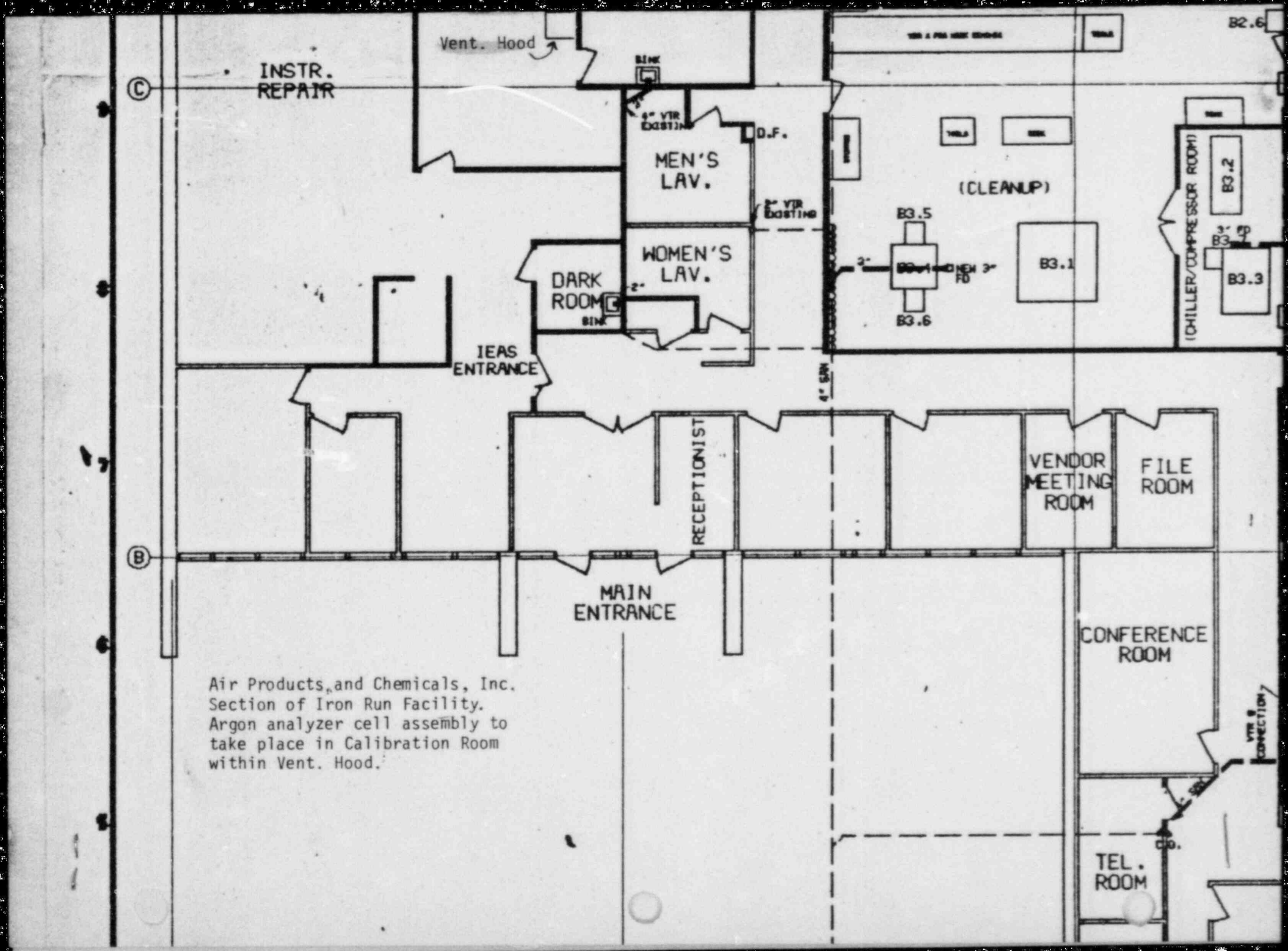
The layout of the laboratory spaces is depicted below showing where the radioactive materials will be used.

Air Products and Chemicals, Inc.

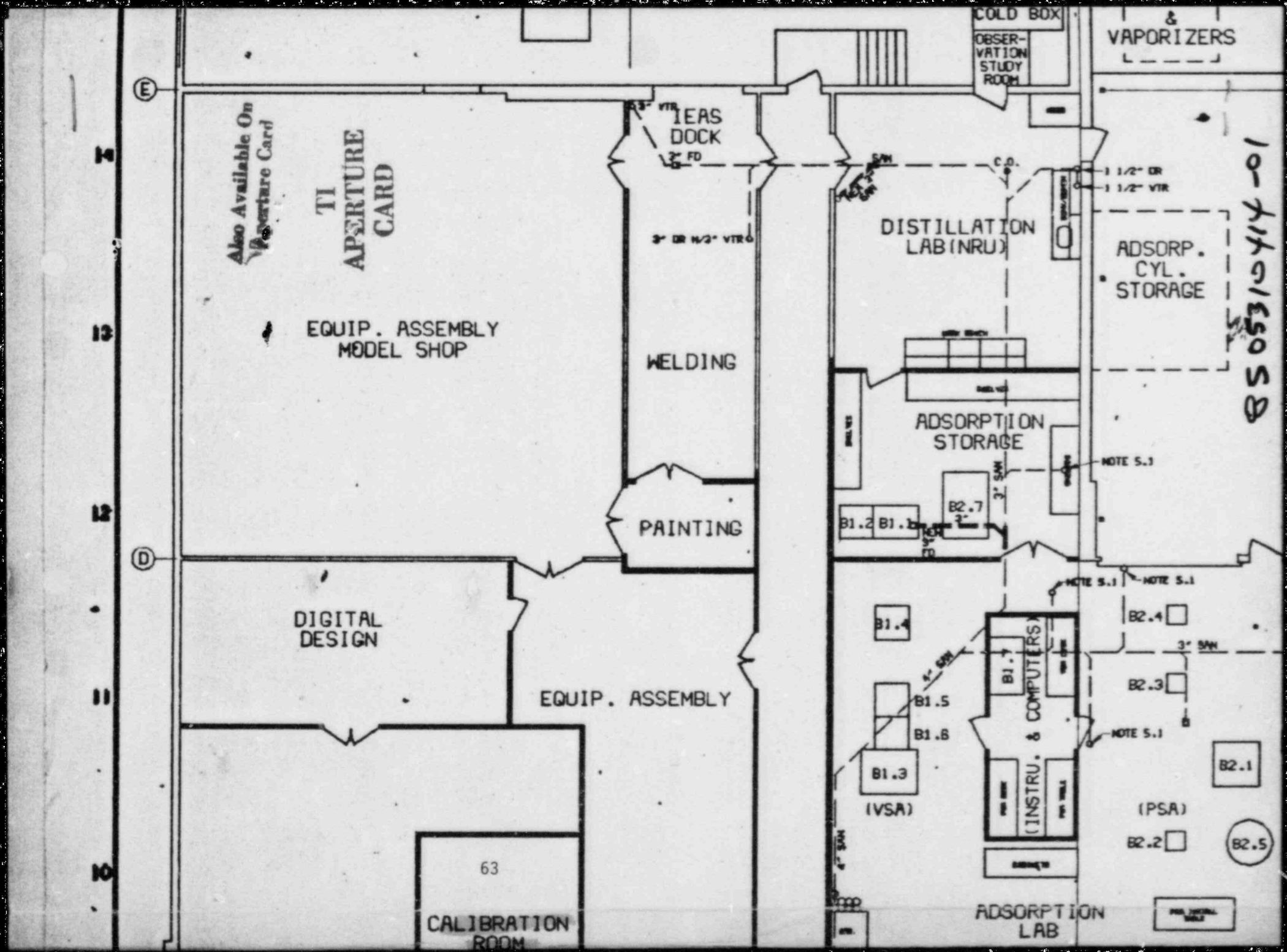
IRON RUN



IRON RUN FACILITY



Air Products and Chemicals, Inc.
Section of Iron Run Facility.
Argon analyzer cell assembly to
take place in Calibration Room
within Vent. Hood.


Also Available On Aperture Card
TI APERTURE CARD
EQUIP. ASSEMBLY MODEL SHOP
WELDING
PAINTING
DIGITAL DESIGN
EQUIP. ASSEMBLY
CALIBRATION ROOM
63
TEAS DOCK
COLD BOX
OBSER-VATION STUDY ROOM
& VAPORIZERS
DISTILLATION LAB (NRU)
ADSORP. CYL. STORAGE
ADSORPTION STORAGE
B2.7
B1.2
B1.1
NOTE S.1
B1.4
B1.7
B1.5
B1.6
B1.3
(VSA)
(INSTRU. & COMPUTERS)
B2.4
B2.3
B2.1
(PSA)
B2.2
B2.5
ADSORPTION LAB
E
D
14
13
12
11
10

Radiation Safety Program

Introduction

This document is a summary of the rules and procedures pertaining to the use of radioactive materials in the Iron Run Facility of Air Products and Chemicals, Inc. (hereafter Iron Run, APCI). Compliance with these rules is necessary primarily to protect the health and safety of yourself and your colleagues.

Air Products and Chemicals, Inc. is legally responsible for enforcement of these rules and for assuring that all personnel using radioactive materials fully comprehend the reasons for the rules. A breach of the safety procedures put forth herein is a serious matter which may lead to irreversible harm to health and a loss of all APCI privileges in using radioactive materials.

The use of all radioactive materials at APCI is authorized by the Nuclear Regulatory Commission (hereafter NRC) through a Byproducts Material License for Industrial Use given to APCI. The Director of the laboratory is nominally responsible for these matters. The Director delegates operational authority for radiation safety to the Radiation Protection Officer (RPO). The RPO is, in effect, the Nuclear Regulatory Commission's representative at APCI. He is charged with safeguarding and instructing those within his jurisdiction and will ensure compliance with the applicable parts of Title 10, Chapter 1, Code of Federal Regulations - Energy.

All users of radioactive materials in Iron Run, APCI are designated either "Authorized Users" or "Supervised Users". All radioactive materials are the responsibility of designated "Authorized Users". Authorized Users' responsibilities include training and control of supervised users, execution of safety measures, cleanup and personnel monitoring measures, proper recordkeeping, and appropriate communication with the RPO. Supervised users are immediately and directly responsible for proper safety and experimental procedures to their supervisory authorized user.

