FIRST ISSUE - CONTENTS

INMM

NUCLEAR MATERIALS MANAGEMENT

VOL. I, NO. 1

APRIL 1972

JOURNAL OF THE INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT

NUCLEAR MATERIALS MANAGEMENT is published four times a year, three regular issues and a proceedings of the annual meeting, by the Institute of Nuclear Materials Management. Official headquarters of INMM: Office of the Secretary, INMM, Suite 12, Barr Bldg., 910 — 17th St., N.W., Washington, D.C. 20006. Subscription rates: annual (domestic), $15; annual (foreign), $25; single copy of regular issues mailed in April, July and January (domestic), $3; single copy of regular issue (foreign), $5; single copy of proceedings issue mailed in September (domestic), $7.50; and single copy of proceedings (foreign), $16. Subscription requests should be addressed to: NUCLEAR MATERIALS MANAGEMENT, 18 Seaton Hall (EES), Kansas State University, Manhattan, KS 66502. Second-class postage paid at Manhattan, Kansas, and at additional mailing offices. NUCLEAR MATERIALS MANAGEMENT is published in Manhattan, Kansas. Copyright 1972 by the Institute of Nuclear Materials Management, Inc. Inquiries about the distribution and delivery of NUCLEAR MATERIALS and requests for changes of address should be directed to the Publisher, NUCLEAR MATERIALS MANAGEMENT, 18 Seaton Hall (EES), Kansas State University, Manhattan, KS 66502. Allow six weeks for a change of address to become effective. Phone number of the editorial and advertising office: Area Code 913 532-5844. Inquiries regarding membership in INMM should be directed to Raymond L. Jackson, INMM Membership Chairman, 505 King Avenue, Columbus, OH 43201.

EDITORIAL CONFERENCE: Dr. Curtis G. Chezem (left), editor of Nuclear Materials Management, confers with Thomas A. Gerdis, managing editor and advertising director for the new journal of the Institute of Nuclear Materials Management.

MBA-99

My ideal editor would pontificate on earth-shaking subjects for his first editorial. With me the image just doesn't seem to make. How can you be a hard-nosed pontificater when you can just barely see the paper through the moisture in your eyes?

There have been times in all our lives when we've had to realize we've grown up a bit. I remember my twelfth birthday. . .I was old enough to be a boy scout. It came as some surprise to discover that some of the privileges of age carried with them responsibilities and problems seemingly out of proportion to the benefits. Our Institute is twelve-year-oldish and undergoing normal maturation.

So now we have a journal . . .clumsy and big-footed maybe, but confident.

Your emotional editor has been thinking about our old colleagues . . . You know, the guys who have moved out of the field and especially those who have closed their accounts. Thanks, just thanks!

One fellow we've really come to appreciate is Ray Jackson, publisher, editor, and babysitter of the journal's ancestor, the INMM Newsletter. What a great job he did!

As to where we're going? Right now I marvel at the youthful vigor, enthusiasm and know-how of our Managing Editor, Tom Gerdis. Under our present plans, we'll all meet him in Boston. We're going ahead and need your continuing support.

Our special thanks to the authors who responded to our initial appeal for papers for this issue. It was short notice and you did great. The editor will continue to face decisions on the type of materials you wish to read. Our present guidelines are the past issues of the transactions which leave us a wide spectrum of choices. It is imperative that I hear from you with your suggestions for publications policy.

We thank our advertisers for their expression of confidence in our success. Please show your appreciation to them and point out our services to your own organization. We are old-fashioned enough to believe that advertising dollars must show a return to the advertiser. Therefore, our medium must justify the advertiser's confidence. . . advertising is not just a subsidy but a hard-headed business proposition.

MBA-99? Well, I reckoned there must be someplace in the plant where you can store anything from graphite to graffiti, some recoverable, some waste, but none seems to fit any other classification.

Drop us a line! Letters to the editor will start next issue.

THE CHAIRMAN SPEAKS

New Journal— A Bold Step

Junior materials management personnel frequently ask, "Why should I join the INMM when I can't come to the annual meetings?" The logic is debatable, because attendance at meetings usually depends more on presenting a paper than on membership, but the question itself is valid. Why should anyone belong to the INMM if annual meetings are all there is? For that matter, why should anyone belong to the INMM, with or without annual meetings?

In recent years the Executive Committee has attempted to answer this question. The first answer, of course, is that if no one belonged, there wouldn't be an INMM, and there wouldn't be any annual meetings. These meetings are important. They provide a forum both for government agencies and for those who wish to challenge the wisdom of those agencies. They provide a platform from which to present new ideas or problems. Perhaps most important, they provide an informal meeting ground, where those with common interests or problems can meet to discuss their mutual interests in a spirit of friendship. But if that is all the INMM is really for, it seems doubtful that it is worth the effort.

There is also a second answer to the question of INMM membership. The INMM provides a common voice between its members and the government. At least it does so to the extent that the members have a common opinion. The questions of safeguards policy in the past year have amply demonstrated that the INMM members represent many widely-diverging opinions, and that a policy consensus is not easily achieved.

Nuclear Materials Management, the Journal of the Institute of Nuclear Materials Management, of which this is the inaugural issue, is intended to provide a much-needed third answer. Membership in INMM is, or should become, important because membership carries with it a valuable reference journal. The scope of this new journal is described elsewhere, and need not be repeated here, Rather, here should be stated what the Executive Committee expects the new journal to accomplish. We expect it to become the voice of the INMM, speaking to the members themselves. We expect it to make available the technical information presented at the annual meetings, not just to those who attended the meeting, but to all members. We expect it to provide a mechanism for the publication of technical information which for one reason or another was not presented at an annual meeting. In short, we expect it to answer the question of why one should belong to the INMM if he cannot attend meetings.

The journal is a bold step, one that has been almost two years in the making, and one that without the support of the membership, could prove expensive. It is, nevertheless, a step that must be taken. The INMM is over ten years old, and it has close to 400 members. It must recognize its responsibilities to its members. Conversely, its members must recognize their responsibilities to the INMM. In the words of that great philosopher, the turtle, "If you want to go anywhere, you have to stick your neck out."

I will not be so trite as to end this introduction to the new journal by asking for constructive suggestions. Those who care enough will comment without an invitation, and those who don't care wouldn't bother anyway. I will end it with a plea for cooperation. If you have done (or are doing) something worth talking about, or if you have an opinion or a problem, take the time to write it up for publication. (By the same token, if you have rehashed the same topic at the last five annual meetings, don't rehash it yet again for the journal.) A journal can only be as good as the material it receives. — James E. Lovett.

NOMINATION OF INMM OFFICERS

The report of the nominating committee of the Institute of Nuclear Materials Management to the INMM executive committee meeting Feb. 18-19 in Bethesda, Md., recommended that Harley L. Toy, current INMM vice chairman, be nominated as chairman.

