IN THIS ISSUE

16th Annual Meeting, Institute of Nuclear Materials Management, Hotel Monteleone in the French Quarter, New Orleans, La., June 18-20, 1975.

INMM

NUCLEAR MATERIALS MANAGEMENT

VOL. III, NO. II

SUMMER 1974

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 of the Institute of Nuclear Materials Management, Inc. Official headquarters of INMM: Mr. V. J. DeVito, INMM Secretary, Goodyear Atomic Corp., P.O. Box 628, Piketon OH 45661.

Subscription rates: annual (domestic), $20; annual (foreign), $30; single copy of regular issues published in spring, summer and winter (domestic), $5; single copy of regular issue (foreign), $7; single copy of fall proceedings (domestic), $10; and single copy of proceedings (foreign), $20. Mail subscription requests to NUCLEAR MATERIALS MANAGEMENT, Journal of INMM, Seaton Hall (EES), Kansas State University, Manhattan, KS 66506. Make checks payable to INMM, Inc.

Inquiries about distribution and delivery of **NUCLEAR MATERIALS MANAGEMENT** and requests for changes of address should be directed to the above address in Manhattan, Kan Allow six weeks for a change of address to be implemented. Phone number of the I.N.M.M. Publications and Editorial Office: Area Code 913 532-5720.

Inquiries regarding INMM membership should be directed to Mr. V. J. DeVito, INMM Secretary, Goodyear Atomic Corp., P.O. Box 628, Piketon OH 45661.

Third-class postage paid at Manhattan, Kansas 66506.

JOURNAL'S NEW EXECUTIVE EDITOR, W. A. (Willie) Higinbotham, at right, shown in a session at the 15th annual INMM meeting in Atlanta in June. Mr. Higinbotham succeeds Dr. Curtis G. Chezem.

CONCERNS DO CHANGE

BY W. A. HIGINBOTHAM

My introduction to INMM was at the 1969 meeting in Las Vegas, soon after our little group at Brookhaven had plunged into safeguards. We found the meeting very profitable and that all the right people were there. Perhaps the same people attend the ANS circus. If they do, I haven't been able to find them and only a handful of the faithful attend the ANS safeguards sessions. It is remarkable, and it is good that the government types and the industry types and the R&D types work together to make these meetings so pleasant and so interesting.

The prime topic of discussion this year at Atlanta was safeguarding the Egyptian reactor against diversion and sabotage, which illustrates how times have changed. Years ago the INMM constitution stated its goal as the management of nuclear material because of its high monetary value. Those who framed that constitution were, of course, concerned about diversion too. But today you would put diversion and terrorism away ahead of the dollar value.

In 1969, there was a lot of talk about better measurements, about new developments for non-destructive assay and of fully measured material balances. People still spoke of normal operating loss (NOL) as something distinguishable from MUF. The only mention of physical security was Sam Edlow's scathing critique of transportation. Safeguards today starts with physical protection.

This is 1974. The public is worried about nuclear safety, nuclear diversion and nuclear sabotage. The Congress is worried. The AEC feels the pressure and responds by issuing license amendments and writing guides. That puts the monkey on the back of industry.

The fact is that neither the AEC nor the nuclear industry has knocked itself out to prove reactor safety or to provide highly reliable protection of nuclear materials. That there have been no serious incidents so far does not satisfy the intervenors, who point out that an incident could be a whopper. To make things worse, the public associates nuclear materials with Hiroshima and with insidious, invisible radiation.

INMM has been and is fulfilling a useful role, especially via the annual meeting. Its members work diligently and effectively on ANSI standards. And there is this journal, about which I have mixed feelings. But one might hope to encourage more dialogue between the members on the government side and those on the industry side, perhaps moderated by other members not so committed. We have some tough jobs to do together.

Let me close by giving out reading assignments for those who have not yet done their homework: (1) "Nuclear Theft: Risks and Safeguards" by Mason Willrich and Theodore B. Taylor, Ballinger Publishing Company, $4.95 (paperback), an excellent discussion of the safeguards problems, now and in the future, with a critique of the present U.S. system and a number of interesting proposals; (2) "The Curve of Binding Energy" by John McPhee (originally in the New Yorker Magazine), Farrar, Strauss and Giroux ($7.95), a scary piece for the layman, a profile of an unusual scientist and required reading for those who think terrorists couldn't make a bomb; (3) report written by a panel headed by David Rosenbaum for Regulatory and released by Sen. A. Ribicoff on April 28, which says that materials management is not worth its cost (perhaps I exaggerate) and which recommends a federal guard force and a federal transportation system.

THE INMM CHAIRMAN SPEAKS

Mr. Soucy

INSTITUTE NEARING 16th YEAR OF INCORPORATION

By Armand R. Soucy, Chairman
Institute of Nuclear Materials Management, Inc.

Attaining the age of 16, New Year's Day, the night before the big game, assuming a new job, all are events related to an analysis of our character, the initiation of new resolves, the anxiety of a great challenge and a review of our responsibilities. Our Institute of Nuclear Materials Management is about to be touched by all of these events.

Founded in 1959 by a group of dedicated people with vision and foresight, the Institute is nearing its 16th year of incorporation. We are no longer a young organization struggling in a new industry, but a well-established, financially sound group of nearly 400 professional individuals whose technical competence in the field of nuclear materials management is superior to any other organization.

The accomplishments of the Institute are numerous and impressive. Some of the most noteworthy are:

(A) The development of standards for the control of special nuclear materials

(B) The publication of the first major report on the security problems of nuclear materials in transit.

(C) The sponsorship of fifteen successful technical meetings whose proceedings have been documented and are considered the most important source of knowledge on the science of nuclear materials management.

(D) The publication of an excellent journal which is unique in the coverage of events and studies which relate to the accountability and safeguards of nuclear materials.

(E) The establishment of a certification program in Nuclear Materials Management which provides a source of experienced and responsible personnel for the industry.

As we enter our new fiscal year, it is proper that we should savor these past accomplishments. However, of more importance is our projection into the future and the establishment of goals to meet current problems.

The nuclear power industry, of which we are a part, is the hope of our nation to challenge and conquer the energy crisis. We are fortunate to be participants in this dynamic and exciting segment of the American economic system. Our specific challenge is not only to promote the advancement of nuclear materials managemenr, but to convince the public that our control techniques are effective. Recent publications have raised doubts in the public's mind about our ability to control special nuclear materials. Our institute has the resources to launch a public information program to inform the public of the positive steps which are in effect by government and industry to prevent the diversion of nuclear materials.

As your newly elected officers and executive committee members meet for the first time in the new year, they will review the basis for the existence of an organization such as INMM. It has always been my belief that many organizations continue to exist long after their need has terminated. When INMM was first organized it is fair to state that its existence could be classified as desirable. Today, however, the problems of plutonium re-cycle, large inventories of nuclear materials, and the use of high enriched uranium in high temperature gas-cooled reactors has made the existence of INMM an absolute necessity.

Many of the answers to the basic questions of responsibilities, goals, and reasons for existence are found in the following, excellent articles of our constitution:

(A) The advancement of nuclear materials management in all its aspects which involve, but are not limited to, the application of principles of chemistry, chemical engineering, nuclear physics, accounting, auditing, and statistics to the management of nuclear materials.

(B) The promotion of research in the field of nuclear materials management.

(C) The establishment of standards, consistent with existing professional and regulatory standards, for use in nuclear materials management. Such standards include, among others, material standards, accounting standards, units of measurement, and container standards with due attention to health, safety, and criticality consideration.

(D) The improvement of the qualifications and usefulness of those engaged in nuclear materials management through high standards of professional ethics, education, and attainments and the recognition of those who meet such standards.

(E) The increase and dissemination of nuclear materials management knowledge through meetings, professional contacts, reports, papers, discussions, and publications.

(Continued on page 7)

SECRETARY'S CORNER

Mr. DeVito

Soucy Elected INMM Chairman At June Atlanta Meeting

BY V. J. DeVITO

Secretary of INMM

According to Article III, Section 6, of the INMM Bylaws, "The Secretary shall notify each member in good standing of the results of the election by November 15 of each year." For the record, this notice in the Journal shall be construed as having fulfilled that obligation.

In accordance with Article III, Section 4, of the Bylaws, the Nominating Committee selected the following candidates for each office and position:

Chairman ..... Armand Soucy
Vice Chairman ..... Roy Cardwell
Secretary ..... Vince DeVito
Treasurer ..... Ralph Jones

Executive Committee:
Richard Alto
Thomas Bowie
Sheldon Kops
Eugene Miles
Roy Nilson

There were no petitions for candidates to be added to the ballot.

In accordance with Article III, Section 5, a ballot was mailed to each of the Institute's 405 members, of which 212 returned valid ballots.

As a result of the balloting, the officers and members of the Executive Committee for fiscal year 1975 will be as follows:

Chairman ..... Armand Soucy
Vice Chairman ..... Roy Cardwell
Secretary ..... Vince DeVito
Treasurer ..... Ralph Jones

Executive Committee:
Fred Forscher to June 30, 1975
Curt Chezem to June 30, 1975
Thomas Bowie to June 30, 1975
Sheldon Kops to June 30, 1975
Harley Toy—Immediate Past Chairman

Mr. Alto

INSTITUTE IS VISIBILITY BUILT THROUGH STANDARDS DEVELOPMENT

BY R. A. (DICK) ALTO
Secretary of N15

Editor's Note: The following report was delivered at the INMM annual meeting June 19-21 at the Riviera Hyatt House in Atlanta, Ga., by R. A. [Dick] Alto, Secretary of N15. At the meeting recognition was given to R. L. [Bob] Delnay who served so capably as N15 Chairman but who has resigned the INMM position since being transferred by Dow Chemical from Rocky Flats, Colo. to Midland, Mich. Mr. Alto received a plaque on behalf of and in the absence of Mr. Delnay at the meeting where Mr. Delnay's outstanding efforts as N15 Chairman were renumerated and lauded. The new N15 Chairman is John L. Jaech, Staff Consultant with Exxon Nuclear, Richland, Wash. Mr. Jaech has been a frequent contributor to this Journal. — Tom Gerdis, Editor.

Gene Miles and others have pointed up the need for our visibility. One way the Institute and you have been visible is through Nuclear Materials Control Standards development. INMM through its secretariatship of the ANSI N15 Committee has been an active force in standards work since 1966 and is continuing and hoping to expand its program.

In keeping with the worldwide concern for assuring that nuclear material remains under the control of responsible persons, N15's scope was modified within the past year to include protection of the material in addition to control and accounting.

I'll have to say more about that later, but first I'd like you to meet Ann Savolainen. Ann is the American National Standards Institute's Director for all nuclear standards.

Ann is an extremely busy person working to coordinate some 16 U.S. standards committee efforts involving 500 standards, appropriate tie-in with governmental requirements and also non-nuclear organizations. Along with all this, she finds time to work with the I.S.O. on their nuclear standards effort. Nevertheless, Ann has felt strongly enough about the Institute's program to attend our annual meeting. (At this point, Ann was introduced to the audience.)

Since the last annual meeting, the ANSI Board of Standards Review has approved three more N15 Standards:

N15.13 Nuclear Material Control Systems for Fuel Reprocessing Facilities. Developed by Ralph J. Jones' Task Group INMM-1.5.

N15.15 Assessment of the Assumption of Normality, and

N15.16 Limit of Error Concepts and Principles of Calculation. Both developed by Subcommittee INMM-3 chaired by John L. Jaech.

This makes a total of 12 nuclear material control standards approved by the American National Standards Institute under the auspices of your Institute.

Beyond that, two additional standards have completed ballotting by N15 and public review by ANSI with favorable results and should be published within the next few months. They are,

N15.8 Nuclear Material Control Systems for Nuclear Power Reactors. By INMM-1.4 chaired by Armand R. Soucy.