Radiation Control Procedures

A. Authorization Procedures

All persons who will use radioisotopes at Iron Run, APCI must have a personal "entrance interview" with the RPO or Authorized User. The interviewee must attest, in writing, to his/her understanding and accepting the contents of this document prior to beginning any work with radioisotopes. If the interviewer determines that the interviewees training and experience are sufficient for him/her to safely carry out the proposed experiments, the interviewee may be designated a Supervised User by the RPO. Acceptable training should include but is not limited to:

1. Principles and practices of radiation protection.

2. Radioactivity measurements, standardization and monitoring techniques and instruments.

3. Mathematics and calculations basic to the use and measurement of radioactivity.

4. Biological effects of radiation.

Note: The use of millicurie quantities of the radioisotope listed in the industrial license for Iron Run, APCI by a person with a minimum of training and experience under precisely specified and controlled conditions subject to the surveillance of a competent and adequately trained radiation protection officer may be justified. Such minimum training and experience consist of a few hours of training and experience in the use of one or more radioisotopes similar to the use proposed in the license application under the supervision of a licensed user.

Pregnant females and persons younger than 18 years will be discouraged from working with radioisotopes due to their greater likelihood of harm from controlled or uncontrolled (accidental) exposure.

B. Procurement, Receipt and Transfer of Radioisotopes

Only Authorized Users may purchase radioisotopes to be delivered to Iron Run, APCI.

Radioisotopes may be transferred from Iron Run, APCI with authorization of the RPO's of APCI and the licensed recipient institutions. They must be shipped and packaged by Authorized Users, in accordance with NRC regulations.

All radioisotopes at Iron Run, APCI are assigned to Authorized Users.

Proper keeping of records is essential to the safe use and oversight of radioisotopes. Records of personnel exposure, radiation surveys, instrument calibration, and isotope fate, constitute the primary evidence for compliance by Iron Run, APCI and Users with legally required regulations. Keeping of records is a prime responsibility of Authorized Users.

Each Authorized User must maintain an inventory record of radioisotopes assigned to him/her. The inventory record will include a list of the isotopes, their activities, quantities, form, places of storage, intended and actual fates, and other parameters as may be recommended by the Radiation Protection Officer. Users also may be required to keep logs and records of personnel monitoring done by them, if appropriate to their experiments.

Caution Signs and Labels

Each container of radioactive material must be labelled by the User to Indicate the isotope, its activity, the quantity, the date on which it was assayed, and User's name.

Any room in which radioactive materials are being used must have on its door a sign, "CAUTION--RADIOACTIVE MATERIALS", indicating the radioisotope(s) within. The hood in which the radioactive materials are being handled must be similarly labeled.

Radiation Monitoring and Surveys

Monitoring and radiation surveys of all laboratories and areas containing radioactive materials will be done from time to time by Authorized Users. Laboratory space will not be assigned unless it has been determined to be free from radioactive contamination on the basis of appropriate surveys. Authorized Users will not leave Iron Run, APCI at the conclusion of their work before they have made a final survey of their laboratory.

Authorized Users are required by RPO to conduct weekly surveys during periods of radioisotope use as follows:

A. For monitoring "loose" contamination, an operation called a "wipe test" is performed. It consists of wiping a surface of about 100 cm^2 with a piece of filter paper and then counting it in a liquid scintillation counter. Wipe tests may detect low energy beta radiation. Wipe test survey reports will be given to the Radiation Protection Officer within three days of conducting the survey. The hood area and all completed cells will be subjected to a wipe test. Counts above 40 cpm will indicate the need for additional what?

Storage of Radioactive Materials

All radioactive materials must be stored in a secured location with appropriate shielding, ventilation, and labeling.

Waste Disposal

Iron Run, APCI provides contracted radioactive waste disposal service with a licensed contractor. No radioactive material or suspected radioactive material may be discarded in the regular trash.

The following packaging procedures must be followed for waste:

A. All waste must be labeled with the identity of the radioisotope, and chemical form, the activity, the date of disposal, and the name and location of the Authorized User.

B. DRY waste should be placed in plastic bags and securely closed.

C. LIQUID waste should be poured into plastic jugs containing enough suitable absorbent to prevent sloshing and securely closed.

Personnel Monitoring

Monitoring systems such as air monitoring and urinalyses will be performed as appropriate. However, based on the nature and amounts of radioisotopes to be used (one curie or less per assembly period) in Iron Run, APCI, it is not perceived that bioassays are necessary or required according to the U.S. N.R.C. Draft Regulatory Guide "Applications of Bioassay for Tritium". Annual physicals are given to all lab personnel as a matter of standard operating practices at Air Products.

Emergency Procedures

Locations and telephone numbers of emergency response personnel are posted at the lab entrance door. The RPO should be notified immediately of any spills, releases to the air, contamination of person or property, or other emergencies involving radioactive material. The User identifying the emergency should proceed as follows, pending subsequent instruction or action by RPO.

A. Spills. Isolate the area and pick up the foils, wearing gloves. Do not spread the contamination by walking through it. Mark off the contaminated area with tape labels and signs until decontamination is complete.

B. Release to the air. Evacuate the area and note the names and locations of all potentially exposed persons.

C. Personal contamination. Avoid contacting the contaminated area with other parts of the body. Wash the contaminated area with soap and water for no longer than 2 or 3 minutes and monitor the areas with a survey meter. Dry with paper towels. Repeat this procedure no more than 4 times. Excessive washing will enhance absorption through the skin and washing areas adjacent to the contaminated one will tend to spread the contamination.

D. Property contamination. Remove contaminated clothing and personal items immediately and place them, and other contaminated articles, in a radioactive waste container or a plastic bag tagged CAUTION! RADIOACTIVE MATERIAL. Store in a shielded, ventilated area if appropriate, pending transfer to a licensed radioactive waste disposal contractor.

Appendix

Iron Run, APCI is committed to keep all exposures to radiation as low as reasonably achievable. This means that any unnecessary exposures are a violation of the terms of our NRC license. The following maximum permissible exposure for workers are specified by the NRC. They do not apply to pregnant women, people under 18 years of age, or members of the general public.

Area of Exposure	Max. Total Exposure* for 3 Month Period	Max. Radiation Field (60-hour Work Week)
Whole Body	1250 mrem	1.6 mR/hr
Skin of Whole Body	7500 mrem	9.6 mR/hr
Extremity	18750 mrem	24.0 mR/hr

The following maximum permissible exposure have been established for non-workers (general public, pregnant women, people under 18 years of age and anyone who is not an authorized user or supervised user):

Area of Exposure	Max. Total Exposure* for 3 Month Period	Max. Radiation Field (60-hour Work Week)
Whole Body	125 mrem	0.16 mr/hr 0.06 mR/hr

*These tables are for external gamma and beta radiation only. It is assumed that 1 R of exposure equals (± 10%) 1 rem of dose.

ARGON PURITY ANALYZER

OPERATING AND MAINTENANCE MANUAL

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LIST OF FIGURES

INTRODUCTION

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This instruction manual will explain the Air Products' Argon Purity Analyzer. It describes the analyzer physically, gives the theory of its operation, and presents concise instructions for both installation and operation. Additionally, there is a parts list for the analyzer and a trouble shooting chart to aid in repairing.

The analyzer has been designed for simplicity of operation and repair. It needs only to be connected to its stable dry gas source and its electrical power to operate. For the users convenience, the analyzer is equipped with terminals to which a recorder may be attached when desired. Solid state devices have replaced the previous tube circuitry. The entire electronics has been constructed of modules for ease of servicing. Recorder output is switchable between 5 or 10mv.

I. DESCRIPTION

The analyzer is a self-contained modular instrument. It features a direct-reading meter in the range of 0 to 50 parts per million and will continuously measure nitrogen concentration in an argon gas stream. The basic design principle for the analyzer makes use of the phenomenon of relative ionic mobility. A weak radioactive source within the analyzer ionizes the gas passing through the instrument. There is a difference in the mobility of the ions of argon and nitrogen which are formed. This difference can be measured electronically and the measurement interpreted to determine the amount of nitrogen contained in the argon stream. The analyzer is designed for a gas pressure of 10 pounds per square inch guage and for a flow 0-700 ccm.

The argon purity analyzer consists of a radio frequency signal generator, a detector cell containing the radiation source, & a electrometer. The signal generator, (G) Figure 1 applies a 100khz sine-wave alternating voltage across the cell, (P1,P2) which containes the radiation source, (S). Direct current flow thru the cell is measured by the electrometer (E). The capacitor, (C) prevents d c from flowing in the signal generator circuit. The resistance, (R) is large compared to the impedance of the capacitor formed by P1 & P2 and prevents any appreciable alternating current from reaching the electrometer.

The detector cell (Fig 2) is a Glass tube cylinder (T) into which two metal electrodes (P1 & P2) are secured. The electrodes are drilled and fastened to the tubing thru which gas is supplied to the cell. The radiation source (S) within the cell is a disc of titanium tritide containing 50 millicuries of tritium. The disc is supported on one of the electrodes by three short wires. The mean range of the beta radiation from the source is 1 CM. which is equal to the spacing of the electrodes.

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Because it contains a source of radioactive material, the detector cell is a sealed unit. It is to be replaced in its entireity and not to be opened, or tampered with. DISPOSE OF THIS PROPERLY. RETURN IT TO AIR PRODUCTS AND CHEM. 50 SNOWDRIFT RD FOGELSVILLE PA 18051. On the Shipping Authority please indicate this cell is spent and is for disposal.

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II. THEORY OF OPERATION

The high-energy beta radiation acting on the argon atoms forms positive ions and electrons (negative) within the detector cell.

Thus:

$$Ar + \text{energy} \rightarrow Ar^{+} + \text{electron}$$

Electrons are highly mobile and will move within the cell during one cycle of alternating voltage to collect in almost equal numbers at electrodes P1 and P2. Slightly more electrons will collect at P1 because this electrode is somewhat closer to the radiation source than electrode P2. In contrast to the negative electrons, the positive argon ions have less mobility. This is for two reasons: they have a larger mass, and they have charge-transferring collisions with neutral argon atoms.

Thus:

$$Ar^{+} + Ar \rightarrow Ar + Ar^{+}$$

After such a collision, the newly-charged atom must be accelerated; the result of these collisions is to effect a slowing of the movement of the new argon ions through the gas. Since these positive ions exist in their greatest concentration near the radiation source which is close to electrode P1 and since their lower mobility does not allow them to traverse the cell during a cycle of alternating voltage, more positive ions will be collected at electrode P1 than at P2. As a result of this excess collection at P1, current will flow through the cell and through the electrometer during the half-cycle of alternating voltage in which P1 is negative. Since the time constant of the circuit is large compared to the frequency of the alternating voltage, this pulsating current will be seen by the electrometer as a direct current. If, however, the cell dimensions and the signal generator frequency are appropriately selected, the slight excess of electrons which will be collected at P1 will balance the excess of positive ions collected at P1 during the other half-cycle and thus no current will flow when pure argon is present in the cell.