If elected at the annual meeting May 31-June 2 in Boston, Toy will succeed James E. Lovett of Nuclear Materials and Equipment Corp., Apollo, Pa. Toy is supervisor, technical support services, at Battelle Institute, Columbus, Ohio.

The nominating committee, chaired by Bernard Gessiness, also placed into nomination the following candidates: Armand R. Soucy, vice chairman; Lynn K. Hurst, secretary; and Ralph J. Jones, treasurer; and Louis W. Doher, Thomas J. Collopy, James W. Lee and John E. VanHoomissen, vacancies on the executive committee.

The nominating committee report was approved by the INMM executive committee at its February meeting.

GENERAL THEME FOR ANNUAL MEETING

Our theme for the annual INMM meeting in Boston May 31-June 2 is "Managing Nuclear Materials in the Seventies—Where Are We?" The intent of the theme is to "focus-in" on the industrial and governmental concerns involved in the management and safeguarding of nuclear materials as we get into the 1970's.

SHALEV TO SPEAK

Dr. S. Shalev, Technion, Israel Institute of Technology, Haifa, will speak on "The Application of Delayed Neutron Spectrometry to the Nuclear Materials Assay" at the annual meeting of the Institute of Nuclear Materials Management in Boston, Mass., May 31-June 2.

A professor in the department of nuclear science at Technion, Dr. Shalev "will give an account of some very original data which he describes as an entirely new technique based on previously unknown and unsuspected physical data," said Roy G. Cardwell, program chairman for the annual meeting.

Dr. Shalev will speak during the Measurements (NDT) session on Thursday, June 1.

LADIES PROGRAM AT ANNUAL MEETING

The Ladies Program Committee for the INMM annual meeting May 31-June 2 in Boston includes smart shops, sweeping promenades, and quaint restaurants. Each morning you will be invited to join us in the ladies' hospitality suite where you may decide on a number of group activities.

Among activities: Freedom Trail Walk, an exclusive visit and coffee hour at historic homes on Beacon Hill, a bus tour of the shore towns on Cape Ann or Cape Cod, a shopping tour of Newbury Street, and for the children and young adults, a visit to the undersea world of the New England Aquarium.

You can also explore on your own numerous museums, restaurants, libraries and specialty shops.

COMMITTEE APPOINTMENT

Peter Fried, active in designing precision weighing systems for nuclear materials control, has been named a consultant to the American National Standards Institute (ANSI), subcommittee on Mass Calibration Techniques by Remote Detection (N15.8.1.2.), of the full committee on Nuclear Materials Control (N15.8), sponsored by the Institute of Nuclear Materials Management. Fried is vice president, Brookline Instrument Co., Elmsford, N.Y. Manley Fortune, Union Carbide Corp., is task force chairman.

(See Next Page)

L. K. Hurst

HURST APPOINTED

E. R. Johnson Associates, Inc., has announced the appointment of Lynn K. Hurst as manager, quality assurance, effective March 6. Hurst is secretary of the Institute of Nuclear Materials Management.

Hurst had been director of the Argonne (Ill.) National Laboratory's special materials and services division. He was responsible for development and administration of Argonne's nuclear material safeguards program, nuclear materials and fuels measurement and quality assurance program, nuclear safety program for storage and transport, neutron and gramma irradiation services, and radioactive material transport services.

NEW MEMBERS

The following individuals have been recently accepted into INMM membership as of March 30, 1971. They are: Dr. Gardner D. Atkinson Jr., 210-B E. Croslin, Austin, TX 78752; Harvey B. Brooks, reactor physicist, Tennessee Valley Authority, 303 Tower Bldg., Chattanooga, TN 37401; Daniel G. Doerr, Nuclear Fuel Services, Inc., P. O. Box 124, W. Valley, NY 14171; Thomas A. Gerdis, news editor (engineering and veterinary medical sciences), Kansas State University, Manhattan, KS 66502; William S. Johnson Sr., vice president, Eberline Instrument Co., P. O. Box 2108, Santa Fe, NM 87501; Eugene J. Miles, assistant to manager, operations, Westinghouse, P. O. Box 355, Pittsburgh, PA 15230; O. P. Pitts, Jr., assistant chief, power accounting branch, Tennessee Valley Authority, 253 Haney Bldg., Chattanooga, TN 37401; Louis A. Sonzogni, Public Service Electric & Gas Co., 80 Park Pl., Rm. 7224, Newark, NJ 07101; and Burt L. Swersey, president, Brookline Instrument Co., 4 Westchester Pl., Elmsford, NY 10523.

CHANGES OF ADDRESS

The following are new addresses for members of the Institute of Nuclear Materials Management: Warnell Brown, 800 Concourse Village W., 5-L, Bronx, NY 10451; Marvin R. Schneller, E. 1824 S. Riverton, Apt. 205, Spokane, WA 99207; Charles N. Smith, physicist, National Bureau of Standards, C-216 Radiation Physics Bldg., Washington, D. C. 20234; and Richard C. Yates, 27525 Mt. Radnor St., Damascus, MD 20750.

KSU DEVELOPS COURSE

Three nuclear engineering faculty members at Kansas State University, Manhattan, have received a grant to develop the first full-semester course in nuclear materials safeguards. The project, financed by the Argonne (Ill.) National Laboratory Center for Educational Affairs, is led by Dr. Walter Meyer, professor. He is assisted by Dr. Curtis G. Chezem, Black and Veatch, professor and department head, and Dr. N. Dean Eckhoff, associate professor.

The project involves development of a programmed instructional course using individually prescribed instruction (IPI). When completed, the course will be available for professional nuclear engineers and scientists either for a course or for self-teaching.

ASSAY EQUIPMENT FOLDER

Gulf Energy Environmental Systems has published a folder describing their Nuclear Materials Management and Safeguards assay equipment and services. Copies are available from Gulf Radiation Technology, P.O. Box 608, San Diego, CA 92112. The Gulf line includes radiation assay machinery for a variety of sample sizes from "small" samples to 55-gallon drums.

NEW ACTIVE ASSAY SYSTEM

"ISAF" has been developed at Gulf Radiation Technology. Its plastic scintillation detectors are movable in order to accommodate samples approximately one pint to five gallons in bulk volume.

The new system is specifically designed for measurement of fissile materials only (^{235}U, ^{239}Pu), rather than both fissile and fertile materials measurable with the standard ISAS. The system can be used passively, that is, without the isotopic source, to measure ^{240}Pu.