N15.9 Nuclear Material Control Systems in Fuel Fabrication Plants. By INMM-1.3 chaired by Gene Miles.

In addition, nine more very important standards under development, at least four of which involve calibration techniques being developed by Lou Doher's subcommittee, INMM-8, and his task groups headed by John Murrell, Frank O'Hara, Darrell Smith, and Sylvester Suda are scheduled for early 1975 publication. Mr. Doher's subcommittee met here Monday and Tuesday (June 17-18) and put in many hard hours hammering out key points of their standards. Their particular dedication and vigor deserves your commendation!

(Continued on page 7)

INSTITUTE'S VISIBILITY

(Continued from page 6)

Concurrent with the addition of protection to N15's scope, a new subcommittee, INMM-10, was formed by Dan Wilkins to work on Physical Protection of Special Nuclear Material Within a Facility. After shepherding the standard through the arduous first drafts, Mr. Wilkins was transferred by General Electric to non-nuclear duties. Bill Shelley of Kerr-McGee has agreed to pick up and carry the standard hopefully to early publication.

We need to get your help in two ways:

1. Use the standards and make others aware of them. Page 3 of the Spring Issue of our Journal lists the available standards and where and how to get them.
2. Participate.

*Contact the standards committee, myself or ANSI if you have some suggestions to improve existing standards.

*Arrange to help the standards committee by commenting during the draft stage. Find out who they are by reading the Journal. Check ANSI publications in your library. Or call me.

*Volunteer to help write the standards. We need help particularly in the Physical Protection area, but if that's not your bag, there is plenty else.

I've made a point to cite names of active standards' writers so you can be sure to get in touch with them. This is one way to stop being the invisible managers.

(Mr. Alto's address: Mr. Richard A. Alto, Manager, Manufacturing, Babcock & Wilcox Company, CNFP, P. O. Box 1260, Lynchburg VA 24505.)

NEARING INMM'S 16th YEAR

(Continued from page 3)

A review of our constitution shows that we should promote research in the field of nuclear materials management. It is, therefore, our responsibility to fulfill the mandate of our constitution and to become involved in research and development. To implement this mandate, I will propose to your officers that we establish an R & D committee. This committee will be charged with four major responsibilities.

(1) To explore the possibility of obtaining funds

(2) To coordinate our R & D efforts with educational institutions

(3) To coordinate our R & D efforts with governmental agencies

(4) To analyze the assets of the institute, and our ability to undertake specific research and development projects.

Although our achievements of the past fifteen years are numerous and impressive, there are many areas of activity which require improvement. Our certification program must receive greater industry recognition. Individuals who are certified nuclear materials managers should be preferential if not the only candidates considered for positions of a sensitive nature in the field of nuclear materials management. To receive such recognition we may have to upgrade the security and examination requirements of a certified nuclear materials manager.

A positive action program to attract more members of the utility industry should be initiated. This broadening of our membership will succeed only with the implementation of an educational program which will increase the awareness of the utility industry of their vast responsibilities in nuclear materials management. We should endeavor to increase the lines of communication between the INMM and the United States Atomic Energy Commission. Our organization, because it is independent of industry or government control, should be an excellent source of knowledge and ideas for the development of regulations.

Our Institute should provide more than indirect benefits to its members. Members who develop products or sell services should receive the active support of other institute members. Job opportunities which are known to members of the Institute should be publicized in order that interested members will be aware of their existence.

Throughout the years, one of the most pleasant benefits of our Institute has been the confraternity and the pleasant associations which have developed. This is a benefit that most of us will treasure long after we have succeeded in spending the financial benefits accrued from our everyday jobs. We hope that these associations will continue to grow and lead to many pleasant dinner hours, interesting discussions and fond memories.

I also ask for your suggestion on any aspect of the Institute and request that you advise me if you are interested in contributing your time to the development of our goals. This invitation for your time and ideas is extended to old and new members alike. We would like to see long-time members of the Institute returning to active participation. The Institute also needs the views and vitality of new members to provide a balanced viewpoint.

I trust that you have had a great summer vacation.

Dr. Fred Forscher (right) is shown conferring with a registrant at the 15th annual INMM meeting held in June in Atlanta, Georgia. Dr. Forscher is currently working on the strengthening of the INMM certification program at the request of the INMM Executive Committee. Look for additional reports on this topic in future issues of this Journal.

WE'VE ADDRESSED THE PROBLEM

Editor's Note: The following letter from Dr. Fred Forscher is reprinted form page 4 of the **Pittsburgh Post-Gazette,** *Monday, July 22, 1974. It is carried in this issue at the suggestion of A. R. Soucy, INMM chairman. Mr. Soucy encourages INMM members to promote the Institute in the media whenever possible.*

This is to comment on your July 6 editorial regarding nuclear blackmail and the proliferation of nuclear know-how among the nations of the world, in which you suggest that "politicians and technicians should brook no delay in addressing themselves to planning and affecting workable remedies."

I think that the public should become aware that the Institute of Nuclear Materials Management is an organization of professionals with international membership, that has for the past 15 years addressed itself to these problems. At the recent annual meeting in Atlanta, Ga., the Institute passed the following resolution:

"Whereas President Nixon has offered to provide nuclear materials to Middle Eastern nations; and

"Whereas public controversy is developing over the adequacy of the control and protection (safeguards) to be applied to the nuclear materials which will be provided; and

"Whereas the Institute of Nuclear Materials Management (INMM) is an organization of persons working in government, industry, and academic institutions who are dedicated to the advancement of nuclear materials management as a profession;

"Therefore, be it resolved that INMM urges that all such nuclear materials be placed under adequate nuclear materials protection and safeguards (control); that, in the public interest, the executive committee of INMM offers the services of the INMM membership in evaluating the adequacy of controls and protection to be applied to any such nuclear materials."

It is well to point out that the INMM, in May, 1970, alerted this country to the dangers of nuclear materials in transportation. The New York Times Magazine (Feb. 4, 1973), in an article on "The Ultimate Blackmail" credited the institute and its "professional" attitude.

Since the INMM White Paper of 1970, considerable progress has been made in the development of safeguards applicable to processing, transportation, and storage of nuclear materials such as: coded cards for personal identification (using handwriting, fingerprints, or voice prints), closed-circuit TV surveillance, continuous monitoring of transport vehicles via satellite, a secure truck that is capable of being immobilized by its crew and resists access to its cargo until help arrives, and many other anti-diversion techniques.

The countermeasures are only limited by the imaginative scenarios that they are intended to defeat. Obviously, it would be counterproductive to discuss the various scenarios in public.

The subject you have raised in your editorial must continue to be of serious concern to the civilized world, and deserves the full attention of qualified professionals in government and in industry. This is to let you know that a small group of such professionals has given this subject much attention over the years past, and will continue to do so in the future.

Pittsburgh FREDERICK FORSCHER, PH.D.

BIGGERS JOINS JOHNSON ASSOCIATES

WASHINGTON, D.C. — G. B. Biggers joined E. R. Johnson Associates, Inc., effective Sept. 1 as a Senior Technical Associate and Regional Manager-Quality Assurance for its Nuclear Audit and Testing Company (NATCO) subsidiary.

Biggers' primary responsibility is managing the new NATCO Regional Quality Assurance Office in Columbia, S.C., to provide audit, surveillance and representation services to utilities in the manufacture of nuclear fuel assemblies and related components. In addition, he will provide support to the other technical programs of Johnson Associates, NATCO, and Fuel Management Corp.

He has been associated with Westinghouse Electric Corp. at Columbia, S.C., as Unit Manager, quality control inspection and engineering. As Unit Manager, Biggers supervised 85 management, technical and inspection personnel.

Before joining Westinghouse in 1969, Biggers was Administration Specialist and also Supervisor, Physical Testing Group, for the Brown and Williamson Tobacco Co., Louisville, Ky.

Biggers is a graduate of the University of Louisville where he majored in physics. He has attended specialized training courses at the University of Indiana and the University of Michigan. Biggers lives in Columbia, S.C. He is married and has three children.

THOUGHTS OF AN EX-CHAIRMAN

'Took a Stand . . . Finally'

BY JAMES E. LOVETT
INMM Past Chairman

As many readers know, I was "heavily involved" in INMM activities from about 1967 until my retirement as chairman in June 1972. Shortly after that retirement I also moved to the IAEA in Vienna. The combined effect was to make the transition from "leader" to "just another member" a very abrupt one. Now, in June 1974, I am back for a few days, technically still a member of the Executive Committee (at least when these words were written). It is a somewhat unique and interesting experience, and I would like to share some of my thoughts.

The Executive Committee meeting (on June 18) starts much as I am used to. It is easy to forget that I have been gone. Then the report on Standards Committee activities is made, and I am shocked back to reality. There seems somehow to have been three or four years' progress during the last two years. The same situation repeats itself, perhaps less dramatically, in other areas. I make a suggestion, only to be told that it's already being done, or at least is under investigation. At least I can take some comfort that my suggestions were being adopted before I suggested them, rather than rejected.

The meeting on Wednesday also starts in a familiar manner, up to a point. Bill Gallagher asked, "Where have all the tigers gone?" Gene Miles makes it quite clear in his opening talk, however, that the tigers haven't gone anywhere. Some of the old tigers may have wandered off, but there seem to be plenty of new ones.

Someone hands me a copy of the "Rosenbomb" report, and is shocked to hear me say that I can go more than half way with its authors. It is very dangerous to comment on a document such as that "in passing," but I really have three basic comments. One, I refuse to sell MUF and LE(MUF) as short as they did; I think it still has an important place in safeguards. Two, whatever happened to clearances, or some other form of personnel security? Willrich and Taylor place a lot of importance on personnel screening, and so do I. Three, I think "batch-wise MUF control" can be made to work. I didn't invent the idea, but neither did they. For example, it was in a **pro forma** which I submitted to the AEC as early as April 1971.

Hooray, the INMM finally "took a stand" on a safeguards issue. Whether I agree with the stand is not for this record, but I have never understood why the experts (INMM) were willing to let the "pseudo-experts" do all the talking. We mutter among ourselves about various published reports that we don't agree with, and then when a resolution is proposed we worry about our tax-free status. Yes Bill Gallagher, this particular tiger hasn't gone into complete retirement. (Incidentally, I researched the tax question pretty thoroughly when I was chairman. Until we hire a Washington representative to deliver all our resolutions and argue for them, and probably even then, we have no problem. We are obviously primarily a professional society, and that's all we need.)

As always, the corridor discussions are at least as interesting and useful as the technical sessions. It is tempting to skip some of the latter, in order to be sure not to miss the former. One can always read the technical papers in the Journal. On the other hand, many of the corridor discussions are about the technical papers; if you didn't hear the paper it's hard to discuss it intelligently.

The number of new faces is pleasantly surprising, especially when the person is wearing a blue badge and is actively participating in INMM activities. Some of the old faces are missing, and we need the new ones to replace them.

It is now the Sunday after the meeting, and I am cleaning up this little dissertation. All in all it was a good meeting. To those who were with us at the Green Dolphin restaurant, and even to those who weren't, whoooopah, and auf wiedersehen.

GUEST EDITORIAL

Mr. Gallagher

WHERE HAVE ALL THE TIGERS GONE?

Play it safe; don't rock the boat; maintain the status quo; let the next guy speak up and take the risk; don't get involved in anything controversial; protect yourself at all costs; . . . even though by speaking out you might be able to make a contribution to our nation's Safeguards program.

Luckily, there are men in the nuclear business who don't adhere to this philosophy when it comes to Safeguards, even though they have undoubtedly suffered a few bruises because of their outspokenness. You may not agree with all of their opinions but you have to agree on one thing; that is, these men aren't "pussycats," and their voices have been expressions of reason which balance many intemperate or uninformed spokesmen heard these days.