If, however, a small amount of nitrogen (or other impurity gas whose ionization potential is lower than that of argon) is present in the argon flowing through the cell, some of the nitrogen molecules will also be ionized by the beta radiation but far more will be ionized by collisions with argon ions.

Thus:

$$Ar^+ + N_2 \rightarrow Ar + N_2^+$$

Since the ionization potential of argon is greater than that of nitrogen, nitrogen ions cannot enter into charge-transferring collisions with argon atoms, thus their transit will not be slowed by this process and they will move more rapidly than argon ions. (Nitrogen ions can, of course, enter into charge-transferring collisions with other nitrogen molecules, but this is insignificant since very few nitrogen molecules are present). As a result of this greater mobility of nitrogen ions, more ions will be collected at P1 than were collected with pure argonn in the cell. A direct current will flow and will be linearly related to the concentration of nitrogen molecules until their number becomes appreciable in comparison with the total number of argon ions. Practically, this linearity limit is about 100 parts per million of nitrogen in argon.

III. INSTALLATION, OPERATION, AND MAINTENANCE

A. Installation

1. General

CAUTION: ALL GAS CONNECTIONS MUST BE LEAK FREE.
Even small leaks will cause erratic or unreliable operation.

Unpack the argon purity analyzer immediately after receiving it and inspect it for physical damage. Remove the two screws on the lower half of the rear cover, then remove the blue cover and check that the circuit boards are seated and not cracked or damaged.

2. Mounting

To mount the analyzer, select an area that is free of excessive vibration, electrical disturbances, and rapid changes in or extremes of temperature. The analyzer may be panel or bench mounted. Most units are equipped with a bezel to mount in an existing larger hole. Dimensions for panel mounting are shown in figure 3. Provide sufficient clearance behind the panel to make the connections to the analyzer.

For mounting extra gas pressure regulators, shutoff valve, pigtails, and disconnect fittings, plan to have space available.

3. Electrical Connections

Provide a source of 120-volt 60-cycle alternating current. The analyzer is provided with a 3-prong plug grounded and a 6-foot electrical cable. (It is available with 220v @50hz)

4. Gas Connections

Note: Prior to connecting the gas lines to the analyzer, all lines, fittings, valves, connections, etc. must be cleaned and purged with clean dry argon.

The analyzer is designed for a gas pressure of 10 pounds per square inch gauge. Therefore, the SPAN and ZERO gases which will be supplying the analyzer from high-pressure cylinders, and the SAMPLE gas if its supply pressure exceeds 10 psig must have pressure reducing valves installed in the lines connecting these gas sources to the analyzer.

It is essential that the volume of the system between the disconnect and the analyzer be kept to a minimum. Reducers should be used where necessary so that 1/8-inch tubing can be used throughout. "Dead Volume" increases the time necessary for an accurate reading when changing from one gas to another.

After assembly of the gas system for the analyzer, test all joints for leaks using a soap solution. The cell has been tested after manufacture and therefore should be leak free. To test connections to the cell, pressurize the cell to 10 psig by plugging the gas outlet and use the soap solution on the connections.

B. Operation

1. Make gas and electrical connections.

2. Start ZERO gas flowing through cell and set flow to exactly 500 ccm.

   Note: Once put in use, maintain a gas flow through the analyzer to prevent diffusion of atmospheric nitrogen into the detector cell.

3. Allow instrument to warm up and purge for several hours if possible.

4. After warm up, check the gas flow and readjust to 500 ccm if necessary.

5. Assuming a quick connects ball valve is used for sample manifolds, calibrate the analyzer for ZERO. Check the analyzed nitrogen content of the ZERO gas cylinder as given on its cylinder. Adjust the control until the meter reads the same nitrogen value as that given on the cylinder. (i.e., if the ZERO gas contains 2 ppm nitrogen, set the meter to read 2.)

6. Calibrate the analyzer for SPAN. Switch valve to SPAN and adjust the SPAN gas flow for 500 ccm. If both regulators are set properly, no adjustment of flow is necessary. Allow sufficient time for the meter to stabilize. Check the nitrogen content given on the cylinder of SPAN gas. Adjust the control until the meter reads the same nitrogen value as that given on the cylinder. (i.e., if the SPAN gas contains 45 ppm nitrogen, set the meter to read 45).

7. Alternate ZERO and SPAN flows several times until the meter reads the proper value for the gas passing through it.

8. Switch the valve to SAMPLE gas and set the flow rate at 500 ccm. A few minutes will be required for the analyzer to stabilize before the meter will read with the concentration of nitrogen in the SAMPLE gas.

9. If the instrument is in continuous operation, take ZERO and SPAN readings daily and record them in a log for a few weeks.

   For intermittent operation, follow steps 2 through 8 for each start-up.

NOTES ON OPERATIONN

a. If desired, the instrument may be spanned for 100 ppm of nitrogen. In this case, the meter reading must be multiplied by two to obtain nitrogen concentration.

b. Operation with a recorder: A recorder with a sensitivity of 0 to 5 millivolts or 10 millivolts can be used with the argon purity analyzer to give a continuous record. The recorder output terminals are located on the back panel of the instrument. The instrument has been set so that a reading of 50 on the meter corresponds to a full-scale deflection of a 5 mv recorder. (4-20 ma can be ordered)

c. Stand-by Operation: Whenever the instrument is not in use, the INLET and OUTLET connections to the analyzer should be blocked to prevent contamination of the cell with the air, moisture, or dirt. The outlet can be blocked by closing the gas sample valve. The electrical system may be left on for extended periods without damage to the instrument.

d. Change to a new cylinder of SPAN or ZERO gas whenever cylinder pressure falls below 50 psig.
Erattic Operation

C. Maintenance

The phenomenal gas detection used in this instrument is very critical and many variables exist. Correct and constant temperature, stable pressure regulation for constant flow. Maintaining these factors to a minimum change will undoubtedly yield a better performance.

Note: Any gas leak which allows gas to leak out may also allow atmospheric nitrogen to diffuse into the cell. Thus, the most important maintenance problem is to keep all gas connections leak free and to provide a clean, dry, and representative sample gas. The inside of the case has been insulated to aid in temperature control, also keeping dirt from getting inside under handle.

The instrument does not require any routine maintenance. In the event that the instrument fails to function properly the tests listed below may be undertaken. If these tests fail to locate and cure the trouble, the instrument should be returned for repairs, to the AFCI Instrument Pool at 50 Snowfrift Road, Iron Run Industrial Park, Fogelsville Pa. 18051.

Wiring schematics and pictorals for the oscillator and cell box, electometer and power supply are shown in Figures 4 - 9, respectively. Detailed specifications for electronic components are given in the Parts List, Section IV, Part A.

	PROBLEM	POSSIBLE SOLUTION
1.	Red power light is out.	(a) Defective lamp. (b) Amp fuse open - 1/4 amp.
2.	Yellow heat light is out or doesn't cycle.	(a) Defective lamp. (b) Heat fuse open - 1/4 amp.
3.	Analyzer reacts to span, but has little or no indication.	(a) Measuring cell is getting weak, see Section "D" Instrument Sens. (b) Analyzer is trying to mea- a leak in the system. Now span measures the difference between leak and span.
4.	No reaction to span, and high zero setting (past 5).	(a) Oscillator not functioning. Check with oscilloscope for 300 - 500 v P/P @ 100 khz.
5.	No meter indication. All power lights are on.	(a) Boards are not properly seated. Remove and clean edge connector and re-install. (b) Check for +/- 15 vdc at rear of electrometer socket or red and black wires on rear of zero knob. Referenced to chassis ground.
6.	Excessive noise on recorder.	(a) Cell bad - replace. (b) Electrometer bad - replace. (c) Damping cap bad - replace. (d) Resistor board dirty --- wash with acetone.
7.	Drift	(a) Bad Cell (b) Check flow for consistency. Temperature in analyzer changing, defective, or large ambient fluctuations. (c) Not warmed up enough. (Temp should be constant between 100-130)

D. INSTRUMENT SENSITIVITY

Intention:

The overall sensitivity of the instrument can be improved after the cell has had extended use.

A DipSwitch located behind the front panel meter provides a series of shunt resistors that parallels the existing range resistors.

The switch is intended for use on the 50 ppm range. Range 0-10 will no longer be in relative with the 50 ppm.

Use: (See Figure 6)

The DipSwitch has seven individual switches. Switch #1 is used to activate the shunting. Therefore, it can be considered the on-off switch. Each switch to the left will add more sensitivity. If all switches are closed, the maximum effort upon sensitivity is achieved. Use of this feature does not affect the cell, it changes the output load impedance of the electrometer, some additional recorder noise may be experienced.