AUTOMATIC FUEL PELLET SYSTEM

An isotopic source, sub-MeV neutron interrogation assay system is now offered by Gulf Radiation Technology for measuring the fissile contents of fuel pellets or small sample vials up to one inch by two inches. A cartridge-type, feed mechanism, holding up to 36 samples per loading, will move the sample into and out of the interrogating neutron beam, while a printer records each individual measurement.

This system, as are other Gulf isotopic source assay systems, is designed to be operated by a technician.

ACQUIRE WEIGHING SYSTEM

A unique Brookline Instrument Co. weighing system, combining hydraulic load cells which provide a high level of ruggedness together with a mechanical beam for high accuracy and electronics for digital readout and computer interface, has been acquired by Goodyear Atomic Corp.

It is a 18,000 Kg weighing system with an accuracy of plus or minus 0.23 Kg. It has a reproducibility of plus or minus 0.11 Kg from zero to 3,000 Kg with 70 seconds response time.

The Brookline (Elmsford, N.Y.) Series 1000 has an accuracy of one part in 1000, and it is available in capacities for from 5 Kg up to 50,000 Kg.

ENVIRONMENTAL QUALITY

RICHLAND, Wash. — The Atomic Energy Commission's Division of Regulation is preparing environmental quality statements for many of the nuclear reactors now going through licensing procedures.

Personnel at the Battelle-operated Pacific Northwest Laboratory and other AEC laboratories, functioning as extensions of the staff of the division of regulation, are assisting in the preparation of these statements.

Batelle — Northwest has been asked to work with the division on the environmental quality statements for several nuclear power stations.

R. G. Cardwell

R. A. Bradley

J. D. Sease

AUTHORS FOR THIS ISSUE

Roy G. Cardwell (B.S., University of Tennessee) has been with Oak Ridge National Laboratory since graduation from college. He is manager of finance and material with ORNL's Metals and Ceramics Division. He was co-author of the first book on nuclear materials management published in 1960 in which he wrote the section, "Principles of Fuel Element Fabrication." He is an INMM member and a Certified Nuclear Materials Manager.

R. A. Bradley (M.S., Ceramic Engineering, North Carolina State University) has been at ORNL in the Metals and Ceramics Division since 1967. He has been engaged in the fabrication and characterization of plutonium-bearing fuels for irradiation tests. He assisted in the design of the plutonium laboratory and has line responsibility for its operation.

J. D. Sease (M.S., Ceramic Engineering, Clemson University) is head of the Fuel Cycle Engineering and Development Group in the Metals and Ceramics Division at ORNL. He has extensive experience in design and operation of glove box and remote fabrication facilities. He is in charge of developing a remote line to refabricate ^{233}U-bearing fuel for High Temperature Gas-Cooled Reactor applications.

INMM EXECUTIVE COMMITTEE MEMBERS attending the executive session Feb. 18-19, 1972, at the Governor's House Motor Hotel, Bethesda, Md.: Standing from left—John W. Arendt, Ralph J. Jones and Russell E. Weber, treasurer. Seated from left—Lynn K. Hurst, secretary; James E. Lovett, chairman; Harley L. Toy, vice chairman; and Walter G. Martin. Planning for the 13th annual INMM meeting was among topics of discussion.

PLAN INMM ANNUAL MEETING IN BOSTON — The local arrangements committee in Boston for the annual meeting of the Institute of Nuclear Materials Management include (from left) Ann Jones, Dale Mulkern, Armand R. Soucy (assistant treasurer, Yankee Atomic Electric Company), and Mildred A. Canavan. Among activities organized for delegates to enjoy while in Boston May 30-June 2: a night at the Boston Pops Concert, bus tour to the shore towns of Cape Cod or the North Shore, a walk along Boston's famous Freedom Trail and visits to numerous museums and educational centers in Boston.

ADVERTISING INDEX

Control of Materials in Research: A Special Management Problem

By Roy G. Cardwell
Metals and Ceramics Division
Oak Ridge (Tenn.) National Laboratory

When considering activities utilizing nuclear materials, one usually thinks in terms of in-production, in-reactor, or in-recovery; i.e., a part of the normal fuel cycle. However, a large quantity of materials is tied up in the many complex research programs now in progress; and the nuclear materials management problems in research differ significantly from the "straight lines" and repetitive-type operations of production and recovery.

The Honeycomb Effect

First, a materials research facility will most often be concerned with a variety of programs and projects — some nuclear and some non-nuclear — requiring a variety of materials in the various laboratories. This situation results in what can best be described as the "honeycomb" effect. "Cells" of various sizes, shapes, and quantities of the nuclear materials are dispersed among other "cells" of non-nuclear materials that can influence their hazard potential through reflection, moderation, absorption, or transmutation. To add to the problem, maximum freedom of movement between nuclear and non-nuclear materials must be permitted; but there are no straight production lines from which a control base can be premapped.

Zero Velocity

A second situation almost always found in a research, but not a production, facility is that small amounts of material will find their way into a single laboratory where they will remain in an indefinite, static condition — a number on the material controller's book that is brought forward from month to month until the annual or semiannual physical inventory demands that it be confirmed by measurement. These materials lie within a gray area of control. In all probability, their quantity-value factor does not justify a frequent physical inventory; but, by not being moved or used occasionally, the possibility of losing control becomes a reality.

Uncounted, unmeasured archive samples are a good example of this type material. These are further discussed under the **Central Control and Storage** section of this article.

Hidden Dangers

If your economic "sixth sense" tells you that small amounts of material are "really not that critical should a loss or misplacement occur," remember there are other more serious hazards involving the location of fissionable materials relative to ever-present moderators and reflectors found in the general research facility.

In addition, with current research oriented more and more toward fast breeder reactors, the researcher finds himself involved with mixtures of uranium and plutonium. Mingling of these isotopes increases the possibility of a nuclear incident not only from the standpoint of criticality, but also from the radiation safety view because of the increased potential for contamination and toxicity from the dispersed plutonium.

A small, inexpensive batch of material could become a serious, costly incident; and these must be avoided at any necessary cost.

How, then?

The general control problem, then, becomes dual. First, we must satisfy all requirements and regulations imposed by both the normal hazards of handling nuclear materials and the special hazards peculiar to a research operation; and, second, we must maintain a satisfactory control and accounting of our materials with a minimum of interruption to either the research or the researcher.

The particular case I shall describe is based on a functional organization of the research facility. It could just as well apply to a program or departmentally oriented organization if the basic program or department activities were physically separated and separately managed within the organizational structure.

The case involves the Metals and Ceramics Division (materials research) at the Oak Ridge National Laboratory (ORNL). This division is organized around functional laboratories rather than research programs. For example, all primary research on the joining of metals, regardless of program orientation, is performed in the Welding and Brazing Laboratory; all nondestructive testing is done in the Nondestructive Testing Laboratory; and so forth. Each laboratory is supervised by a technical specialist designated as its Laboratory Head. Primary control areas, called Sub-Balance Areas, are centered in each laboratory that requires nuclear materials.