This article is too brief to do justice to the many "tigers" in the nuclear industry, but let's see if you can identify the following few.

How about that former NMM Manager and fiery editorial writer out of Pennsylvania who is now devoting his efforts to international Safeguards in Vienna.

. . . Or that good friend of mine who appeared on the "60 Minutes" television show last month and expressed his concern about the potential hazards in transporting fissile materials. He is head of his own transportation consulting organization in Washington, D. C.

The keynote speaker at the 1973 INMM Meeting in San Diego is an outspoken advocate of Safeguards. This well-known gentleman was a co-founder of NUMEC. Today, as President of Energy Management Consultants in Pittsburgh, he has adopted "Energy Cannot Be Recycled," as the motto of his organization.

One of the most well-liked men in the nuclear business has never hesitated to make his position known. He is head of a consulting organization in Virginia and he also happens to have a Ph.D. after his name. In 1967, as Chairman of the "Ad Hoc Advisory Panel on Safeguarding Special Nuclear Materials," he presented a report that was the turning point in upgrading Safeguards.

Of course, any article concerning "tigers" must include that dynamic gentleman in the USAEC who is as close to being a legend in his own time as any man in the nuclear business. When someone refers to him as "The Admiral," and you have to ask "Which Admiral," this editorial is wasted on you.

Where have all the tigers gone? They haven't all gone—some are still in there pitching, and I'm even beginning to hear growling noises coming out of some of the newer members of the nuclear industry.—*Wm. G. Gallagher.*

PUBLIC RELATIONS REPORT

Mr. Dale

EXPOSURE INDEED

BY LARRY F. DALE

One way to achieve exposure is to "streak" around the pool at the Riviera Hyatt House during an INMM Annual Meeting. There are unconfirmed rumors that this phenomemon was observed at 1:39 a.m. on the morning of June 21, 1974. The "streaker" remained unidentified and the visibly shaken "streakee" refused to comment on the incident.

One other, and perhaps more socially acceptable, manner is to have an INMM Annual Meeting approximately one week after the President of the United States has indicated an intention to provide nuclear reactors and fuel materials to Middle Eastern nations; and then to adopt an Institute position on those intentions and to send it in a resolution to the President, the Secretary of State, the Chairman of the Joint Committee on Atomic Energy and the Chairman of the U.S. Atomic Energy Commission.

The latter is the route that was chosen by the INMM membership (with the exception of the individual mentioned in the first paragraph) during its 15th Annual Meeting in Atlanta during June. It is safe to say that the news media were most interested in the Institute's views on the Middle East matter. During the meeting we were besieged by representatives of television and radio stations, newspapers, and magazines within the Atlanta area. My thanks to Armand Soucy, Roy Cardwell, Jim Lee, Gene Miles and George White for allowing me to impose upon their time to provide interviews and discussions with members of the various news organizations.

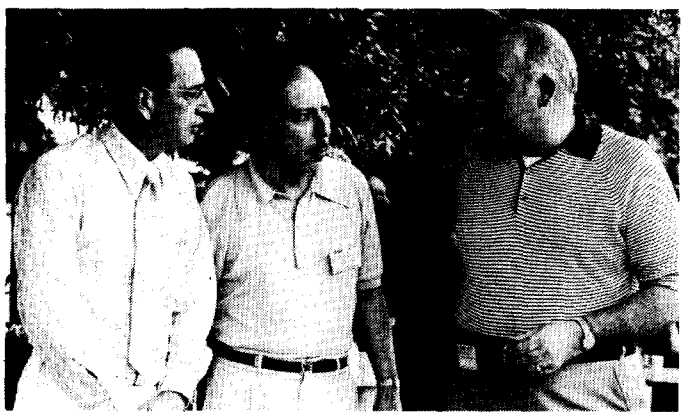
As everyone is probably aware by now, in the business session the Institute adopted a resolution urging the President and the AEC to ensure the application of adequate safeguards to the nuclear materials that may be provided to the Middle East. Further, the resolution offered the services of the members of the INMM, acting in the public interest, to evaluate the adequacy of those safeguards provisions.

On June 24, 1974, the resolution was transmitted, via telegram, to the parties listed in the second paragraph above. Also, a news release regarding the resolution was transmitted to the national wire services. To date, replies have been received from the Executive Director of the Joint Committee and from the Acting Director of the AEC Division of Safeguards and Security. Both responses indicated an appreciation for the Institute's concern and offer, and an intention to seek its assistance should the need arise.

A major concern of many INMM members and a topic of much discussion during the Annual Meeting was that of the Institute gaining national visibility and exposure. The adoption of this resolution was certainly a giant step for the Institute toward shedding its cloak of anonymity and emerging as a well-known and respected professional organization in the scientific community. The wheels are beginning to pick up speed—everybody PUSH!!!!

PHOTO HIGHLIGHTS

Atlanta INMM Meeting June 19-21, 1974



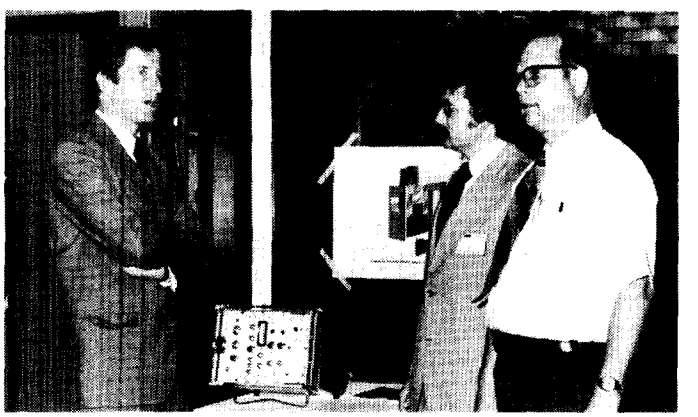
Three past chairmen of the Institute of Nuclear Materials Management (left to right)—Lynn Hurst, Bernie Gessiness, and Tom Bowie—were photographed poolside at the Riviera Hyatt House at Atlanta at the Thursday evening Hawaiian Luau.

Mr. James E. Lovett (right), Vienna, Austria, is a past chairman (1970-1972) of the Institute of Nuclear Materials Management. In addition to attending the meetings of the INMM Executive Committee in Atlanta in June, he gave an excellent paper as well. He is shown conferring with Mr. Tom Gerdis of Kansas State University, Manhattan, the Editor of Nuclear Materials Management, the Journal of INMM.

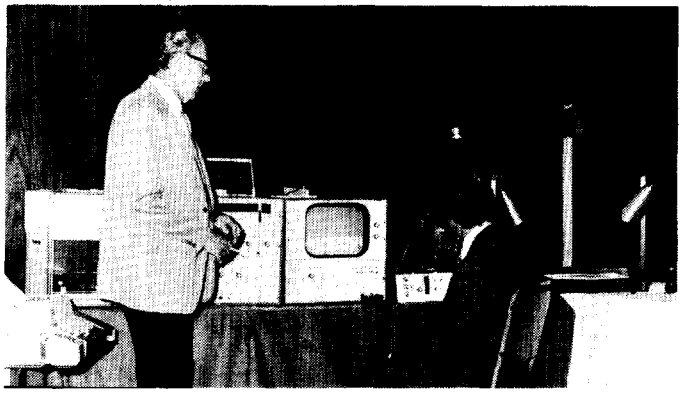
Chatting informally in the lobby during the Atlanta INMM meeting (left to right) were Walter G. Martin, USAEC, King of Prussia, Pa.; Ralph J. Jones, INMM Treasurer who is with the USAEC, Washington, D.C.; and Douglas E. George, Nuclear Surveillance and Auditing Corp., Falls Church, Va.

There was considerable interest in the excellent cuisine available during the Hawaiian Luau on Thursday night during the 15th annual INMM meeting in wonderful Atlanta, Georgia. The excellent food was just part of an excellent meeting which attracted more than 250 registrants.

Jim and Dot Joyner were the local host and hostess for the 15th annual INMM meeting in Atlanta. Their hard work and excellent arrangements and hospitality made for one of the best INMM meetings in the institute's history. Special appreciation is due this fine couple.



Steve Shepard of National Nuclear Corp., Redwood City, Calif., was one of several exhibitors at the INMM meeting in Atlanta. He displayed a doorway monitor to Dr. Frank (Nick) Costanzi, formerly of Kansas State University, now with USAEC, Washington, D.C., and Thomas J. (Tom) Collopy, United Nuclear Corp., Uncasville, Conn.



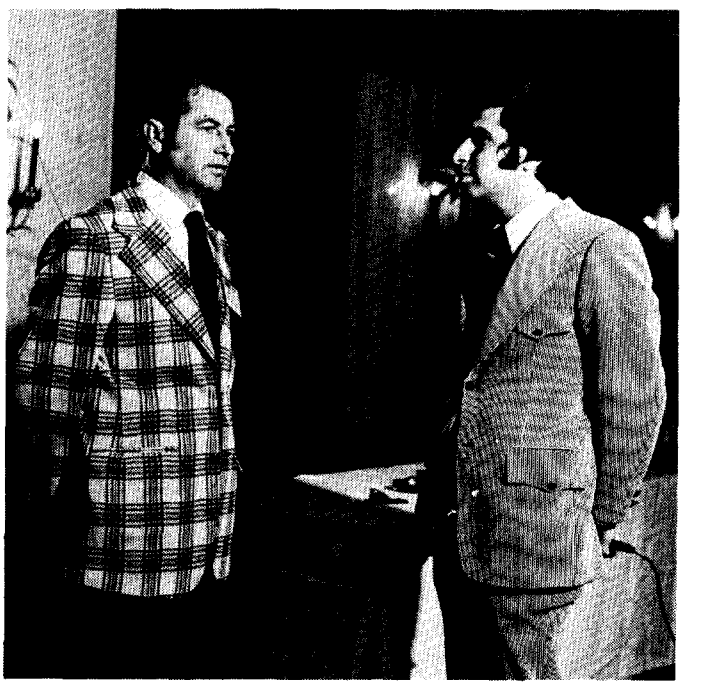
J. P. Geisel (left) of the Scientific Optical Products Division of Bausch & Lomb, Atlanta, was an exhibitor. There was considerable interest shown by INMM registrants in this and several other industrial exhibits at the annual meeting.

Harley L. Toy, Battelle Memorial Institute, Columbus, Ohio, was Chairman of the 1974 INMM Annual Meeting in Atlanta. Mr. Toy, succeeded by Armand R. Soucy, Westboro, Mass., continues on the INMM Executive Committee for the next two years as Past Chairman (1972-1974). His hard work on behalf of the Institute the past two years is deeply appreciated.

Interest in the technical sessions at the annual meeting was excellent. A tribute is due Roy G. Cardwell and his technical program committee for an excellent job in making arrangements for the sessions. The quality of the papers presented at the meeting was quite good.

1974-1975 INMM OFFICERS—Armand R. Soucy (second from left), Yankee Atomic Electric Co., Westboro, Mass., is the new Chairman of INMM succeeding Harley L. Toy (not pictured), Battelle Memorial Institute, Columbus, Ohio. Newly-elected Vice Chairman is Roy G. Cardwell, Oak Ridge, Tenn., who has been Technical Program Chairman. Treasurer Ralph J. Jones (left), USAEC, Washington, D.C., and Secretary V. J. (Vince) DeVito (second from right), Goodyear Atomic Corp., Piketon, Ohio, were re-elected to their offices.

Ann Savolainen, director of nuclear standards of the American National Standards Institute, New York, N.Y., was a special guest of the Institute during the annual meeting June 19-21.