E. RECOMMENDED SPARE PARTS

1.	Sealed Detector Cell	Part No 4402 A Version
2.	Red Lamp	
3.	Yellow Lamp	
4.	Fuses	Mdl-1/4
5.	Meter	Simpson 15087
6.	Electrometer	Contact APCI Instrument Pool
7.	Temp Switch	Fenwal 18000-0

IV. PARTS LIST

A. Electronic Components And Chassis

NO.	FIGURE NO.	QUANTITY	DESCRIPTION - NAME	NUMBER	MANUFACTURER
1		1	Showcase	BB-1803	BUD order extra
2		1	Chassis	BBC-1822	BUD
3		1	4 x 6 x 3	AC-430	BUD
4		1	Recept. A.C.	LAC 3GD	Switchcraft
5		2	Fuseholder		Buss
6		2	Fuse	Mdl 1/4	Buss
7					
8		2	Switch (Range & Off/On)	MST-105D	ALCO
9		1	Socket. Lamp	911401X	Littlefuse
10		1	Red Lamp	901-2-53-22K or equ'n	Littlefuse
11		1	Yellow Lamp	901-2-53-22K	Littlefuse
12		1	Recept REC	2143-0	Pamona
13		1	Plug REC	2244	Pamona
14		1	6 Lug Sol Strip	LTS-506B	Voltrex
15					
16		3	Recepticle P.C.	582771-2	AMP
17					
18		1-3	Clamp	NCC-2	
19		1	Zero Pot	62JA 100K	Clarostat
20		1	Span Pot	D53C1 10K	Clarostat
21		1	Trim Pot Rec	03-200	Clarostat
22		1	Trim Pot Range	RJ12CP103-10K	Clarostat

23			Grommet 1/8 ID hole		
24			Grommet 3/8 ID hole		
25					
26		3	Ground Lug	1456 #6	Smith
27	Spare Part	1	Meter	15087	Simpson
27A			Scale, custom logo		In House
28		1	Cap. Electrometer	180 pf @ 100v	
29					
30					
31					
32					
33			Nut, misc.	4-40 Keps	
34			Nut, misc.	6-32 Keps	
35			Screw	4-40 1/4 F020	
36			Screw	4-40-3/8	
37			Screw	4-40 1/2 FO21	
38			Screw	6-32 1/4 F503	
39			Screw	6-32-3/8 F504	
40			Screw	6-32 1/2 F014	
41			Screw Heater	6-32-1 F475	
42			Screw Heater	6-32-1 1/4 F476	
43			Spacer 7/8	60606	
44			Spacer 2" Teflon Board	60611	
45			Spacer	60199	
46			Boards with parts for range/rec/sensitivity		
47			5-10mv switch 3.3K	RN60D	
48			Dip Resistor 25K	RN60D	
49			Dip Switch 150	RN60D	

50	1	1/8" & Coil Sample Tube		APCI In House
51	1	1/8 Bulkhead	SS-200-61	
52	1	1/4 Bulkhead	SS-400-61	
53				
54	1	1/8 P x 1/8 T El.I	B-200-2-2	
55	1	1/8 P x 1/4 Tube	B-400-1-2	
56	1	3/16 Nut & Ferr.		
57		3/16 Tube	1/4 Tube T	
58		1/8 pipe x 3/16 tube EL.	1/4 P-1/4T	
59		1/8 P x 1/4T 45 Deg.		
60		Flowmeter Tube	#700CC	
61	1	Heater 30 watt	C202 1 1/2" 136688	Chromalox
62	1	Block. Heater		APCI
63		Block. Sample		
64	1	Block. Bracket		
65				
66				
67		Alternate	17000-0	Fenwal
68	1	Cap .01 Noise		Sprague
69				
70				
71	2	10 Turn Dial	12F2773	Spectrol
72	1	Cap Amp Damp	20 pf Poly	20F238
73				
74				
75				

76	Spare Part	1	Electrometer	302	in-house
77		1	Socket	3021	in-house
78		1	+/- 15v P/S	D15-05	Acopian
79					
80		1	30k Meg	RX1 2%	Victoreen
81		1	20k Meg	RX1 2%	Victoreen
82		1	85k Meg	RX1 2%	Victoreen
83		1			Comsip
84					
85		1	Teflon Board with hi Meg Res & Caps mounted	80-1,2,115,116	
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					

101					
102					
103					
104					
105					
106					
107					
108					
109					
110					
111			Cell		Delphi
112			Cell mounting hose 3/16 I.D.		APCI
113			Cell mounting hose clip wires Nichnone		APCI APCI
114			Moore Products flow Reg. 63BD2		
115		1	Teflon Cap	.001 uf @ 400	Comp Research
116		1	Teflon Cap	.0022 uf @ 400	Comp Research
117			Panel Mt Bracket		APCI
118					
119					
120	Spare Part	1	Osc Cir. Board Transformer parts	Complete	

INSTRUCTIONS

for

MODEL D

ION MOBILITY DETECTOR

DELPHI INDUSTRIES
EL MONTE, CALIFORNIA

TABLE OF CONTENTS AND LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

MODEL D

ION MOBILITY DETECTOR

SECTION I: Description

A. Physical Description: The analyzer is a self-contained instrument. It features a direct-reading meter and will continuously measure nitrogen concentrations in an argon gas stream. The basic design principle for the analyzer makes use of the phenomenon of relative ionic mobility. A weak radioactive source within the analyzer cell ionizes some of the gas passing through the cell. There is a difference in the mobility of the ions of argon and nitrogen which are formed. This difference can be measured electronically and the measurement interpreted to determine the amount of nitrogen contained in the argon stream. The analyzer is designed for a gas pressure of 10 pounds per square inch gauge and for a flowrate of from 0 to 1400 cc/min. The flowrate to be used when operating is 700 cc/min. (No.7 on the flowmeter)

The argon purity analyzer consists of a radio frequency signal generator, a detector cell containing the radiation source, and an electrometer. The signal generator, (G) (Figure 1) applies a100 kilocycle sine-wave alternating voltage across the cell, (P_1, P_2) which contains the radiation source, (S). Direct current flow through the cell is measured by the electrometer, (E). The capacitor, (C) prevents direct current from flowing in the signal generator circuit. The resistance, (R) is large compared to the impedance of the capacitor formed by P_1 and P_2 and prevents any appreciable alternating current from reaching the electrometer.

The detector cell (Figure 2) is a Teflon lined cylinder (T) into which the two metal electrodes (P_1 and P_2) are secured. The electrodes are drilled and fastened to tubing through which gas is supplied to the cell. The radiation source (S) within the cell is a disc of titanium tritide containing 50 millicuries of tritium. The disc is supported on the cathode (P_1) by three short wires. The mean range of the beta radiation from the source is 1 centimeter, which is equal to the spacing of the electrodes.

Because it contains a source of radioactive material, the detector cell is a sealed unit. It is to be replaced in total and not opened or tampered with in the field.

B. Theory of Operation: The high-energy beta radiation acting on the argon atoms forms positive ions and electrons (negative) within the detector cell.

Thus:

$$Ar + \text{energy} \rightarrow Ar^+ + \text{electron}$$

The electrons are highly mobile and will move within the cell during one cycle of alternating voltage to collect in almost equal numbers at electrodes P_1 and P_2. Slightly more electrons will collect at P_1, because this electrode is somewhat closer to the radiation source than electrode P_2. In contrast to the negative electrons, the positive argon ions have

less mobility. This is for two reasons: they have a larger mass, and they have charge-transferring collisions with neutral argon atoms.

Thus:

$$Ar^+ + Ar \qquad\qquad Ar + Ar^+$$

After such a collision, the newly-charged atom must be accelerated; the result of these collisions is to effect a slowing of the movement of the new argon ions through the gas. Since these positive ions exist in their greatest concentration near the radiation source which is close to electrode P_1 and since their lower mobility does not allow them to traverse the cell during a cycle of alternating voltage, more positive ions will be collected at electrode P_1 than at P_2. As a result of this excess collection at P_1, current will flow through the cell and through the electrometer during the half-cycle of alternating voltage in which P_1 is negative. Since the time constant of the circuit is large compared to the frequency of the alternating voltage, this pulsating current will be seen by the electrometer as a direct current. If, however, the cell dimensions and the signal generator frequency are appropriately selected, the slight excess of electrons which will be collected at P_1 will balance the excess of positive ions collected at P_1 during the other half-cycle and thus no current will flow when pure argon is present in the cell.

If, however, a small amount of nitrogen (or other impurity gas whose ionization potential is lower than that of argon) is present in the argon flowing through the cell, some of the nitrogen molecules will also be ionized by the beta radiation but far more will be ionized by collisions with argon ions.

Thus:

$$Ar^+ + N_2 \qquad\qquad Ar + N_2^+$$

Since the ionization potential of argon is greater than that of nitrogen, nitrogen ions cannot enter into charge-transferring collisions with argon atoms, thus their transit will not be slowed by this process, and they will move more rapidly than argon ions. (Nitrogen ions can, of course, enter into charge-transferring collisions with other nitrogen molecules, but this is insignificant since very few nitrogen molecules are present.) As a result of this greater mobility of nitrogen ions, more ions will be collected at P_1 than were collected with pure argon in the cell. A direct current will flow and will be measured by the electrometer. The amount of current will be linearly related to the concentration of nitrogen molecules until their number becomes appreciable in comparison with the total number of argon ions. Practically, this linearity limit is about 100 parts per million of nitrogen in argon.