Nuclear Safety Review

The Laboratory Head is responsible for the radiation safety and accountability associated with nuclear materials while they are in his laboratory work area. Before any materials may be handled or processed, he must submit a detailed outline of the proposed activity, including the location and quantity of the various batches during the particular process. This proposal is reviewed by the Radiation Control Officer (RCO) and forwarded to the ORNL Criticality Committee. When the Criticality Committee has reviewed and approved the proposal, a Nuclear Safety Review (NSR) number is assigned to the document; and copies are filed with the Nuclear Materials Coordinator

*Research sponsored by the U.S. Atomic Energy Commission under contract with Union Carbide Corporation.

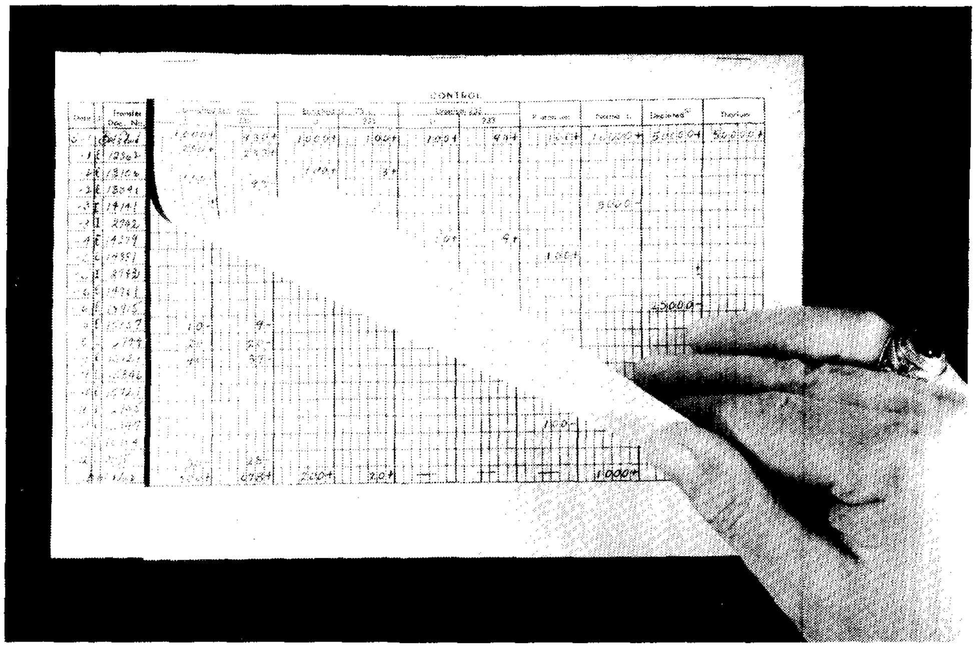
CONTROL

Date	(1)	Transfer Doc. No.	Enriched U > 75% U	Enriched U > 75% 235	Enriched U < 75% U	Enriched U < 75% 235	Uranium 233 U	Uranium 233 233	Plutonium	Normal U	Depleted[2]	Thorium
5-1		Bal Fwd	1000+	930+	1000+	100+	100+	94+	100+	10000+	50000+	50000+
-1	E	12562	250+	233+								
-2	E	13106			100+	3+						
-2	E	13341	100-	93-								
-3	E	14141								3000-		
-3	I	2742	±	±								
-4	E	14279					10+	9+				
-5	E	14381							100+			
-5	I	2743									±	
-6	E	14761			500-	50-						
-6	E	14915									25000-	
-5	E	15057	10-	9-								
-8	I	2744	±	±								
-9	E	15121	40-	37-								
-9	E	15346										47000-
-10	E	15721					10-	9-				
-10	I	2745								±		
-11	E	15947							100-			
-11	E	16104			100-	10-						
-12	E	MUF	30-	28-								
Bal Fwd.			1070+	996+	500+	43+	100+	94+	100+	7000+	25000+	3000+

CONTROL SECTION

The second column (1) shows movement of material to or from external source, E, or movement of material within the Balance Area, I. Internal movements do not affect the control balance and are indicated thereon only by + or — to designate line item and type of material. Depleted uranium (2) is carried only by total element and not by isotope unless it is in a special depletion range. The last line item, MUF, designates an authorized writeoff.

Fig. 1
THE FLIP-SHEET LEDGER



LAB A

Date	(1)	Transfer Doc. No.	Enriched U > 75% U	Enriched U > 75% 235	Enriched U < 75% U	Enriched U < 75% 235	Uranium 233 U	Uranium 233 233	Plutonium	Normal U	Depleted[2]	Thorium
5-1		Bal Fwd	500+	465+	200+	20+	—	—	—	2000+	1000+	—
-1	E	12562										
-2	E	13106										
-2	E	13341	100-	93-								
-3	E	14141										
-3	I	2742										
-4	E	14279										
-5	E	14381							100+			
-5	I	2743									1000-	
-6	E	14761										
-6	E	14915										
-5	E	15057	10-	9-								
-8	I	2744	20-	20-								
-9	E	15121	40-	37-								
-9	E	15346										
-10	E	15721										
-10	I	2745								1000-		
-11	E	15947							100-			
-11	E	16104										
-12	E	MUF	30-	28-								
Bal Fwd.			300+	278+	200+	20+	—	—	—	1000+	—	—

FIRST SUBSIDIARY SECTION

Note the third-dimensional lineup of postings applying to this sub-Balance Area (Lab A) with their matching posting on the Control Section. Control items not found reposted on Lab A will be found on other SUBSIDIARIES under this section.

(described below) who records the limits assigned. If the laboratory has two or more operations in progress at the same time, the total quantity of material in the laboratory can never exceed the sum of the approved NSR totals. In special cases, the total may be limited to the maximum on one NSR.

Central Control and Storage

The primary sub-balance areas are grouped under a secondary control (designated as the Balance Area) which is under the supervision of a Nuclear Materials Coordinator. This individual is the Nuclear Materials "anchor man" of the division. His duties involve the maintenance of a complete and current record of the quantity, status, and location of all the nuclear materials in the division and the monitoring of all movements of the materials between sub-balance areas.

His responsibilities are generally threefold. First, he works closely with the RCO, keeping him informed on current status and location of materials and activities of the researchers and advising him of possible problem areas which he observes. Second, he is responsible for the preparation and coordination of the reports and forecasts required from holders of nuclear materials; and the central position he occupies provides maximum efficiency for these tasks. Third, he maintains a limited storage operation for the Balance Area.