Armand R. Soucy, Assistant Treasurer, Yankee Atomic Electric Co., Westboro, Mass., the new Chairman of the Institute of Nuclear Materials Management, was interviewed by an Atlanta TV newsman during the annual meeting.

BOOK REVIEW

Mr. Lovett

NUCLEAR MATERIALS, ACCOUNTABILITY MANAGEMENT SAFEGUARDS

"Nuclear Materials, Accountability Management Safeguards" is a new book written by James E. Lovett, Vienna, Austria. With the International Atomic Energy Agency, Mr. Lovett is a past chairman of the Institute of Nuclear Materials Management.

This long-awaited presentation of the philosophy and practices of nuclear materials control in a compact, easily readable form offers both basic information and "reasons why." Examples of good and bad materials control are drawn from the author's observations over more than 20 years at facilities throughout the U.S. nuclear community.

The philosophy developed in the nuclear field and organized by the author stresses "control commensurate with dollar and strategic value of material."

This book will help a reader in designing an optimum system for a specific management situation. All who need to be concerned, directly or indirectly, with the control of nuclear materials—users, handlers, persons who arrange for handling, those in management and various associated organizational functions—will benefit from this compact but comprehensive treatise.

The book should serve as a most useful guide and reference source—in the field where the work goes on and in the manager's office where plans and decisions are authorized. Around this text instruction courses can be structured for training the technical personnel to meet growing mapower demands.

The book focuses on the closed material balance, discussing concepts as well as existing systems. The volume is organized to cover Part I: History and Philosophy; Part II: Classical Accountability; Part III: Nuclear Materials Management; and Part IV: Nuclear Materials Safeguards. Numerous forms and records required or commonly used for control and accountability are reproduced among the over 45 illustrations in the 310-page volume.

Order from the American Nuclear Society, 244-A East Ogden Avenue, Hinsdale, IL 60521. Price: $27.90

RESOLUTION ADOPTED ON NUCLEAR MATERIALS IN MIDDLE EAST

The Institute of Nuclear Materials Management, at its 15th Annual Meeting in Atlanta during June 19-21, adopted a resolution urging President Nixon and the USAEC to ensure the application of adequate protection and control (safeguards) to the nuclear materials which will be provided to Middle Eastern nations. Further, the resolution offers the services of members to the Institute, acting in the public interest, to evaluate the adequacy of the safeguards provisions and regulations applied to such nuclear materials.

The resolution was transmitted by telegram to President Richard Nixon, Secretary of State Henry Kissinger, Joint Committee Chairman Melvin Price, and AEC Chairman Dixie Lee Ray.

RESOLUTION

Whereas President Nixon has offered to provide nuclear materials to Middle Eastern nations; and

Whereas public controversy is developing over the adequacy of the control and protection (safeguards) to be applied to the nuclear materials which will be provided; and

Whereas the Institute of Nuclear Materials Management (INMM) is an organization of persons working in government, industry, and academic institutions who are dedicated to the advancement of nuclear materials management as a profession;

Therefore, be it resolved that INMM urges that all such nuclear materials be placed under adequate nuclear material protection and control (safeguards); in the public interest, the Executive Committee of INMM offers the services of the members of the Institute in evaluating the adequacy of controls and protection (safeguards) to be applied to any such nuclear materials.

Signed:
Harley L. Toy, Chairman

Signed:
Armand R. Soucy, Vice Chairman

June 27, 1974

Mr. Roger Newburger
Nucleonics Week
1221 Avenue of the Americas
New York, New York 10020

Dear Mr. Newburger:

The Institute of Nuclear Materials Management, at its 15th Annual Meeting in Atlanta last week, adopted a resolution regarding the control and protection of nuclear materials to be supplied to certain Middle Eastern nations.

I have enclosed a news release on this subject and a copy of the actual resolution. We shall appreciate any coverage you may give us.

Sincerely,

Larry F. Dale, Chairman
INMM Public Relations Committee

June 28, 1974

Mr. Harley L. Toy, Chairman
Mr. Armand R. Soucy, Vice-Chairman
Institute of Nuclear Materials
Management
Columbus Laboratories

Gentlemen:

The Atomic Energy Commission has received your June 24 telegram, indicating that the INMM adopted a resolution that all nuclear materials be placed under adequate nuclear material protection and control (safeguards), and further indicating that in the public interest the Executive Committee of INMM offers the services of the members of the Institute in evaluating the adequacy of controls and protection (safeguards) to be applied to any such nuclear materials.

The AEC fully agrees with the sense of the resolution to the effect that all nuclear materials must be placed under adequate nuclear materials protection and control and I am confident that the current activities of the Commission organizations bearing responsibilities in this area are carrying out this objective expeditiously and effectively.

We deeply appreciate the offer of the services of the members of the INMM in evaluating the adequacy of controls and protection. Members of the Institute may be called upon to assist us in our continuing evaluation responsibility from time to time as we deem appropriate.

Sincerely,
Paul F. Gaughran, Acting Director
Division of Safeguards and Security
U.S. Atomic Energy Commission

(Continued inside back cover)

GENERAL ATOMIC POLICY STATEMENT

Editor's Note: The following is a statement from Gulf Atomic Company. The statement does not necessarily represent the INMM positions on issues addressed to. Comments and reactions are welcomed from readers.

The General Atomic Company believes that foreign and domestic commerce in nuclear materials and equipment cannot proceed without trust among the trading partners, and that this trust requires a system of international law and safeguards to assure that nuclear materials and equipment are used for peaceful purposes only.

The safeguarding of nuclear materials and the equipment which can produce nuclear materials is essential because some ten to twenty pounds of certain nuclear fuels—plutonium, Uranium-235, Uranium-233—if not diluted isotopically, constitute adequate fuel for a nuclear explosive device. These materials may also be diluted chemically, be made to contain radioactive contaminants, or be mechanically or physically encased so as to make it more difficult to seize and use them illicitly.

The fuel cycles for all nuclear power reactors involve production or use of these materials and commercialization of all major fuel cycles is necessary for meeting world-wide energy demands.

- Light water reactors, heavy water reactors and natural uranium reactors all produce plutonium. This fuel can be used in these reactors improving their economics substantially or reserved for fast breeder reactors.
- Fully enriched uranium (used in the High Temperature Gas-cooled Reactors that General Atomic manufactures) permits the efficient burning of thorium in nuclear power plants, which during operation transmute the thorium into Uranium-233. The availability of thorium to the power economy increases the world's nuclear fuel resource base by at least a factor of two and possibly by as much as a factor of four.
- The fast breeder reactors will increase our ability to burn uranium and thorium by a factor of thirty to forty.

The availability of commercial nuclear power on a world-wide basis carries with it the certainty of transporting, storing, and fabricating large quantities of plutonium, Uranium-235 and Uranium-233.

General Atomic Company believes that while there are specific points of difference in safeguarding the several nuclear fuel cycles, the inherent risks for each are essentially equivalent and the means of maintaining accountability and security protection are essentially identical.

Atomic energy legislation in the United States carefully prescribes the conditions that must be satisfied for nuclear materials and equipment of U.S. origin to flow in international commerce. The government of a recipient country must provide guarantees to the United States Government under an appropriate executive Agreement for Cooperation that none of the materials or equipment supplied from U.S. sources will be used for atomic weapons or for any other military purpose.

Moreover, to assure compliance with these sovereign guarantees the United States has insisted on the exercise of internationally administered safeguards including the rights of inspection and independent verification of materials quantities, locations and uses. The rights pertain not only to special nuclear materials of U.S. origin but also to all special nuclear material subsequently generated from material initally transferred from the United States.

The United States has taken the lead since 1953 in establishing a framework of international law for developing the peaceful commercial uses of nuclear energy. Today, the United Kingdom, the Federal Republic of Germany, France, Canada, and the Soviet Union all manufacture and sell nuclear fuel and power reactors in international commerce, and each of these countries generally subjects its sales to the established framework of international law. The United States has been the dominant force in the international market, however, and the nuclear business promises to make an increasingly important positive contribution to the United States Balance of Payments.

At the present time large quantities of plutonium, Uranium-235, and Uranium-233 are not in commerce. Light water reactors use low enriched uranium as their initial fuel and no large High Temperature Gas-cooled Reactors have yet been sold abroad. By the end of this decade, however, the light water reactors both here and abroad that are just now or will shortly be coming into operation will be producing tens of tons of plutonium annually. The quantities of highly enriched Uranium-235 and Uranium-233 will not approach this level until the middle of the eighties.

Thus, the need to establish an adequate regime of safeguards for plutonium in international commerce will come about first. This experience can be transferred directly to the problem of adequately safeguarding Uranium-235 and Uranium-233.

The fuel cycles for all nuclear power reactors involve key points where these special nuclear materials are concentrated.

- The most serious safeguards problems with respect to plutonium arise after the plutonium is recovered from irradiated fuel elements in a chemical reprocessing plant, while it is in storage at such a facility or in shipment to a plutonium fuel fabrication facility and until it is reinserted into a power reactor.
- The parallel risk points for Uranium-235 are from the time the material is withdrawn from the enrichment plant, while it is in shipment, and after receipt at the fuel fabrication facility, until it is combined with dilutents for incorporation into fuel blocks for shipment to a reactor. At this point the U-235 is physically dispersed and chemically diluted to the point that on the order of a ton of fuel is required to yield a critical mass of U-235.
- Uranium-233, as a reactor produced material, presents safeguards problems quite comparable to plutonium except that with the buildup of radioactive daughter products, the Uranium-233 becomes a radiation source that can have serious near term effects on anyone who tries to handle it without shielding. The daughter product irradiation arises from Uranium-232 which cannot be chemically separated from Uranium-233.

The most vulnerable of all segments of the fuel cycle are those which involve the transportation of concentrated plutonium oxide and fully enriched uranium hexafluoride.

Because of the development in the last decade of the terrorist threat, growing concern by safeguards theorists has been expressed not so much that governments might seek to divert special nuclear material covertly from peaceful programs to be used for military purposes, but rather that squad-sized or larger groups acting overtly might try to steal special nuclear material for purposes of threatening established governments with some form of nuclear blackmail.

This threat has grown sharply in the past decade as witnessed by acts of terrorism in Europe, South America, and the United States. It does not appear to be a major problem yet in the Communist bloc countries.

The premise of safeguards policy, strongly reflected in U.S. atomic energy legislation, is that the possession of an adequate quantity of weapons material should be considered equivalent to the possession of a weapon itself. Therefore, General Atomic Company believes shipment of concentrated forms of plutonium, Uranium-235 and Uranium-233 should be given the same level of protection as if the material were one or more nuclear weapons.

Custodial protection for shipments of concentrated forms of plutonium, Uranium-235, and Uranium-233 should, in the considered judgment of the General Atomic Company, be the responsibility of a Federal Protective Service. There are questions of law as to whether and when privately employed guards might be entitled to use firearms to protect against a perceived real or illusory threat to property, in this case special nuclear material, with or without a clearly defined threat to life. They are essentially the same as those underlying any private law enforcement, made more acute and difficult by the nature of special nuclear material. The effect of this uncertainty should be focused where it belongs—in government—by a Federal Protective Service. Moreover, such a Service could make use of highly sophisticated national security communications equipment, call upon local, state and national security back-up forces and maintain intimate liaison with the national intelligence agencies whose daily duty it is to monitor potential threats.

When special nuclear materials are diluted isotopically, chemically, or otherwise, less stringent safeguards measures will be adequate to provide the required high degree of protection. Seizing a sufficient quantity of finished HTGR fuel blocks, moving them to a clandestine facility, breaking them up and chemically recovering sufficient U-235 to manufacture a weapon is a substantially lower order threat and probably can be adequately met by having a secure vehicle or convoy in constant communication with the Federal Protection Service.