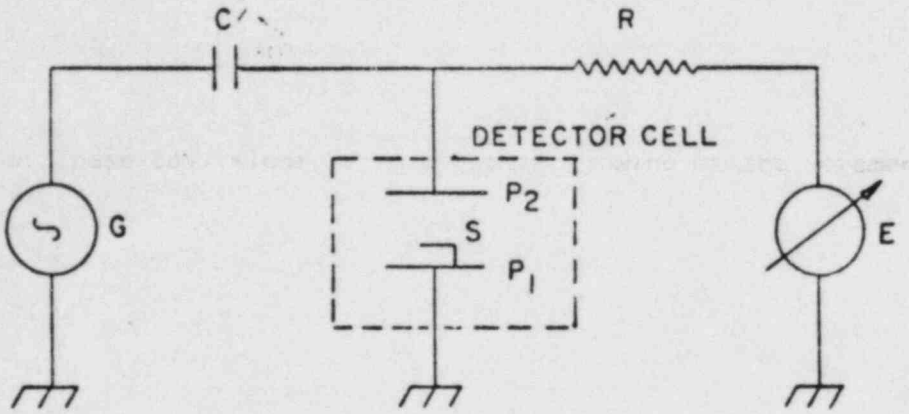


Figure 1. BLOCK DIAGRAM ARGON PURITY ANALYZER

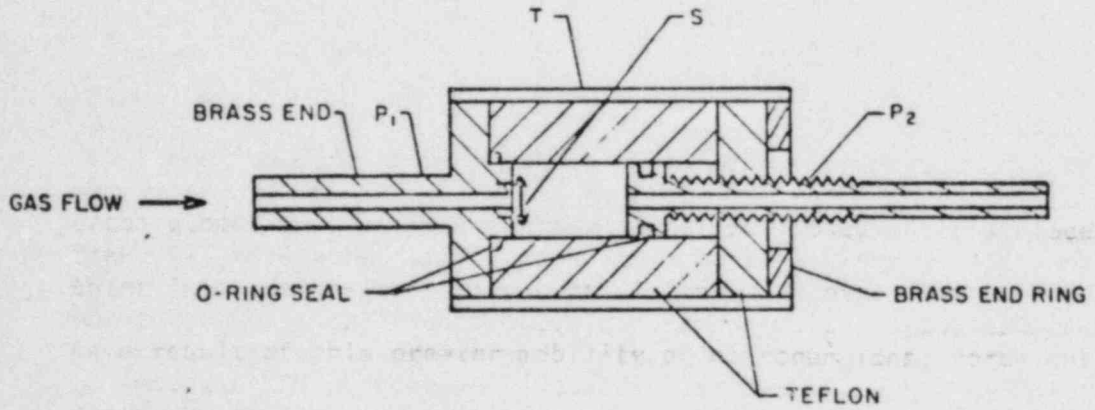
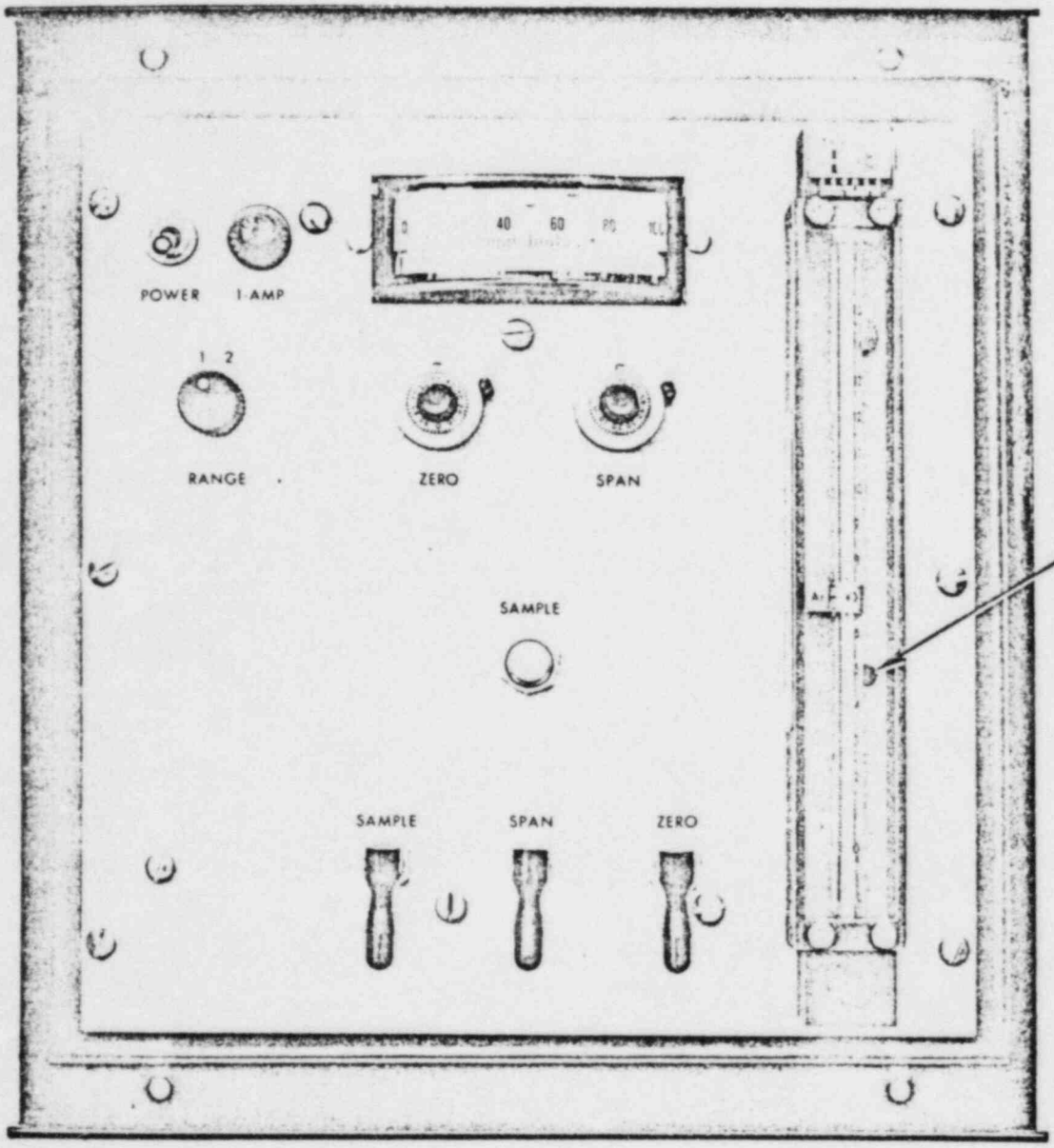


Figure 2. DETECTOR CELL CROSS SECTION

REV. 1



DELPHI		
SCALE:	APPROVED BY:	DRAWN BY: I.D.S.
DATE: 12-8-67		REVISED:
MODEL D ION MOBILITY DETECTOR		
FRONT VIEW		DRAWING NUMBER 4100-A

SECTION II: Installation

A. Location: The analyzer should be located as close as possible to the sample point in order to avoid unnecessary lags in measurement due to the time required to get the sample to the analyzer. The location selected should be as free as possible from shock, vibration, drafts, and temperature extremes.

B. Mounting: (If the analyzer has been mounted and interconnected by Delphi, a drawing of this arrangement will be found in Section V).

The analyzer is designed for flush panel mounting. Panel cutout dimensions are shown in Drawing 4102. Mounting screws and nuts are provided with the analyzer. The instrument should be mounted so that the bottom of the case is approximately level. Access space should be left behind the instrument so that sample and electrical connections can be conveniently made. This will also facilitate removal of the entire instrument chassis if this should become necessary.

C. Interconnections:

1. Electrical Connections: Drawing 4103 shows the external electrical interconnections between the analyzer, the power source, and the indicating or recording device. The location of the $\frac{1}{2}$" conduit knockout holes is shown in Drawing 4102. Leave 12" service loops for both power and signal wires.

Power Wiring should be consistent with local electrical codes. The total power required is 100 watts at 115 volts, 50 or 60 cycle alternating current.

Signal Wiring from the analyzer to the recorder or indicator should be No.22 or larger two wire shielded cable. The shield should be grounded at the analyzer only. Do not ground at Recorder. Neither of the signal leads should be grounded. The signal leads can be up to 2000 feet long. They should not be run for over 10 feet in the same conduit with power wiring.

2. Gas Connections: Drawing 4102 shows the connections required. The fittings at the instrument are 1/8" NPT, Female.

Caution: All gas connections must be leak free.
Even small leaks will cause erratic or unreliable operation.

SECTION III: Startup

A. Warmup: After making the gas and electrical connections, turn on the power and run zero (or other) argon gas through the analyzer. The analyzer will take from two to three hours to reach temperature equalibrium. The sample lines will take at least this much time to purge down to a few ppm contamination.

B. Standardization: It is generally easier to use the analyzer if all the inlet gases are the same pressure. If possible, adjust the zero, span, and reference gas pressure regulators to be the same pressure as the sample. (This can be anything from 30" H_2O to 50 psi, but is preferably 10 psi.) Then when switching from one gas to the other, flowrates will be the same, and one gas will not contaminate the other.

1. Zero:

   a. After warmup, check the zero gas flow and readjust to 700 cc/min. if necessary.

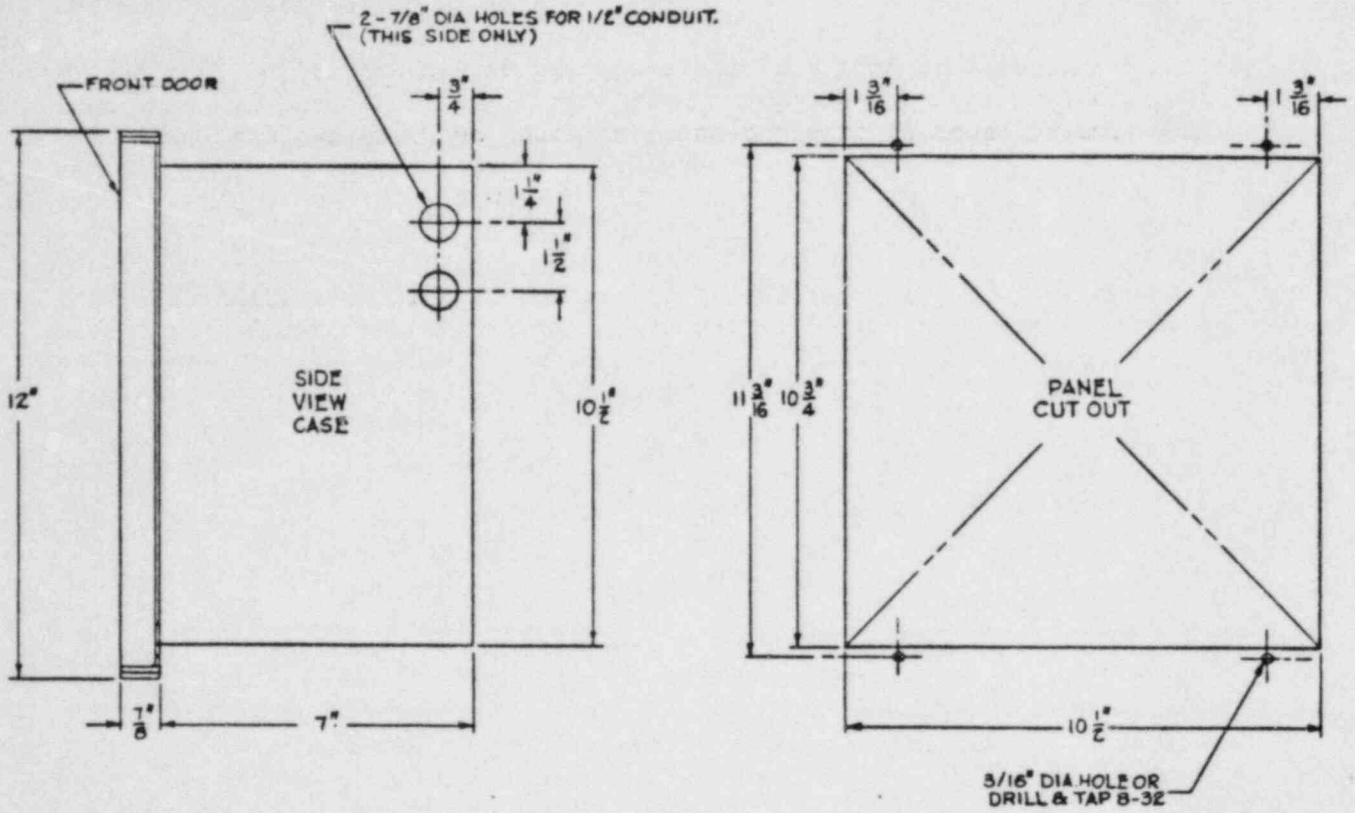
   b. Calibrate the analyzer for ZERO. Check the analyzed nitrogen content of the ZERO gas a given on its cylinder. Adjust the zero control until the meter reads the same nitrogen value as that given on the cylinder. (i.e., if the ZERO gas contains 2 ppm nitrogen, set the meter to read 2).