This third function should not be extensive. The Coordinator will, in all probability, have neither the time nor the storage space to handle a large number of batches or movements. He should provide only a clearinghouse for receipt and shipment of materials to and from the Balance Area and a limited storage for zero-velocity materials, such as archive samples. Additionally, his responsibility should be to review periodically the status of materials in his storage and remove those no longer required. He should also encourage transfer to him of materials not in current use so that they can be stored and, as soon as possible, disposed of. At all times, he should try to maintain the lowest minimum nuclear inventory possible for the total operation.

Flip-Sheet Ledger

As a result of experience in solving some of the problems in research materials control, some valuable basic tools have been developed and used in the system. (1) One of these, originated and developed by the author, which has elicited a great deal of interest from nuclear management people will be described here.

The Flip-Sheet Ledger (2) (Figure 1) is a concise version of the more familiar double-entry, control-subsidiary systems. Single-entry bookkeeping is used in combination with an overlay of the columns that contain the quantities in each transfer. Each gram quantity is posted on the proper subsidiary ledger sheet in the same column and line position as on the control sheet.

The quantity sheets have multiple columns (in this case, ten) so that any type of material may be recorded in chronological order of receipt or disbursement. This is important in the movement of the many batches of mixed isotopes common to the fabrication of breeder fuels. It also serves to condense the ledger system further by eliminating the need for separate ledgers for each type of material. This technique permits a single posting of the transfer identification and associated information for each control and subsidiary entry. The feature not only saves time, but also reduces the possibility of posting error, since there is no repeat posting of the identity information. The result is a complete-control subsidiary system contained in a single document that accurately accounts for the nuclear materials by quantity and location.

The control ledger is on the top sheet; and each quantity posting on a subsidiary sheet (Figure 2) is aligned in the same third-dimensional plane as its control counterpart, a feature that enhances the visual qualities of the system during inspection or audit. Of course, the total subsidiary accounts (labs) are limited in that the thickness of the ledger increases with their number; but, by using a lightweight paper of suitable quality for the shorter forms, a relatively large number of pages may be included in each section without impractical bulkiness.

Impractical System

In fact, if one expects to encounter the bulkiness problem in his particular system, it is a good indication that the Balance Area represented by the single complete ledger covers too much physical territory (too broad) or includes too many functional activities (too many sub-balance areas). In the first instance, the use of two or more balance areas with separate control centers and a procedure for transfer of materials between areas is recommended as the most efficient method of managing the materials. There need not be separate balance area coordinators. Given sufficient time, the single coordinator can manage more than one area by maintaining separate (but parallel and coordinated) systems, reporting them out separately, collectively, or both, as needed.

In the latter case, two alternatives are available. First, the number of sub-balance areas can be reduced by assigning the nuclear materials responsibility of two or more closely located laboratory functions to a single individual (assigned to and working in one or both of the labs) instead of each of the Laboratory Heads, as is usually done. The dual reporting responsibility of such an individual must, of course, be worked out with each supervisor in advance to prevent the occurrence of any personnel problems.

Or, alternatively, the large number of functions can be computerized. If a regular computer system is available for other purposes, the number of separate laboratory functions is large, and the movement of nuclear materials between these functions is frequent, programming and use of a computerized nuclear-materials control system is probably the best approach. (3) If no computer is available, there are a number of limited, relatively inexpensive computational systems available that are readily adaptable to nuclear materials control.

Research Approach to Production

As an interesting afterthought, let us suppose that non-nuclear industry becomes interested in producing a nuclear product, and that this particular product looks very suitable for their particular type of production and technical orientation. It will be both desirable and economical to put their designs through a trial phase, using their on-hand facilities and equipment without any (or very little) additional capital investment.

Nuclear-materials control systems designed for research laboratories can be suitably adapted to control of nuclear materials in such trial or pilot operations. The regular non-nuclear production can continue side by side with the nuclear pilot operation until a decision on producing the nuclear product is reached. If the decision is favorable, production may be accomplished either as a parallel to the non-nuclear work, using an expanded research-type control, or by establishing separate, straight production lines with conventional production-type controls. A decision on capital expansion can be made after the pilot experience.

References

1. R.G. Cardwell, B.E. Foster, and J.C. Gower, **An Integrated System of Nuclear Materials Control at Oak Ridge National Laboratory,** ORNL-4607, p. 4, Oak Ridge National Laboratory, April 1971.
2. **Ibid,** p. 9.
3. L.D. Hazelton, and D.A. Dunn, "Automated Data Processing System for SS Material Control," pp. 89-128 in **Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management, Las Vegas, Nevada, April 28-30, 1969.**

The Design and Operation of a Plutonium Laboratory

By R. A. Bradley and
J. D. Sease
Metals and Ceramics Division
Oak Ridge (Tenn.) National Laboratory

Introduction

The growth of the nuclear power industry will be dependent upon the ability to economically utilize plutonium. With the present emphasis on the Liquid Metal Fast Breeder Reactor (LMFBR), considerable knowledge has been gained in the fabrication of plutonium-bearing fuels. However, there is a general lack of appreciation for the problems and difficulties associated with plutonium operations.

The extreme toxicity of plutonium requires that it be contained in specially designed glove boxes within laboratories that have been specifically designed for handling plutonium. Although the design criteria for any plutonium laboratory must conform to current AEC guidelines (1) on the construction of such facilities, this paper attempts to provide some insight on the design and operation of a plutonium laboratory by describing a laboratory which was designed and built based on several years of experience in plutonium operations.

This laboratory, the Fuel Cycle Alpha Facility (FCAF), was constructed at the Oak Ridge National Laboratory in 1970 to perform fabrication development on plutonium-bearing fuels, primarily for the LMFBR and for the High Temperature Gas-Cooled Reactor (HTGR). The FCAF consists of three alpha containment laboratories, a change room and storage area, and air lock to the building corridor. A floor plan of the FCAF is shown in Fig. 1.

Containment

At least two lines of containment are required for plutonium handling. The glove-box system constitutes the primary containment with the surrounding laboratory providing secondary containment. In the FCAF the glove boxes are maintained at a negative pressure with respect to the laboratory, and the laboratory is maintained at a negative pressure with respect to the outside.

Primary Containment

The glove-box system consists of the individual glove boxes with their associated gas supply and exhaust systems. A sheet metal "H" gasketed type glove (2) is adequate for containment of plutonium. At ORNL safety plate glass windows are used because of the reduced fire hazard. A properly sealed "H" gasketed type glove box with glass windows will have a leak rate $\ll$ 0.5 vol. percent per hour per inch of water pressure and is capable of maintaining its integrity to at least —6 inches of water pressure. For operations requiring high purity inert atmosphere, glove boxes with flange-compressed-gasket sealed windows with a leak rate $<$ 0.05 percent per hour per inch of water pressure are required. (3) All glove boxes should be leak checked (4) and the leak rate determined before placing them in operation.