Cost of maintaining a Federal Protective Service should be borne by the taxpayer as a special type of policing arrangement which the national security interest requires. The security needed is clearly in excess of that required to protect the property interests of the owner of the material and, in fact, is directed at protecting the security interests of the body politic. An alternative arrangement would be to require the nuclear utility industry to pay the cost of the Federal Protective Service through an added assessment on the rate payer. In addition to fuzzing the national security interests at issue, such an arrangement is virtually equivalent to an excise tax and would be somewhat more regressive than funding the Service out of the general revenue.

The General Atomic Company believes that the United States Government should encourage cooperating governments to form similar national protective services so that international shipments of special nuclear material can be safeguarded with a very high degree of confidence on the basis of governmental involvement and responsibility.

While transportation presents the most serious safeguards vulnerability in the fuel cycle, the holding of large stocks of special nuclear material at chemical reprocessing plants or fuel fabrication plants in excess of what is required for reasonable inventory should not be permitted. General Atomic Company recommends that Federal Special Nuclear Material Storage Facilities be available for use so that private industry is not given the burden of storing quantities of special nuclear material in excess of what is required for reasonable working inventory.

The General Atomic Company believes that in the coming years completely adequate safeguards can be developed to give industry, the market, and the public at large full confidence that nuclear materials can be safeguarded against the threat of covert or overt diversion to illicit uses.

The importance of atomic energy to a world hungry for fuels is too great to be unreasonably restricted. We would, therefore, strongly oppose any proposed policy which would have the effect of preventing the shipment of plutonium, Uranium-235 and Uranium-233 on safeguards grounds. If the United States were to so restrict itself, it is virtually certain that other nations would not do so. We would, therefore, urge a consistent policy of international leadership by the United States to develop the framework for the full commercial utilization of nuclear energy, to retain the commercial advantage which the United States enjoys and to assure that the evolution of international law covering commercial transactions in nuclear material and equipment comports with our national security interests.

NONDESTRUCTIVE ASSAY OF PLUTONIUM AND URANIUM IN MIXED-OXIDES

BY HANS J. WEBER

INTRODUCTION

Nondestructive assay measurements were performed on mixed-oxide fuel samples with the objective of determining their Pu and U content. A total of nine mixed-oxide samples were measured, in addition to a separate set of calibration standards.

The measurements were performed with a Rad Tech Isotopic Source Assay System (ISAS), which directly counts fission events by utilizing the fact that fission is characterized by a high multiplicity of particles, 7 gammas and 2.5 neutrons, on the average, simultaneously emitted in each fission event. ISAS utilizes coincidence counting techniques for the assay of fissionable materials (Ref. 1).

SAMPLES ASSAYED

A. Mixed-Oxide "Unknowns"

The nine mixed-oxide samples were separated into three different groups of three samples each, depending on isotopic composition (see Table 1). Two sets of samples contained natural uranium: samples PPO 13, 14, and 15 with 89.5% fissile Pu, and samples PPO 17, 18, and 19 with 80.3% fissile Pu. Set PPO 20, 21, 22 contained 91.13% enriched U and 91.54% fissile Pu.

B. Calibration Standards

Both uranium samples (Table 2) and plutonium samples (Table 3) were available as calibration standards. They were selected on the basis of the criteria that they should be as similar as possible to the mixed-oxide unknowns in isotopic composition for Pu and uranium enrichment, should approximately bracket the unknowns in mass, and should be of the same physical type in the same matrix.

The Pu-isotopic composition of the mixed-oxide unknowns containing 80.3% fissile Pu was well represented by three calibration standards with identical isotopic composition. Only one standard, with 91.4% fissile Pu, was available for the remaining unknowns. The U standards, both natural and 93% enriched, matched the enrichment properties of the unknowns. All categories, except the one containing high-enriched U, had one or more calibration samples whose mass exceeded that of the unknowns. The match between physical properties was not as good; whereas the mixed-oxide unknowns were all in pellet form, of the calibration standards, only those containing natural U were pellets—the remainder were all powder.

DATA ACQUISITION AND REDUCTION

All samples were measured actively with the interrogating neutron beam from the ^{252}Cf source. In addition, all samples containing Pu and appreciable amounts of ^{238}U were measured passively, that is, without being irradiated by the interrogating source. Also, all measurements were performed with a 0.25-inch-thick B_4C shield surrounding the sample. The shield provided a hardened, more highly penetrating interrogating beam, which considerably reduced self-shielding effects. A comparison between the active response to fissile Pu with the shield (Figure 2), and without it (Figure 3), illustrates its effectiveness. With the shield the response was linear over its measured range (up to 372-g ^{239}Pu); without it the linear region extended to 200-g ^{239}Pu.

The measured data were reduced to give the average (usually over two runs) net active and average net passive counts for every sample by subtracting all ambient background, and the passive yield from the total active yield. They were subsequently normalized to the yield from a standard that was measured at about two-hour intervals throughout the day to account for any gain changes that might have occurred in the system. Such changes were indeed observed as a function of temperature, which varied by up to 30^{o} on two hot days in the non-airconditioned room. The normalized net active and passive counts, along with their respective absolute statistical uncertainties, are given in Table 4 for all samples. The brackets in Table 4 designate those cases in which Pu and a sample containing enriched or natural U were measured simultaneously to establish the response of the system to U in the presence of Pu.

RESULTS

A. Calibrated Detector Response

Figure 1 shows the results of the passive measurements performed on all four Pu calibration standards. The passive detector response to ^{240}Pu is shown to be independent of isotopic composition. Furthermore, it was unaffected when Pu and U standards were measured simultaneously. This is demonstrated in Table 5 in which the results of the measurements on the combined Pu plus U calibration standards are tabulated. The ^{240}Pu content was established on the basis of the passive calibration results shown in Figure 1. The Pu content was derived from the ^{240}Pu results utilizing the nominal isotopic ratios provided by the manufacturer. The agreement between the measured Pu content and the manufacturer's records is within the 5% associated as a statistical uncertainty with each measurement, even though the amount of U present varies considerably from 6.4 to 470.4 g. These results indicate that the passive response to ^{240}Pu is esentially unaffected by the presence of U for the range of samples measured. However, there is a multiplication effect for more than about 80-g