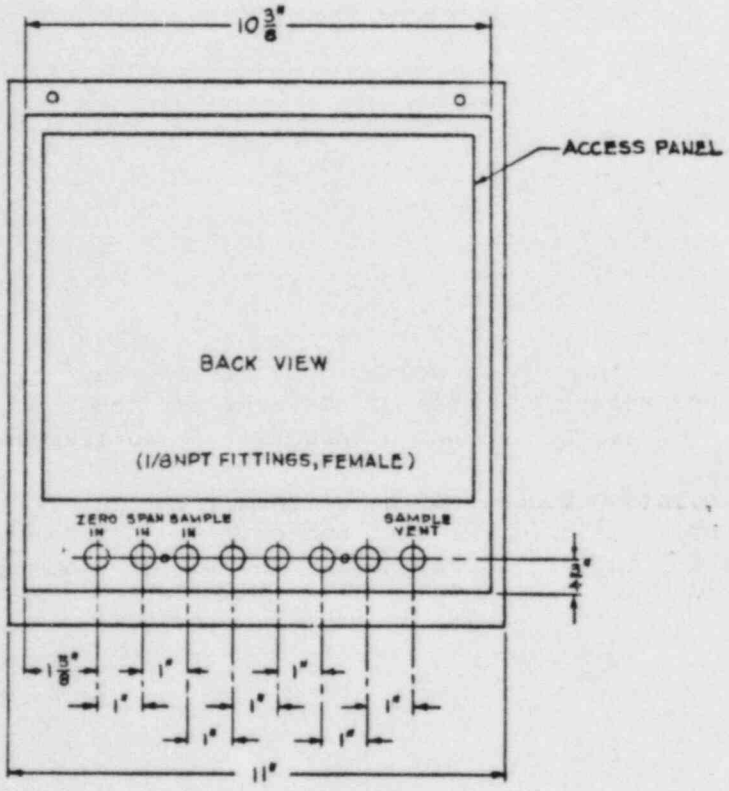
2. Span: Calibrate the analyzer for SPAN. Open the span toggle valve and close the zero toggle valve. Adjust the SPAN gas flow for 700 cc/min. Allow sufficient time for the meter to stablize. Check the nitrogen content given on the cylinder of SPAN gas. Adjust the span control until the meter reads the same nitrogen valve as that given on the cylinder. (i.e., if the SPAN gas contains 45 ppm nitrogen, set the meter to read 45).

Alternate ZERO and SPAN flows several times until the meter reads the proper value for the gas passing through it.

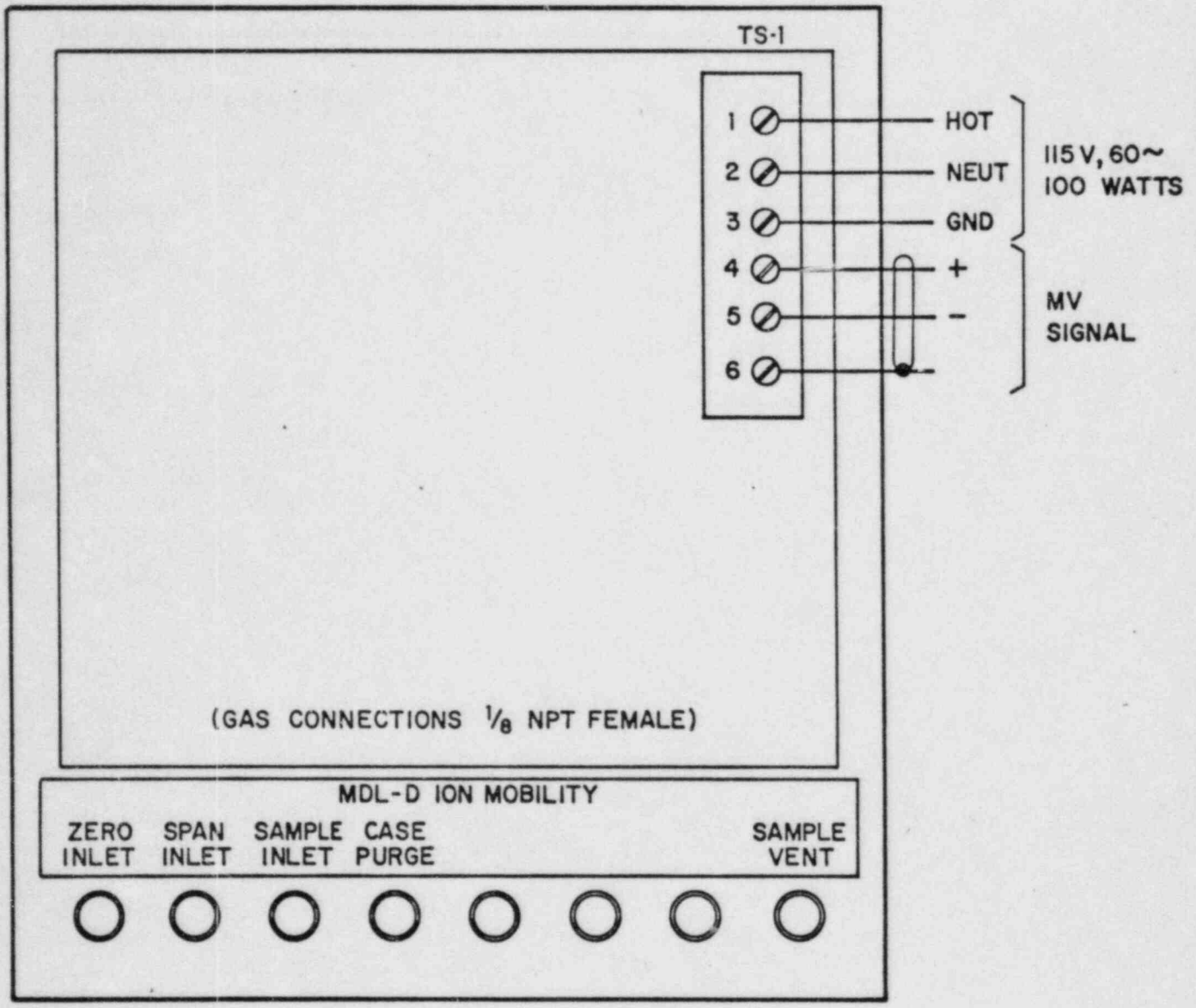
3. Normal Operation: Open sample toggle valve and close span toggle valve. Set the sample flowrate at 700 cc/min. A few minutes will be required for the analyzer to stablize before the meter will read the concentration of nitrogen in the SAMPLE gas.

If the instrument is in continuous operation, take ZERO and SPAN readings daily and record them in a log for a few weeks. Calibrate the instrument to correct for any drift. After the initial period, ZERO the analyzer daily and SPAN it twice a week.





DELPHI		
SCALE 1/2" = 1"	APPROVED BY	DRAWN BY I.D.S.
DATE 8-30-66		REVISED
DIMENSIONAL & MOUNTING DIAGRAM		
MODEL DION MOBILITY		DRAWING NUMBER 4102



DELPHI		
SCALE:	APPROVED BY:	DRAWN BY: I.D.S.
DATE:		REVISED:
MODEL D ION MOBILITY ANALYZER		
EXTERNAL CONNECTION-BACK VIEW		DRAWING NUMBER 4103

SECTION IV: Operation and Maintenance

A. Notes on Operation:

1. Operation with a recorder: A recorder with a sensitivity of 0 to 5 millivolts can be used with the argon purity analyzer to give a continuous record. The recorder output terminals are located on the back panel of the instrument. The instrument has been set so that a full scale reading on the meter corresponds to a full-scale deflection on a 5 MV recorder.

2. Stand-by Operation: Whenever the instrument is not in use the INLET and OUTLET connections to the analyzer should be blocked to prevent contamination of the cell with air, moisture, or dirt. The outlet can be blocked with a $\frac{1}{4}$ inch Swagelok cap. The inlet may be blocked by closing the gas sample valve. The electrical system may be left on without damage to the instrument

3. Change to a new cylinder of SPAN or ZERO gas whenever cylinder pressure falls below 50 psig.

B. Maintenance:

Note: Any sensitive gas analyzer must be protected from leaks and sample contamination. Dirt or moisture in the gas sample will cause erratic or false readings. Any gas leak which allows gas to leak out may also allow atmospheric nitrogen to diffuse into the cell. Thus, the most important maintenance problem is to keep all gas connections leak free and to provide a clean, dry and representative sample gas.

PROBLEM	SOLUTION
1. Cannot get on-scale reading (too high)	(a) Check gas lines for leak. (b) Gas flow less than 700 cc/min. (c) Check electrometer and circuitry against voltages called for in schematic. Test voltages are circled on the schematic. (use a meter with a sensitivity of 20,000 ohms per volt.)
2 Cannot get on-scale reading (too low)	(a) Gas Flow excessive (above 700 cc/min.) (b) Same as (c) above.
3. Reading below zero on sample gas.	(a) Zero gas contaminated. Improper Zero setting (too low)
4. Unable to span properly Span pot (max.)	(a) Incorrect span gas. (b) Cell electrode setting incorrect.

PROBLEM	SOLUTION
5. Insensitive: Meter on scale but analyzer does not react to Span or Sample gases.	(a). Oscillator failed to oscillate. Turn power switch on and off several times. This will cause unit to oscillate. (b). Stainless steel wire interconnecting Electrometer and Oscillator chassis not making contact with adjustable cell electrode. (c). Moisture in cell. Purge cell with dry gas until proper response is obtained. (d). Cell contaminated with oil or dirt that coats Tritium source (See next section for cleaning instructions).
6. Span pot setting high 950-990	(a) A high span setting is normal on this type of analyzer.
7. Inoperative flowmeter	(a) High pressure has been applied to detector cell. Plastic outlet tube on cell must be reconnected. Note: When connecting tube to cell be careful not to turn cell electrode.