In the FCAF the glove boxes may operate with either air, inert atmosphere purge, or recirculating inert atmosphere. In all cases, a negative pressure of at least 0.5 in. water with respect to the laboratory is maintained within each glove box by regulating valves on the exhaust line. The air flow through a normal 6 ft. long glove box in the air mode at —0.5 in. water pressure is about 1 SCFM. The air inlet on boxes operated in the air mode and the exhaust line on all boxes have filters capable of removing 99.95 percent of all particles 0.3 μm and larger. The glove-box exhaust line must contain at least two such filters in series and must have provisions for performing **in situ** DOP tests (5) to ensure continued filter efficiency.

For inert atmosphere operation where the volume of gas normally supplied to the box is small, a system to compensate for glove movements in the relatively small closed volume of the glove box is required. The gas supply system for inert atmosphere operation is shown in Fig. 2. This control system has two independent means to control glove-box pressure surges caused by glove movement. A pressure gage with electrical set points activates solenoid valves which control gas flow to the glove box, and a high-capacity regulating valve controls the exhaust flow. At normal operating pressure, the normal purge flow is 0.5 to 1 cfm. If a glove is withdrawn, the pressure in the box is reduced and the pressure gage actuates the fast purge compensation system (approx 5 cfm) while the regulating valve throttles the exhaust flow. If a glove is inserted, the pressure rises and the pressure gage turns off all flow to the box; at the same time the regulating valve opens further to increase exhaust flow. The glove-box exhaust system, shown schematically in Fig. 3, was designed to limit the minimum pressure anywhere in the system to —6 inches water gage. A minimum pressure of —6 inches water gage is the ORNL standard because windows will be pulled out of "H"-gasketed boxes at pressures much below this. Flanged boxes will withstand pressures lower than —6 inches water gage. Thus, the design used in the FCAF is inherently safe because all glove boxes used in the FCAF are capable of maintaining their integrity at the minimum pressure possible in the glove-box exhaust system. The centrifugal blowers in parallel are a significant feature in the glove-box exhaust system. An individual centrifugal fan used in the FCAF attains its minimum static pressure over a wide

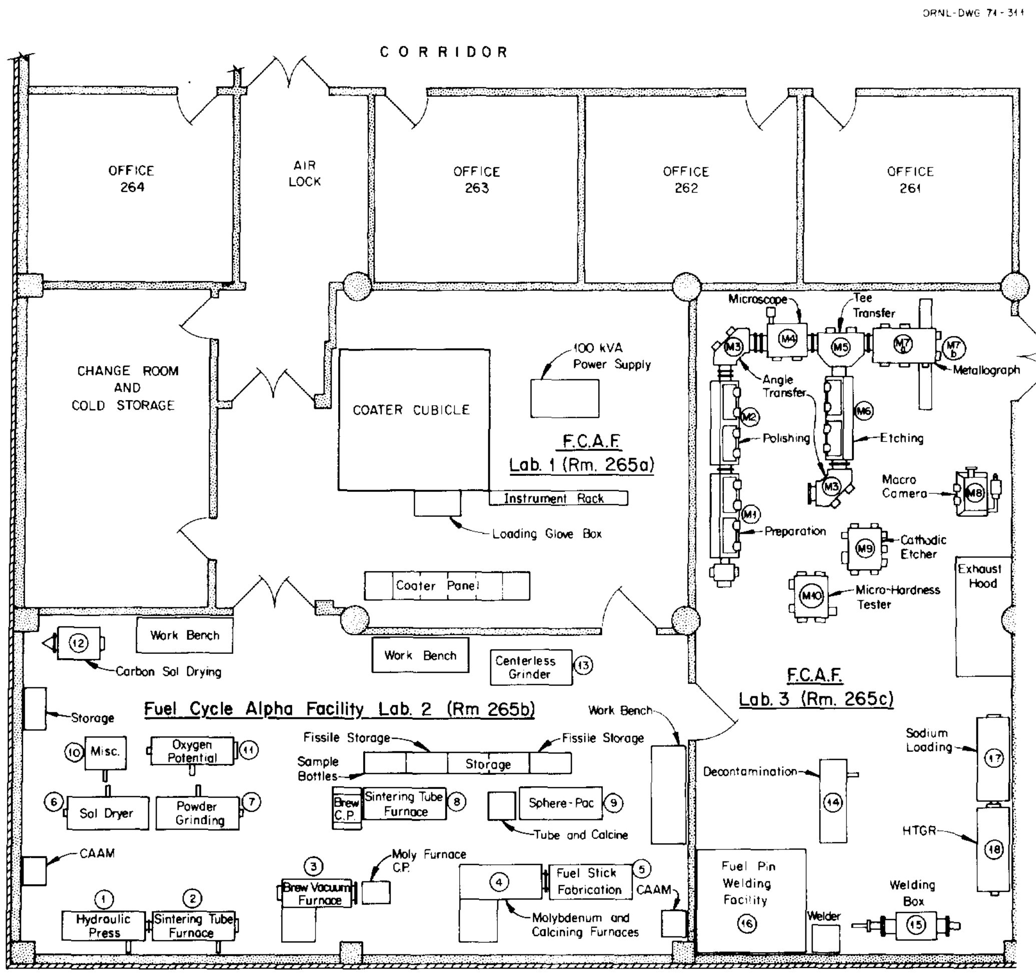


Fig. 1 FUEL CYCLE TECHNOLOGY

Fuel Cycle Alpha Facility

range of flow as shown in Fig. 4. This contrasts, for instance, with a positive displacement blower which would tend to have a linearly ascending static pressure with decreasing flow. Systems with negative pressure capabilities in excess of glove-box structural limitations require control valves or safety relief valves with response time and capacity sufficient to protect the glove boxes. Operating centrifugal fans in parallel not only provides more capacity at about the same minimum header pressure, but also provides additional reliability through redundancy. Two fans are normally operating with a third fan in standby, ready to come on automatically should the pressure in the glove-box exhaust system exceed —3 inches water gage.

Secondary Containment

The secondary containment is provided by the laboratory and its associated air-handling system. The FCAF is partitioned into three modular laboratories of approximately 24′ X 48′ to help air contamination control. The outer walls and all partitions are constructed of concrete block and are sealed for ease of decontamination. The doors are weather stripped, and all floors have a sheet vinyl covering to minimize joints, thus making decontamination easier. Wall penetrations into adjacent areas for utilities are sealed at the wall.