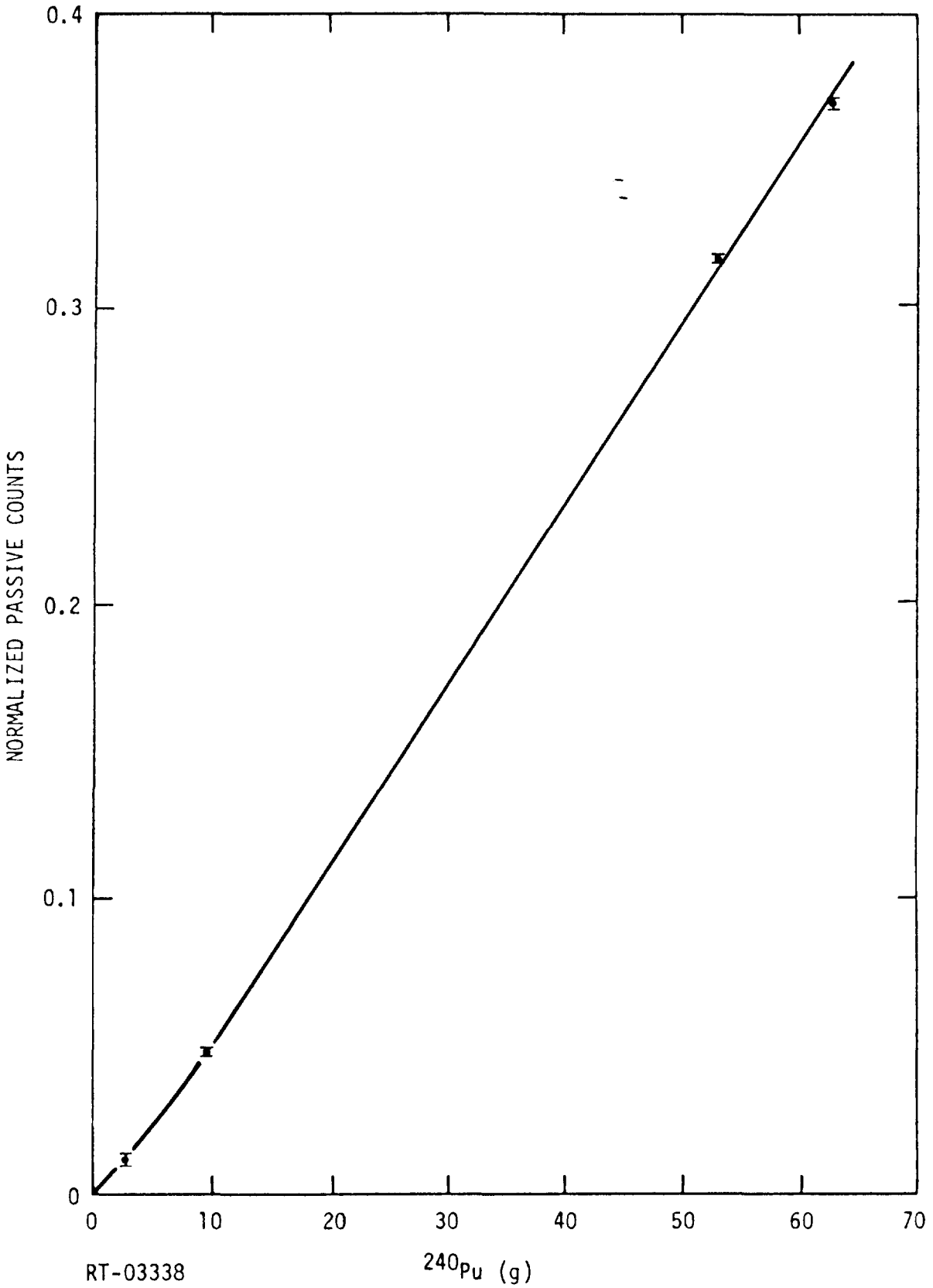


Figure 1. Passive response to plutonium

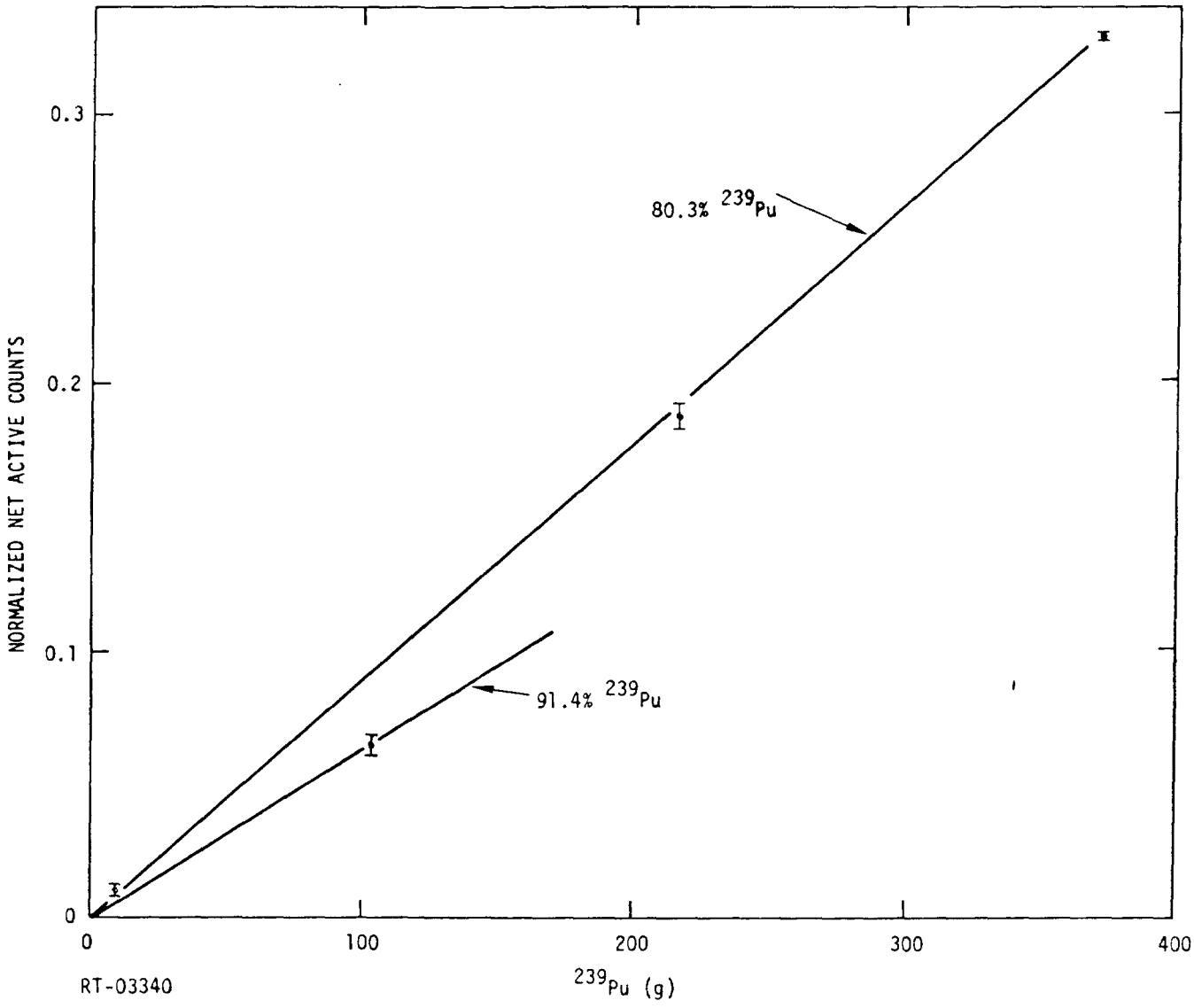


Figure 2. Active response to plutonium with B_4C

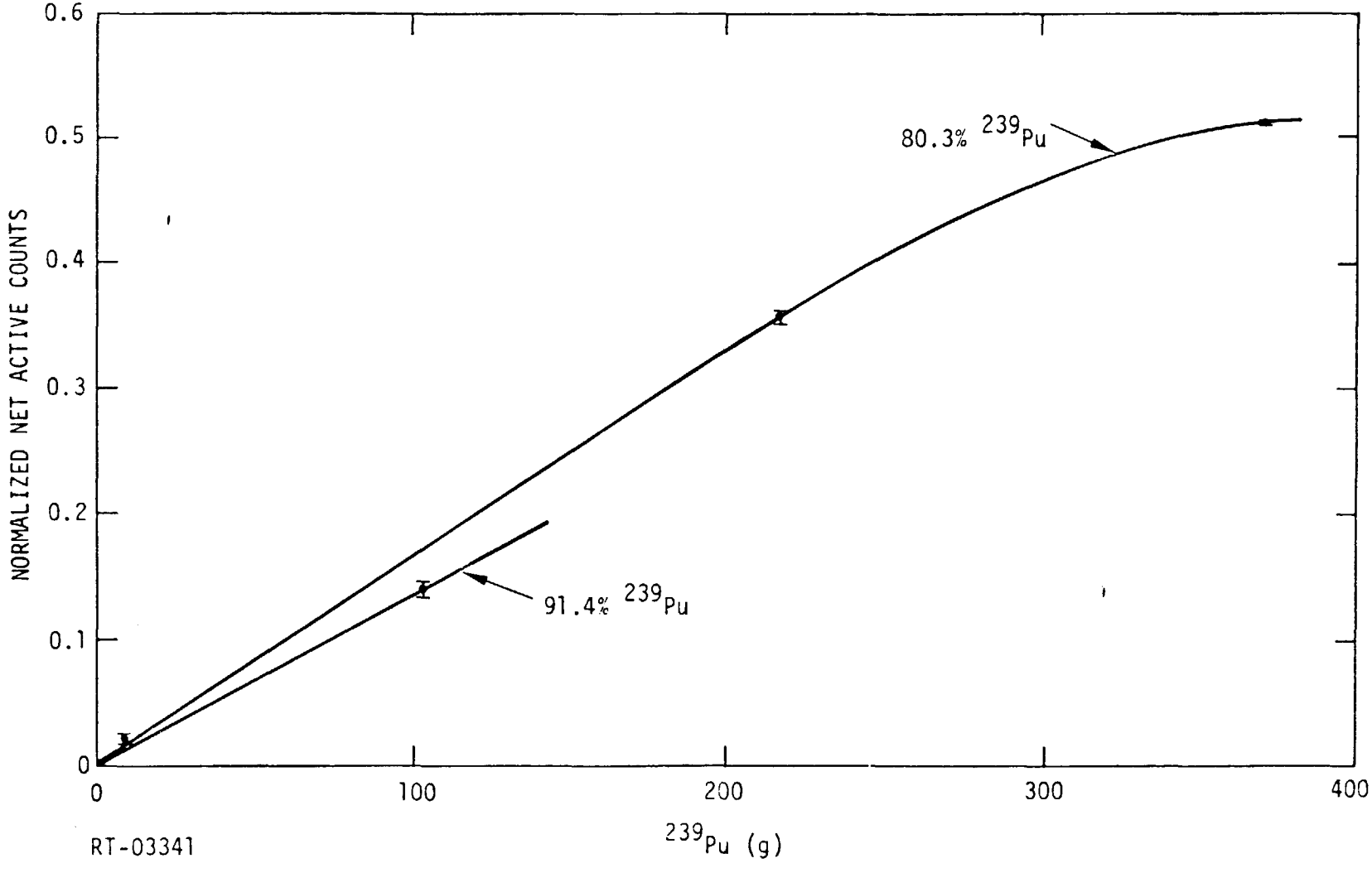


Figure 3. Active response to plutonium without B_4C

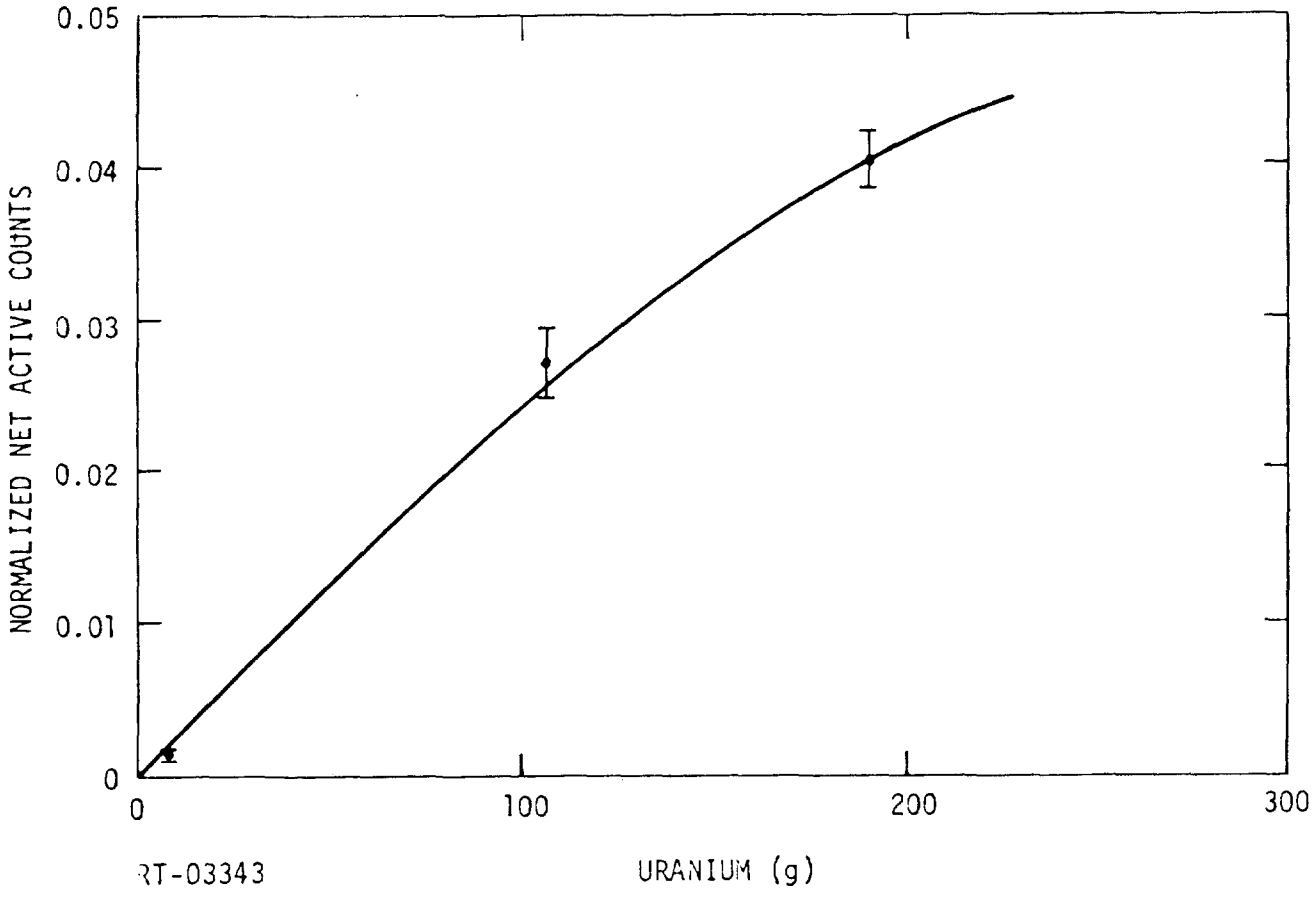


Figure 4. Active response to 93% enriched uranium

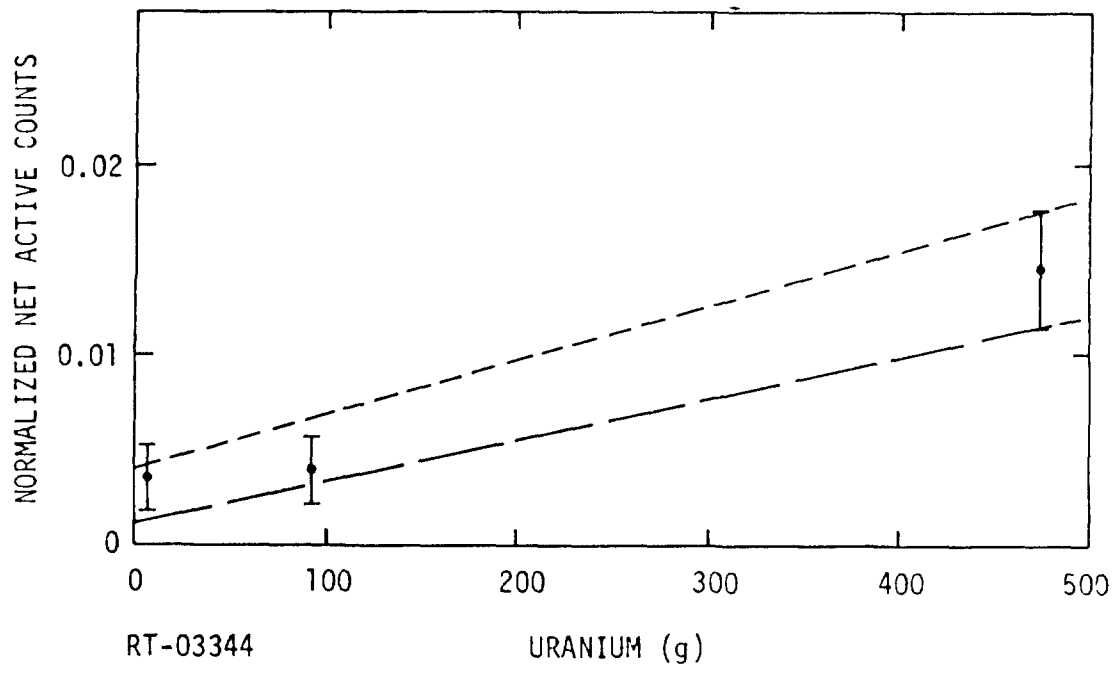


Figure 5. Active response to natural uranium

Table 1

MIXED-OXIDE SAMPLES

Sample		Net Weight (g)	Pu (g)	U (g)	Fissile Pu (g)	Fissile U (g)	^{240}Pu (g)	^{238}U (g)
PP014	M0078	50.62	4.09	40.55	3.66	0.30	0.43	40.25
PP015	M0078	101.85	8.23	81.58	7.36	0.60	0.87	80.98
PP013	M0081	504.99	24.46	420.84	21.88	3.11	2.58	417.73
PP017	M0089	50.22	1.12	43.14	0.90	0.32	0.22	42.82
PP018	M0089	100.18	2.24	86.07	1.80	0.64	0.44	85.43
PP019	M0089	500.88	11.21	430.31	9.00	3.18	2.21	427.13
PP020[a]	B0548	50.90	11.09	33.79	10.15	30.79	0.94	3.00
PP021[a]	B0548	101.20	22.06	67.18	20.19	61.22	1.87	5.96
PP022[a]	B0548	500.80	109.15	332.46	99.91	302.97	9.28	29.49

[a]Contain enriched U

^{240}Pu which is not shown in Figures 1 and 2 because none of the measured samples contained that large an amount of ^{240}Pu. Figures 2 and 3 display the results of the active measurements of the Pu standards; here, self-shielding effects are obvious. Figures 4 and 5 relate to the active yield from enriched and natural uranium, respectively. The results are based on measurements in which Pu and U standards were measured side by side, simultaneously. The passive response from ^{238}U is included in the total active response to natural U.

B. Mixed-Oxide Samples

The calibration results were utilized to analyze the "unknown sample" measurements for their Pu and U content. If the isotopic composition and enrichment is known, the passive measurement determines the Pu content. Subsequently, the total active yield of the unknown sample is reduced by the active yield due to Pu as determined from the appropriate active calibration curve. Finally, the U content is read off the appropriate calibration curve; the results are summarized in Table 6. PPO 20 and 21 show good agreement, with the nominal values for both Pu and U well within statistics. In the case of PPO 22 the Pu content agrees well, but the amount of U was underestimated because no calibration point was available above 190-g U.

For the remaining samples the Pu content is still predicted roughly within statistics, except for PPO 19 and 13, which both contained large amounts of natural U. It is somewhat difficult to speculate on the reasons for this discrepancy; perhaps self-shielding effects might be responsible. Also the fact that the unknowns were true Pu-U mixtures, whereas the standards kept the two materials separated, make the calibration curves less applicable. In any case, a more detailed set of calibration measurements of Pu-U mixtures in pellet form should account for these effects.

The amounts of natural U in the measured amples were predicted with considerable uncertainty, as indicated in Table 6. As the calibration curve for natural U in Figure 5 shows, the sensitivity of the system is so low that considerable effort would have to be expended to establish a more accurate calibration. Even then, self-shielding would still make it impossible to measure even large quantities of natural U (400 g or more) with good accuracy. In the case of mixed oxides containing natural U, it might be better to passively measure the Pu content and determine the amount of natural U on the basis of sample weight.

CONCLUSIONS

In conclusion, a separation of the Pu and U contents in mixed-oxide fuel samples was achieved. In most cases, the Pu content was determined within statistical uncertainties with passive measurements. Uranium was measured with similar precision for the samples containing highly enriched U. The few discrepancies between assayed results and manufacturer's records are attributable to the fact that the available set of standards was somewhat deficient in its representation of the isotopic composition and physical properties of the unknowns. Natural U in the presence of Pu was measured with poor accuracy due to the fact that the yield per gram from 90% enriched Pu was about 300 times greater than that from natural U. It is better determined on a weight basis after the Pu content is passively measured.

ACKNOWLEDGMENTS

The measurements described above were performed at the Vallecitos Nuclear Center of the General Electric Company. The author wishes to express his gratitude to General Electric for providing use of their facilities during the measurements, and to Mr. D. M. Bishop for providing the samples.

LITERATURE CITED

1. T. Gozani and D. G. Costello, "Isotopic Source Assay System for Nuclear Materials," ANS Trans. **13**, 746 (1970).

Table 2

URANIUM CALIBRATION SAMPLES