C. Cell Cleaning Procedure:

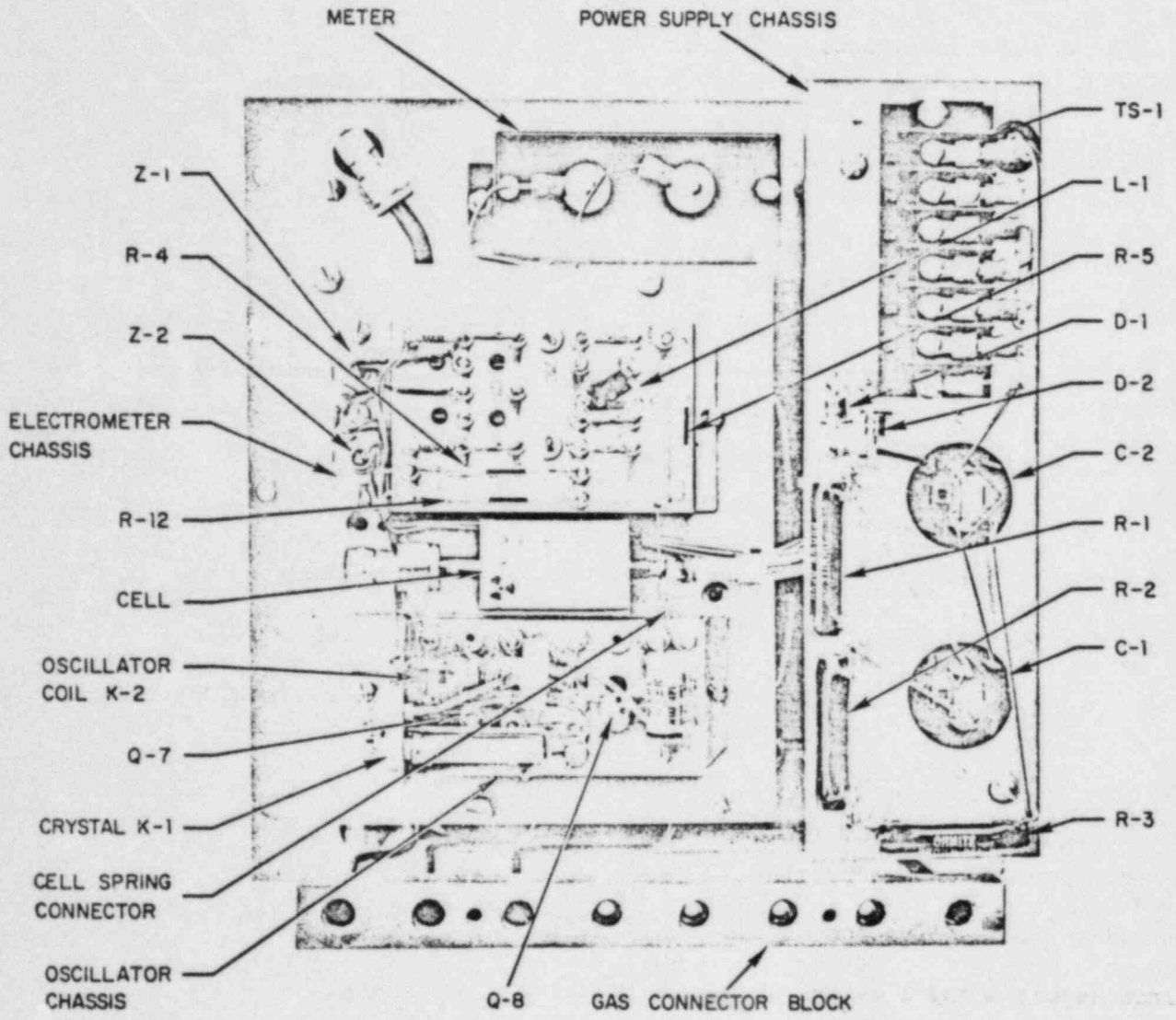
Flush cell with reagent grade acetone and dry with clean, dry argon gas. (Note: The spacing between the cell electrodes is critical and has been set during manufacture. The cell should be returned to the manufacturer if repairs are necessary.)*

D. Calibrating Gases:

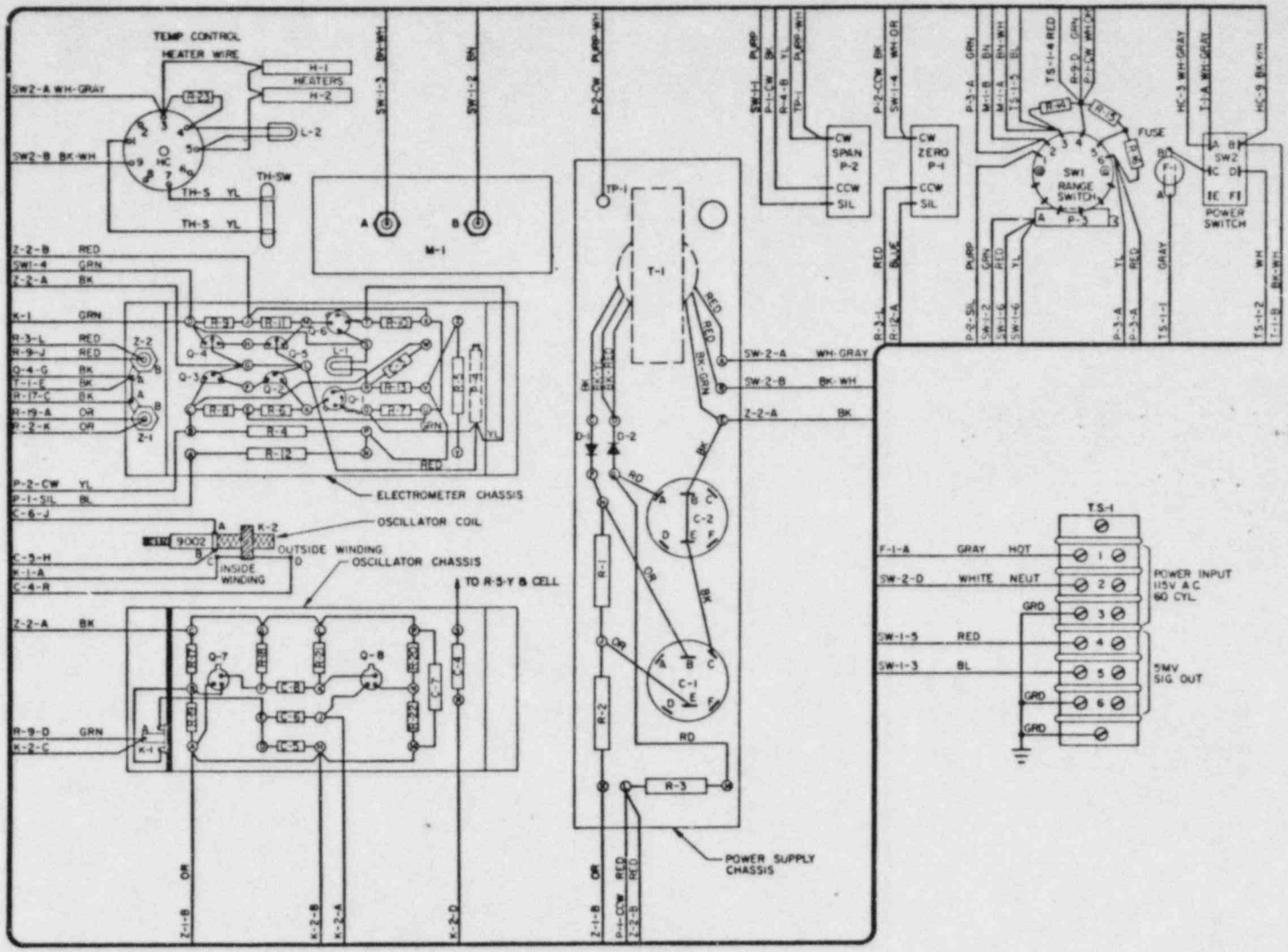
ZERO gas	200 cubic foot cylinder of high-purity argon (nitrogen content about 2ppm).
SPAN gas	200 cubic foot cylinder of approximately 45ppm of nitrogen in high-purity argon. An exact analysis for nitrogen content must be supplied with this cylinder.

When the pressure in either the ZERO or SPAN gas cylinders falls below 50 psig, it must be replaced. Reorder early enough to assure a continuous supply of calibrating gases.

*Caution: The detector cell contains radioactive material 50mc H^3. It is supplied as a sealed unit as a safety measure. Do not attempt to ope the cell in the field



DELPHI		
SCALE:	APPROVED BY:	DRAWN BY: I.O.S.
DATE: 12-8-67		REVISED:
MODEL D HEAT COMPARTMENT		
REAR VIEW, COVER REMOVED		DRAWING NUMBER 4100-B



Delphi		
SCALE	MATL	DRAWN BY W.B.
APPROVED BY —	TOLERANCE	DATE 11-19-68
DEM DWG #	ASSEM DWG #	REVISED 12-9-69
MODEL-D ION MOBILITY		
INTERNAL WIRING DIAGRAM		DWG NUMBER 4105

SECTION IV D REPLACEMENT PARTS LIST
10/3/66

DELPHI INDUSTRIES
11672 McBean Drive
El Monte, California

MODEL D ION MOBILITY DETECTOR

NOTE: -Minimum Billing $10.00.
-When Ordering please give Model and Serial Number of your instrument.

Part#	No. Used per Instrument	Recommended Number of Spare	Description	Price/ Each
20017	1	1	Solid State Relay	/ 25.00
20032	2	0	Heater: Chromalox #C-205 100 Watt 120 V	12.00
20021	1	1 Box of 5	Fuse: Littlefuse 1A-3AG	1.00/box
20035	1	0	Thermoswitch: Princo #T-151-3/125°F	27.00
20013	3	0	"O" Ring for Thermoswitch PRP-568-010 Butyl # 10/3/800	.50/ea.
4015	1	0	Cell	150.00
20166	1	0	Zener diode Z-1-IN3005A 100 Volts	7.00
20008	1	0	Zener diode Z-2-IN1608 25 Volts	7.00
20143	2	0	Potentiometer: Span; Spectrol 510, 100K Zero; Spectrol 510, 100K	22.50 22.50
20051	2	0	Duodial, Spectrol, 11-1-11	15.00
20183	1	1	Meter	$ 354.00

PATENT AND KNOW-HOW LICENSE AGREEMENT

THIS AGREEMENT shall be effective as of April 1, 1966, by and between DELPHI INDUSTRIES, a corporation of California, having an office address at 11672 McBean Drive, El Monte, California, hereinafter referred to as LICENSEE; and AIR PRODUCTS AND CHEMICALS, INC., a corporation of Delaware, having an office address at Post Office Box 538, Allentown, Pennsylvania, hereinafter referred to as LICENSOR.