The FCAF has completely independent ventilation and exhaust system. The ventilation system is balanced to maintain the laboratory pressure at 0.3 in. water gage negative to the surrounding area. The facility is provided with an air-lock change room which is maintained at an intermediate pressure between the laboratories and the outside. The ventilation and exhaust fans provide 12 complete air changes per hour. If insufficient flow is perceived by a flow switch in the exhaust fan stack, or if pressure gages indicate that the laboratory pressure is not sufficiently negative, an auxiliary exhaust fan is turned on automatically and the laboratory supply fan is stopped. The laboratory air is exhausted through DOP testable HEPA filters on the roof of the building.

A system is provided to continuously monitor the pressure of the glove-box exhaust system and of the laboratories. The control panel for this system is located in the air lock to the FCAF so that disposition of the systems may be learned without entry into the laboratories. Pressure gages with electrical set points actuate alarms if the pressure in the glove-box exhaust systems or in the laboratory exceed the prescribed operating limits. This panel is connected by telephone line to a central monitoring station to provide continuous monitoring during off-shift hours. The glove-box exhaust fans and the laboratory exhaust fans are supplied with emergency power from a diesel engine driven alternator. Therefore, the negative pressure is maintained even in the event of power failure.

Operation

Three requirements which are absolutely essential to the safe operation of a plutonium laboratory are well designed facilities and equipment, established operating procedures, and experienced personnel.

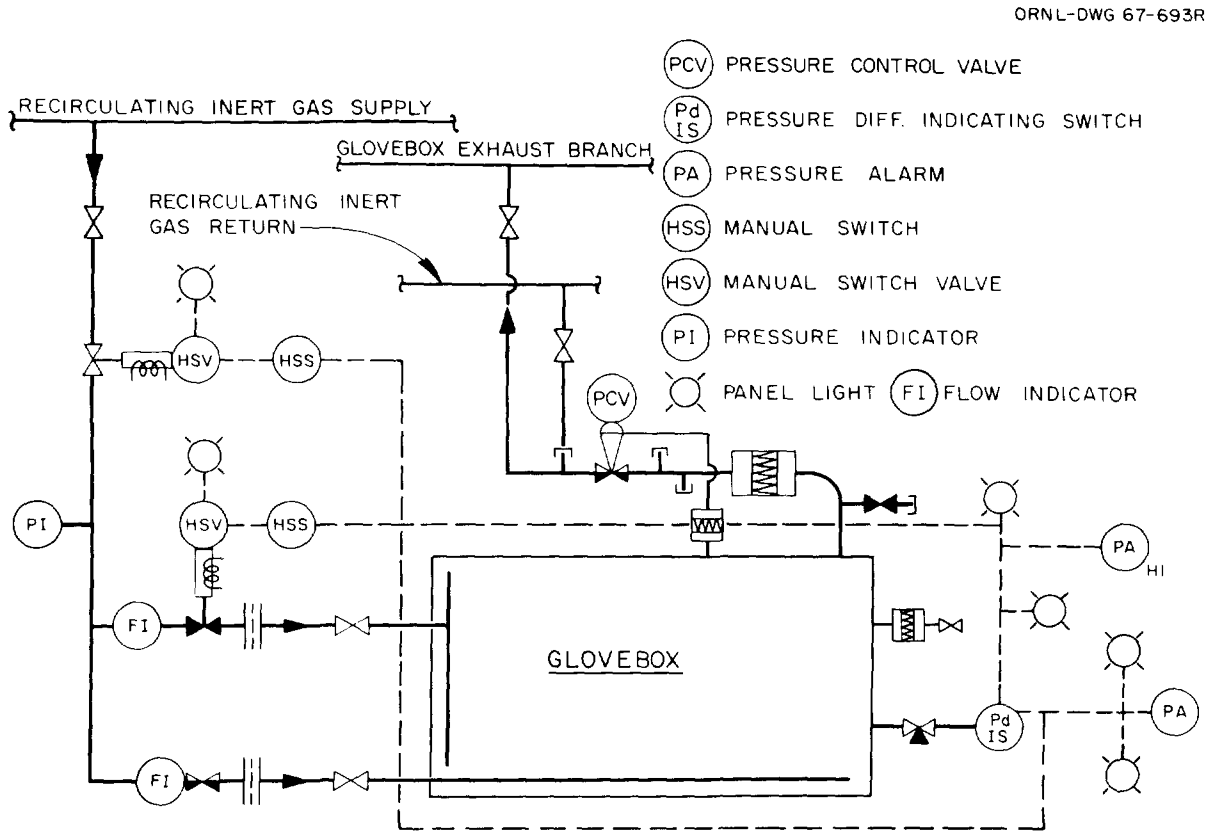
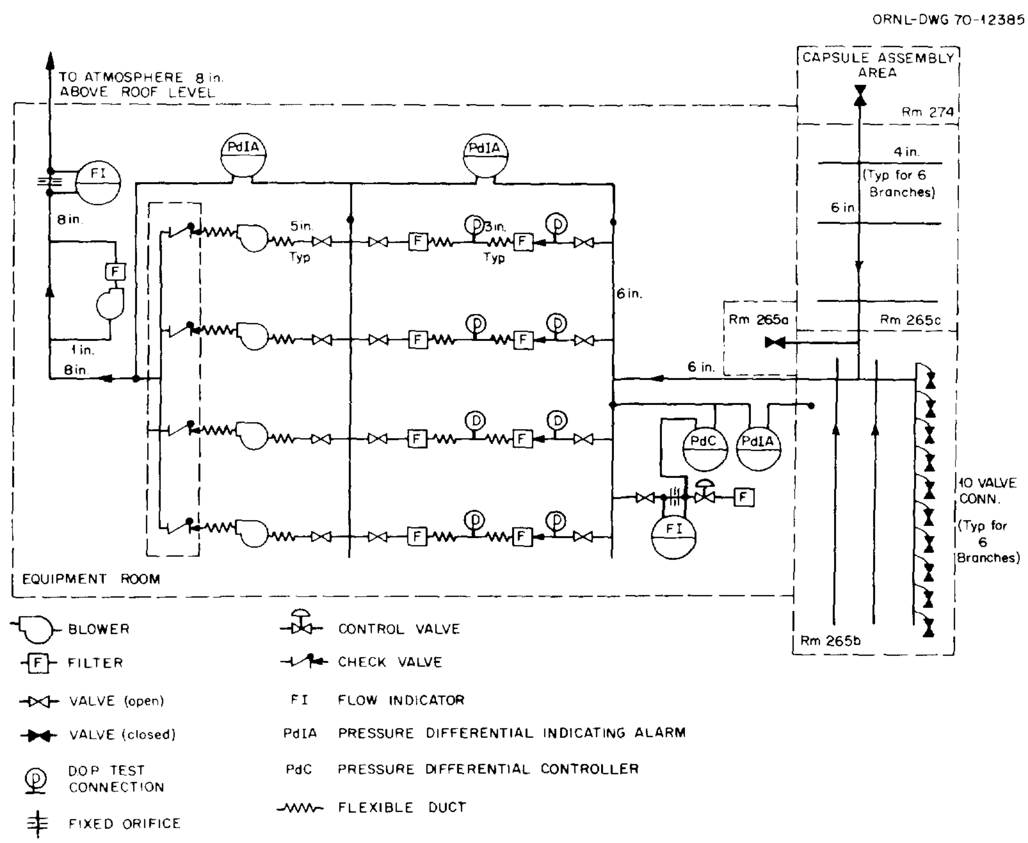