Sample		Net Weight (g)	U (g)	Fissile (g)	^{238}U (g)	Fissile (%)
E0110	00M3	123.40	107.97	100.57	7.4	93.15
E0110	03E8	7.3	6.43	5.99	0.44	93.15
E0157	03N9	203.00	172.06	160.26	11.80	93.15
E0157	03MF	225.00	190.71	177.65	13.06	93.15
U034	01WO	105.97	93.36	0.65	92.71	0.7
U051	01WY	533.97	470.43	3.34	467.09	0.7
U060	01WX	7.55	6.65	0.05	6.60	0.7

Table 3

PLUTONIUM CALIBRATION SAMPLES

Sample	Net Weight (g)	Pu (g)	Fissile (g)	^{240}Pu (g)	Fissile (%)
A0135 0079	13.50	11.60	9.31	2.29	80.3
A0135 007D	313.79	269.55	216.45	53.10	80.3
A0141 00NY	541.40	463.62	372.33	91.29	80.3
A0132 02QL	129.80	113.83	104.07	9.76	91.4

Table 4

NORMALIZED NET COUNTS

Sample	Normalized Net Active Counts	± Δ	Normalized Passive Counts	± Δ
A0141 00NY	0.3278	0.0033	0.5948	0.0044
A0135 007D	0.1859	0.0054	0.3161	0.0023
A0135 079	0.01018	0.0018	0.01249	0.0055
A0132 2QL	0.06506	0.0025	0.04826	0.0009
A0135 79 / U051 01WY	0.02263	0.0017	0.01056	0.0005
A0135 79 / U034 01WO	0.01204	0.00168	0.01126	0.0005
A0135 79 / U060 01WX	0.01314	0.00168	0.01117	0.0005
A0135 07D / U060 01WX	0.1702	0.0036	0.3029	0.0020
A0135 07D / U034 01WO	0.1908	0.0036	0.2955	0.0020
A0132 02QL / U034 01WO	0.06540	0.00210	0.04458	0.0008
A0132 02QL / E0157 3MF	0.1053	0.0022	0.04598	0.0008
A0135 079 / E0110 3E8	0.01272	0.00168	0.01164	0.0005
A0132 2QL / E0110 3E8	0.07056	0.0021	0.04537	0.00084
PP014 M0078	0.00797	0.00164	0.00198	0.00038
PP015 M0078	0.01415	0.00166	0.00386	0.00039
PP013 M0081	0.02585	0.00170	0.00865	0.00047
PP017 M0089	0.00319	0.00154	0.00134	0.00034
PP018 M0089	0.00704	0.00154	0.00173	0.00035
PP019 M0089	0.01428	0.00162	0.00744	0.00045
PP020 B0548	0.01235	0.00169	0.00462	0.00043
PP021 B0548	0.02820	0.00179	0.00871	0.00049
PP022 B0548	0.1053	0.00230	0.04737	0.00087

Table 5

RESULTS OF CALIBRATION MEASUREMENTS OF SAMPLES CONTAINING Pu AND U

Sample	^{240}Pu (g)	Pu (g)	Pu Ratio[a]	U (g)
A0132 2QL U034 01WO	9.5	110.7	0.95	93.36
A0132 2QL E0157 3MF	9.7	112.8	0.99	190.71
A0132 2QL E0110 3E8	9.6	111.6	0.98	6.43
A0135 079 U051 01WY	2.3	11.6	1.0	470.43
A0135 079 U060 01WX	2.4	12.2	1.05	6.65
A0135 079 U034 01WO	2.3	11.6	1.0	93.36
A0135 07D U034 01WO	52.3	265.5	0.98	6.65
A0135 07D U034 01WO	52.2	265.0	0.98	93.36

[a]ISAS/mfg. records

Table 6

RESULTS OF ISAS MEASUREMENTS

Sample	^{239}Pu (g)	Pu (g)	±Δ (%) Statistical Uncertainty	U (g)	±Δ (%) Statistical Uncertainty	Pu Ratio[b]	U Ratio[b]
PP020[a]	9.7	10.6	5	34.5	21	0.96	1.02
PP021[a]	19.5	21.3	4	66.0	19	0.96	0.98
PP022[a]	100.5	109.8	3	215.0	15	1.01	0.65
PP017	1.2	1.5	7	0-48		1.07	0-1.11
PP018	1.8	2.3	7	12-153		1.03	0.14-1.78
PP019	6.5	8.6	6	148-322		0.77	0.34-0.75
PP014	3.8	4.3	7	30-176		1.05	0.74-4.34
PP015	6.8	7.6	6	143-317		0.92	1.75-3.89
PP013	16.1	18.9	5	310-524		0.79	0.74-1.25

[a]Contains enriched U

[b]ISAS/mfg. records

The Westinghouse Electric Corporation contingent at the 15th annual INMM meeting June 19-21 in Atlanta, Georgia, included (left to right) Ronald E. Tschiegg, Eugene J. Miles, Harold Foster, D. J. Haymon. Mr. Tschiegg is the author of the article below, "A Computerized Records and Reports System." Mr. Miles is the author of "The Invisible Man(agers)," also included in this issue of NUCLEAR MATERIALS MANAGEMENT, Journal of the INMM.

A COMPUTERIZED RECORDS AND REPORTS SYSTEM

By R. E. Tschiegg, Manager
Nuclear Materials Management & Safeguards
Westinghouse Electric Corporation
Nuclear Energy Systems

At Westinghouse, the Nuclear Materials Management & Safeguards Group is the central recording and reporting location for all source and special nuclear materials transactions occurring within the Corporation's vast Nuclear Energy Systems organization.

Currently, the following site locations are included in the nuclear materials reporting network:

Cheswick, Pa. Nuclear Fuel Division, Plutonium Fuels Development Laboratory.

Waltz Mill, Pa. Advanced Reactors Division, Analytical Laboratories.

Forest Hills, Pa. Nuclear Fuel Division and PWR Systems Divisions, Metallurgical Laboratory and Test Engineering.

Zion, Ill. Nuclear Service Division, Westinghouse Nuclear Training Center.

Columbia, S. C. Nuclear Fuel Division, Columbia Plant.

One of the functions of the NES, Nuclear Materials Management and Safeguards group is to maintain a record of each receipt, shipment, internal transfer, intentional discard and material unaccounted for (MUF) transaction at the facilities described above. These central records are utilized to generate various reports periodically from the data processing system. The Nuclear Materials Management and Safeguards System (NMMS) was designed to meet Westinghouse mangement requirements for SNM inventory and asset control programs while automating the procedures necessary to fulfill the record-keeping and reporting requirements of the USAEC. The hardware utilized by the system is an IBM-370-55. The software consists of a series of programs, each designed to perform a specific task. A brief description of the programs follows.