WHEREAS, LICENSOR has invented and developed a method and apparatus for analyzing gas mixtures based upon a principle hereinafter referred to as the Ion Mobility principle; and

WHEREAS, LICENSOR has filed a U.S. Patent Application, Serial Number 335,511, covering said method and apparatus, said apparatus hereinafter being referred to as an Ion Mobility Analyzer; and

WHEREAS, LICENSOR has developed and manufactured one embodiment of said Ion Mobility Analyzer, hereinafter referred to as an "Argon Purity Analyzer" although such embodiment is not limited to detection of argon; and

WHEREAS, LICENSOR possesses substantial know-how concerning the Ion Mobility principle, the application thereof, and the manufacture of Ion Mobility Analyzers utilizing this principle; and

WHEREAS, LICENSEE has reviewed and studied the above indicated invention, development, and patent application, and desires to manufacture, market, and further develop analyzers of the Ion Mobility type; and

WHEREAS, LICENSEE desires to obtain a license under LICENSOR's patent rights and know-how for manufacturing, marketing, and developing such Ion Mobility Analyzers;

NOW, THEREFORE, in consideration of the premises and the mutual obligations of the parties as set forth hereinbelow, the parties do hereby agree as follows:

1. LICENSOR hereby grants to LICENSEE an irrevocable, nonassignable, exclusive patent and know-how license to manufacture, use, and sell Ion Mobility Analyzers, under Patent Application Serial Number 335,511 and the U.S. patent resulting therefrom including all divisional, reissue and/or continuation applications and patents resulting therefrom.

2. LICENSOR hereby agrees to supply to LICENSEE a copy of Patent Application Serial Number 335,511, an Operating and Maintenance Manual, drawings, and other technical information useful in the manufacture and use of Ion Mobility Analyzers, and will render reasonable assistance to LICENSEE in manufacturing, using, and selling such Analyzers, if so requested. LICENSEE hereby acknowledges that LICENSOR has already supplied some of the foregoing information, services, and know-how which shall be considered to be performance under this Agreement.

3. LICENSOR hereby agrees that it will expend all reasonable efforts in the diligent prosecution of Patent Application Serial Number 335,511 and will keep LICENSEE advised of any actions affecting the prosecution of this patent

application. LICENSOR further agrees to keep LICENSEE advised of any further developments or improvements made by LICENSOR which relate directly to Ion Mobility Analyzers falling within the scope of the claims of said patent application, however, LICENSOR shall be under no affirmative obligation to continue such development efforts. In the event that such further developments or improvements are made by LICENSOR, LICENSEE shall have the exclusive right to incorporate such developments and improvements in Ion Mobility Analyzers manufactured and used or sold under the present Agreement.

4. LICENSEE agrees to promptly advise LICENSOR of all modifications, embodiments and/or improvements made or suggested by LICENSEE during the life of this Agreement which relate to the manufacture or use of Ion Mobility Analyzers. All such modifications, embodiments and/or improvements made by LICENSEE shall be exclusively owned by LICENSEE, however, LICENSEE agrees to extend all reasonable assistance to LICENSOR in order to coordinate LICENSEE's technical and sales activities with the prosecution of said Patent Application Serial Number 335,511 and all divisional, reissue, or continuation applications thereof.

5. a. In consideration of the grant of the license under LICENSOR's patent rights and know-how above indicated, LICENSEE agrees to pay to LICENSOR with respect to each Ion Mobility Analyzer manufactured and used or sold under this Agreement the following royalties:

1. Four Hundred ($400.00) Dollars per "Argon Purity Analyzer" manufactured and used or sold;

2. Eight (8%) percent of the net selling price of each Ion Mobility Analyzer manufactured and used or sold in an embodiment other than that referred to in Subsection 1 of this paragraph.

3. Irrespective of the amount of sales actually made by LICENSEE, the minimum royalty payable shall be not less than Four Thousand Four Hundred ($4,400.00) Dollars per year, said years extending from April 1 to March 31.

b. In further consideration of the rights granted to LICENSEE hereinabove, LICENSEE agrees to supply to LICENSOR all of the Ion Mobility Analyzers which shall be required by LICENSOR in the conduct of LICENSOR's business including the operation of all technical facilities, laboratories, and plants owned and/or operated by LICENSOR including LICENSOR's domestic and foreign subsidiary companies; the sales price of such Ion Mobility Analyzers to LICENSOR being the subject of mutual agreement by the parties. In the event that no sales price is mutually accepted by the parties concerning such sales to LICENSOR, LICENSEE hereby agrees that it shall then grant to LICENSOR a royalty-free license to manufacture and use Ion Mobility Analyzers to meet LICENSOR's above defined requirements.

6. LICENSEE agrees to report its sales quarterly to LICENSOR and shall at the same time pay to LICENSOR the royalties accrued on each Ion Mobility Analyzer sold, leased, conditionally sold, or put into use by LICENSEE during that quarter. Such quarterly reports and royalties shall be received by LICENSOR within thirty (30) days following the first day of April, July, October, and January, the minimum royalty being due with the last quarterly payment for that year. LICENSEE agrees to maintain appropriate records of all sales subject to this Agreement for the purpose of accounting for royalties, and shall permit

LICENSOR's authorized representative to inspect such records at reasonable times if so requested.

7. In the event that LICENSEE shall become aware of any infringement of any proprietary rights licensed hereunder, it shall promptly notify LICENSOR and LICENSOR shall then have the first right to institute legal proceedings against the infringer. In the event that LICENSOR elects not to institute such proceedings within six (6) months of receipt of such notice, LICENSEE shall have the right to do so in its own name and at its own expense. In such proceedings both parties shall render reasonable assistance to the other party and shall be entitled to be represented by counsel of its own selection. Damages recovered by such legal action shall accrue to the party bearing the cost of the suit. Neither party shall have the right to settle with an infringer without the consent of the other party.

8. LICENSEE agrees that all Confidential and Proprietary information previously or subsequently disclosed to LICENSEE by LICENSOR pertaining to the invention will be received by LICENSEE in strict confidence and used only for the purpose licensed under this Agreement. A description of such Confidential and Proprietary information heretofore disclosed to LICENSEE is attached hereto and marked Exhibit "A". Confidential and Proprietary information disclosed to LICENSEE hereafter will be so identified at the time of its disclosure. This obligation of confidence shall survive the termination of this Agreement but shall not apply to information which is now or later becomes publicly available without any fault or action on the part of LICENSEE, or to information which is now or later becomes available to LICENSEE from another party known to LICENSEE as not

owing any secrecy obligations to LICENSOR, or to information which was already in the possession of LICENSEE from a source other than LICENSOR at the time of disclosure by LICENSOR.

9. LICENSOR hereby confirms that a reasonable novelty investigation has been made and that LICENSOR reasonably believes the claims in Patent Application Serial Number 335,511 to define novel and patentable subject matter. However, LICENSOR makes no affirmative warranty with regard to such patentability nor does LICENSOR assume any obligations with regard to indemnification of LICENSEE against any third-party patents now or hereafter in existence.

However, in the event of court litigation involving allegations that LICENSEE's activities under this Agreement constitute infringement of third-party patents, LICENSOR shall waive his rights to receive royalties under this Agreement during the period of such litigation; provided, the amount of the waived royalties shall not exceed fifty (50%) percent of the actual litigation expenses of LICENSEE.

In the event that LICENSEE becomes obligated to pay patent royalties to third-party patentees, the royalties set forth in this Agreement shall become negotiable and, in the event that such negotiations are not successfully concluded within six (6) months, both parties shall have the right to unilaterally terminate this Agreement.

10. a. The terms of this Patent and Know-How License Agreement shall remain in force and effect for a period of three (3) years from the date first written hereinabove, regardless of the status of Patent Application Serial Number 335,511 during said three-year period.

b. If, at the end of said period, Patent Application Serial Number 335,511 shall have matured into an issued patent not declared wholly or partially invalid, LICENSEE shall have the right to extend the term of the present Agreement for the full lifetime of said issued patent upon the terms set forth in this Agreement. Such right of extension shall be exercised by sending LICENSOR written notice thereof within ninety (90) days following the end of said period.

c. If, at the end of said three-year period, Patent Application Serial Number 335,511 has become abandoned, or if all claims in the resulting patent have been declared to be invalid, then the present Agreement and all obligations thereunder shall terminate automatically.

d. If, at the end of said three-year period, Patent Application Serial Number 335,511 is still pending, or, if matured into a patent, some of the claims of which have been declared to be invalid, then extension of the terms of the present Agreement shall be the subject of negotiation by the parties, provided that in the event of any of the contingencies set forth in paragraph 10d, LICENSEE shall have the option to extend the terms of this Agreement for a period up to ten (10) years.

e. As used in this Paragraph 10, the reference to "Patent Application Serial Number 335,511" shall be construed to mean this Application as well as any and all divisional, reissue, continuation, or continuation-in-part U.S. applications which supersede Patent Application Serial Number 335,511.

11. The parties do hereby agree that the foregoing terms and conditions constitute the entire Agreement of the

parties and that no changes or modifications thereof may be made without the express written consent of authorized representatives of the parties.

12. All notices, royalty payments and other correspondence between the parties concerning the present Agreement shall be addressed to LICENSOR as

Air Products and Chemicals, Inc.
Post Office Box 538
Allentown, Pennsylvania 18105
Attention: Specialty Gas Department

and addressed to LICENSEE as:

Delphi Industries
11672 McBean Drive
El Monte, California

13. The parties do hereby agree that the foregoing Agreement shall be subject to and construed under the Laws of the Commonwealth of Pennsylvania.

IN WITNESS WHEREOF, the parties have executed this Agreement on the 30th day of June, 1966, intending to be legally bound thereby.

DELPHI INDUSTRIES

Witness: Marcia A Foster

By [signature]
President

AIR PRODUCTS AND CHEMICALS, INC.

Witness: Constance D. Dingy

By John K. Stewart
Vice President

EXHIBIT A

CONFIDENTIAL AND PROPRIETARY INFORMATION

1. Copy of Patent Application Serial Number 335,511.

2. Disclosure of An Improved Cell Design by

a. Copy of Memo dated January 31, 1964, entitled "Disclosure of an Improved Apparatus for Gas Analysis".

b. Drawing of cell attached.

c. Cover Letter - R. B. Sherer to W. E. Dixon dated November 22, 1965.

3. Amendment of Patent Application on the Ion Mobility Analyzer filed December 26, 1963, a copy of which was furnished to Delphi under letter of April 21, 1966.