Fig. 2



Glove Box Exhaust System Schematic
Room 265 Alpha Laboratory

Fig. 3

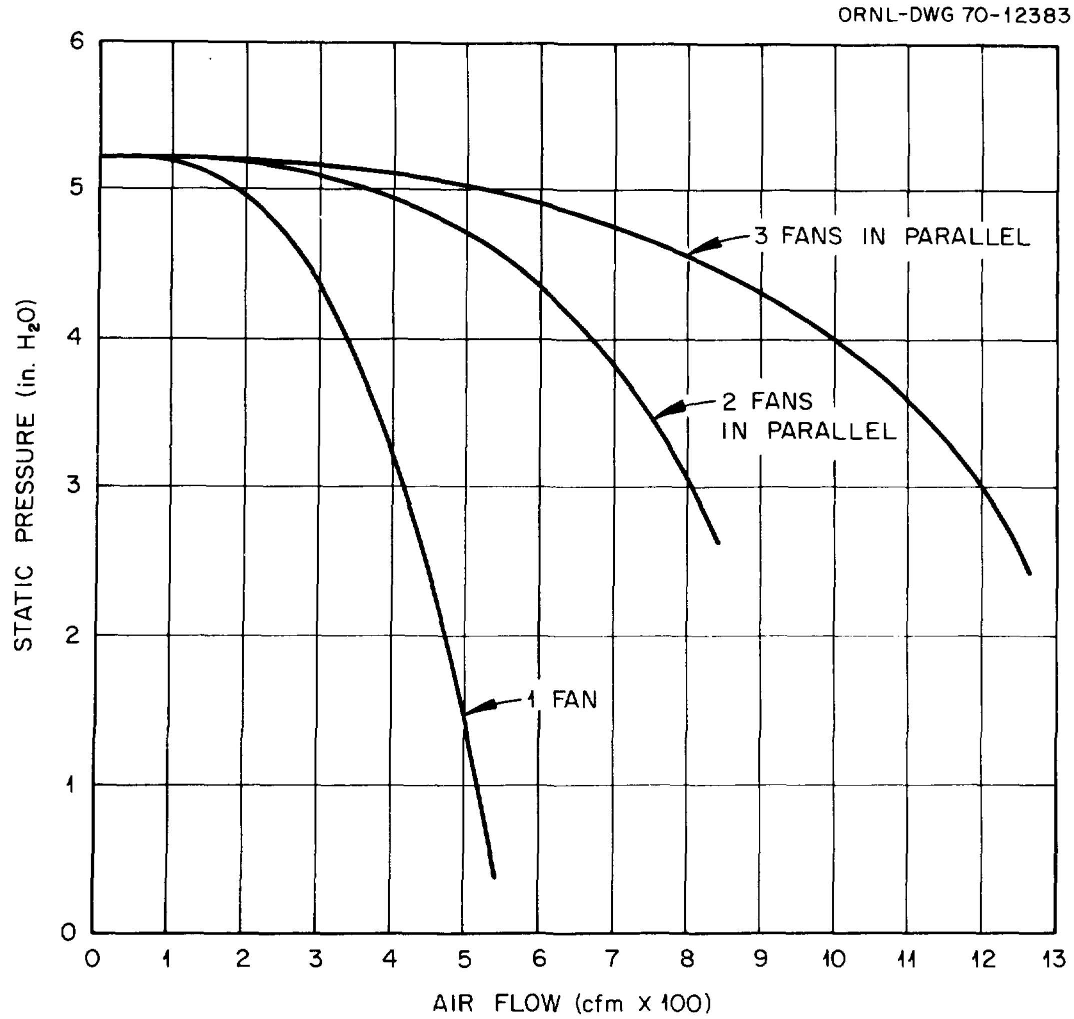


Fig. 4

The design of the laboratory has already been discussed; however, the design of glove-box equipment is equally important. Since plutonium releases are most likely to occur while an operator is transferring or otherwise handling material or equipment, the laboratory, the glove-box equipment, and the process itself should be designed so as to minimize handling operations.

Operating procedures should be aimed toward preventing the release of plutonium and detecting releases which do occur as early as possible. This can only be done through frequent monitoring. In general, monitoring is required after each operation in which the risk of release is high, such as transferring materials into or out of glove boxes, and after working in a glove box. Both the glove box and the operator's hands are normally monitored with scintillation alpha counters.

Even though a properly designed lab and good operating procedures are important, the safe handling of plutonium ultimately lies with the operator. In normal operations, incidents involving small releases of plutonium will occur, but the consequences can be minimized by correct action on the part of alert, experienced operators. In our laboratory most incidents involving potentail release of plutonium, e.g., torn gloves or plastic bags, are detected by the operator, and corrective action is taken before plutonium is actually released. In emergency situations the experience of the operating personnel is extremely important to minimize contamination spread. A situation such as a large glove rip or a bag slipping off during a bagging operation requires quick and calm action by the operator. In these types of situations inexperienced persons can cause weeks of clean-up time, and in a production plant this could be economically disastrous.

The most improtant feature in the design of a plutonium laboratory is its air-handling systems. The key to operating the laboratory safely is experienced, trained personnel.

References

1. United States Atomic Energy Commission Regulation 10 CFR, Part 70, with the amendments, **Fed. Regist.** 36(171), 17573-17575 (Sept. 2, 1971).
2. F. L. Willis, C. E. Dickerman, C. August, and G. G. Dewey, **Design Description of ANL Nitrogen Glove Box,** ANL-7885, Argonne National Laboratory, Lemont, Illinois (November 1971).
3. P.A.F. White and S. E. Smith, **Inert Atmospheres in the Chemical, Metallurgical and Atomic Energy Industries** (Butterworth & Co. (Publishers) Ltd., Washington, D. C., 1962), Chapter 2, p. 17.
4. **Ibid,** Chapter 8, pp. 164-180.
5. C.A. Burchsted and A. B. Fuller, **Design, Construction, and Testing of High Efficiency Air Filtration Systems for Nuclear Applications,** ORNL NSIC-65, Oak Ridge National Laboratory, Oak Ridge, Tennessee (January 1970).

List of Figures