EDIT

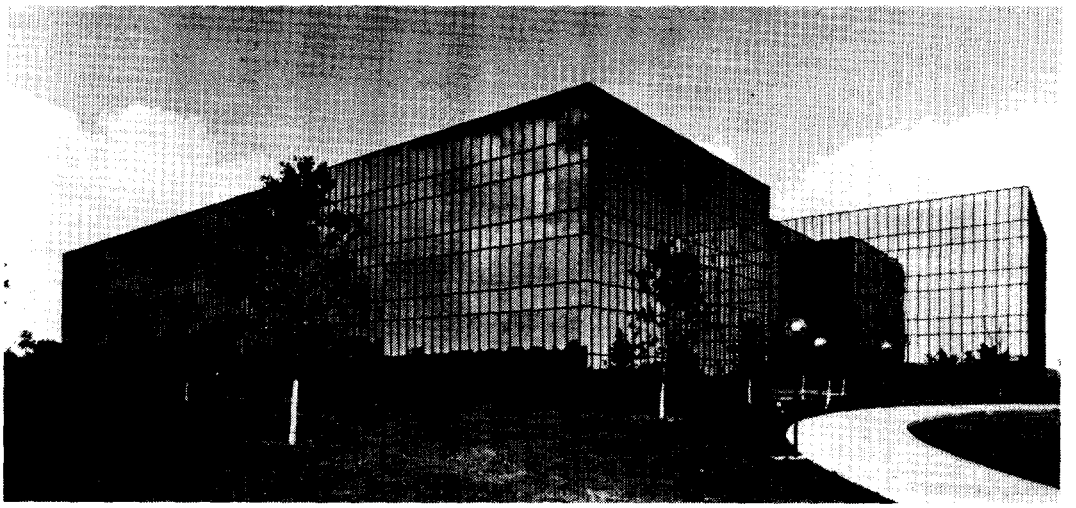
The first program is the EDIT program. Its purpose, simply, is to edit all transactions input to the system. Each data field is tested for valid entries. Punch cards containing invalid entries are rejected. Rejected entries must be corrected and re-entered. Warning messages are also generated when the data appears to questionable.

UPDATE

The next program is an update program. The purpose of the update program is to take the edited transactions and add them to a master file. In adding these records to the file, they are checked for duplication, validity of item numbers and the correction numbers associated with the transfer series. Invalid records are rejected and must be added to the master file on a subsequent edit run.

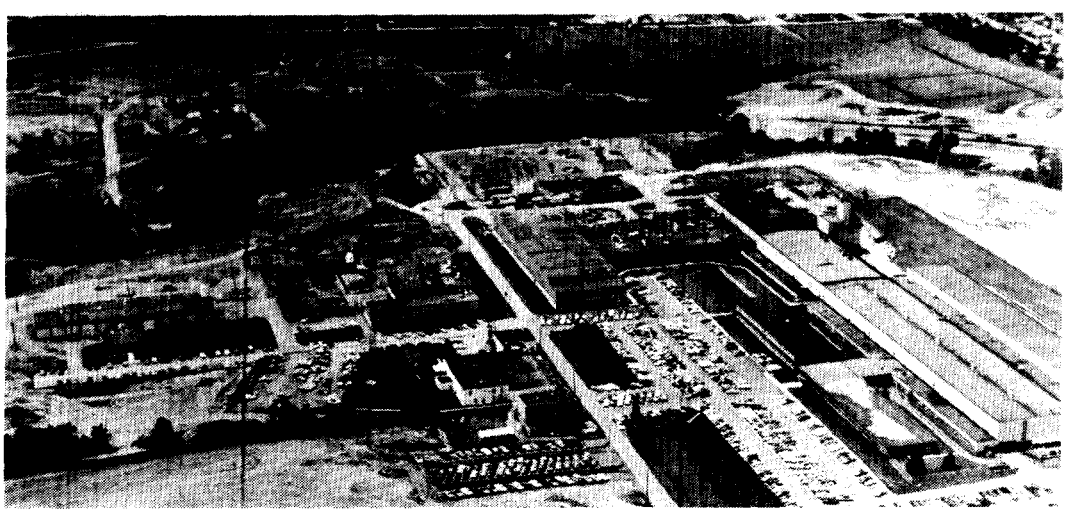
The system records the "status" of the transactions through the use of status codes. (eg. 1-3-5)

1 = current month
3 = previous month (same status period)
5 = previous status period

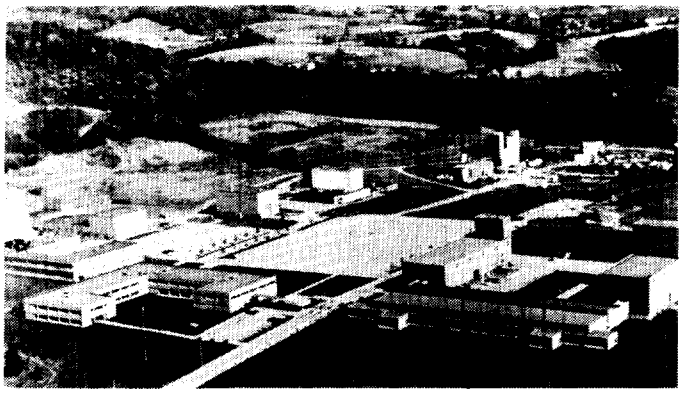


Westinghouse Electric Corporation, Nuclear Center, Monroeville, Pa.

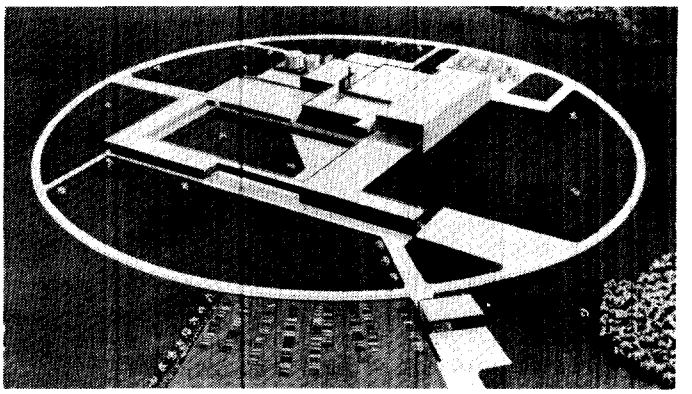
Westinghouse Nuclear Fuel Division, Manufacturing Facility, Columbia, S.C.



Westinghouse Electric Corporation, Nuclear Fuel Division, Plutonium Fuel Development Laboratory, Cheswick, Pa., (bldg. at extreme left).

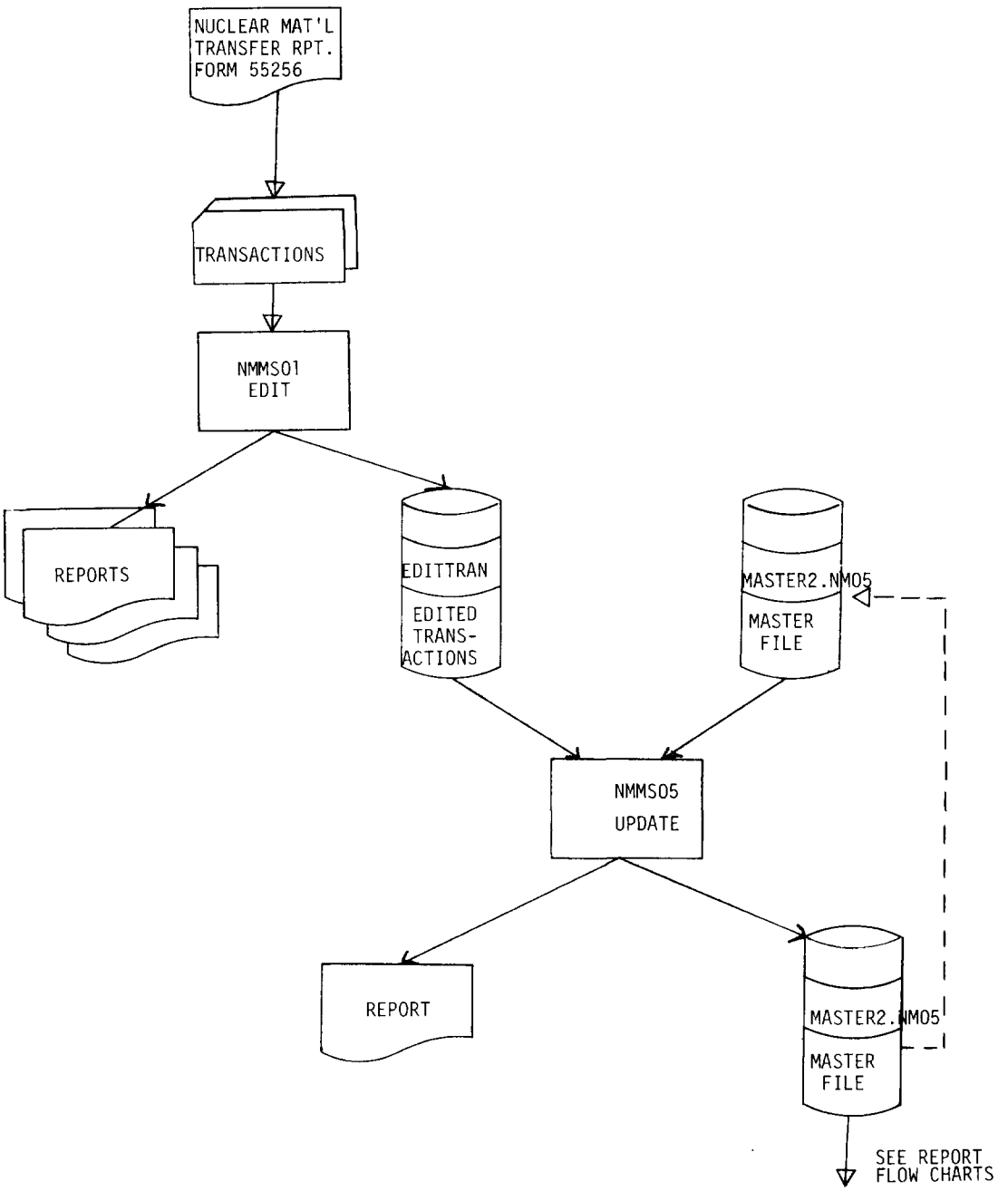


Westinghouse Advanced Reactors Division, Waltz Mill, Pa.



Westinghouse Nuclear Fuel Division, Proposed Re-cycle Fuels Plant, Anderson, S.C.

NUCLEAR MATERIALS MANAGEMENT AND SAFEGUARDS
SYSTEMS FLOW CHART



These status codes are displayed in output reports which will be described later.

PRINT

The third program is the print program. This program generates the majority of the reports needed by persons and groups inside and outside of Westinghouse. The print package provides for the selection of five (5) separate reports, by utilizing a control card. The control card is punched to select any or all of the following reports:

1. Transfer Journal
2. Material Status Report Appendix
3. Internal Transfer Report
4. Monthly Loss Report
5. Material Status Report (Form AEC-742 Format)

The control card contains three dates. These are the beginning book inventory date (monthly) and the beginning and ending status report period dates (January 1 thru June 30, 1974).

Another feature of the program is to provide for the printing of reports on a selected RIS basis. This action is also performed by making specific entries to the control card.

The print program can be run against the master file at any time, and any frequency, during the month. All reports will reflect the status of the master file as of the time of each run.

BOOK INVENTORY ROLL

The next program is a very important one—the Book Inventory Roll program. The Roll program is run after all transactions are entered for the month and all output reports are correct and printed. In this program, the detail is added to the beginning book balance for each project to obtain a Beginning Balance for the start of the next month. Also, the status codes are switched from 1 to 3 for a monthly roll and from 3 to 5 for a period roll. This, too, is determined by punching the control card in an appropriate way.

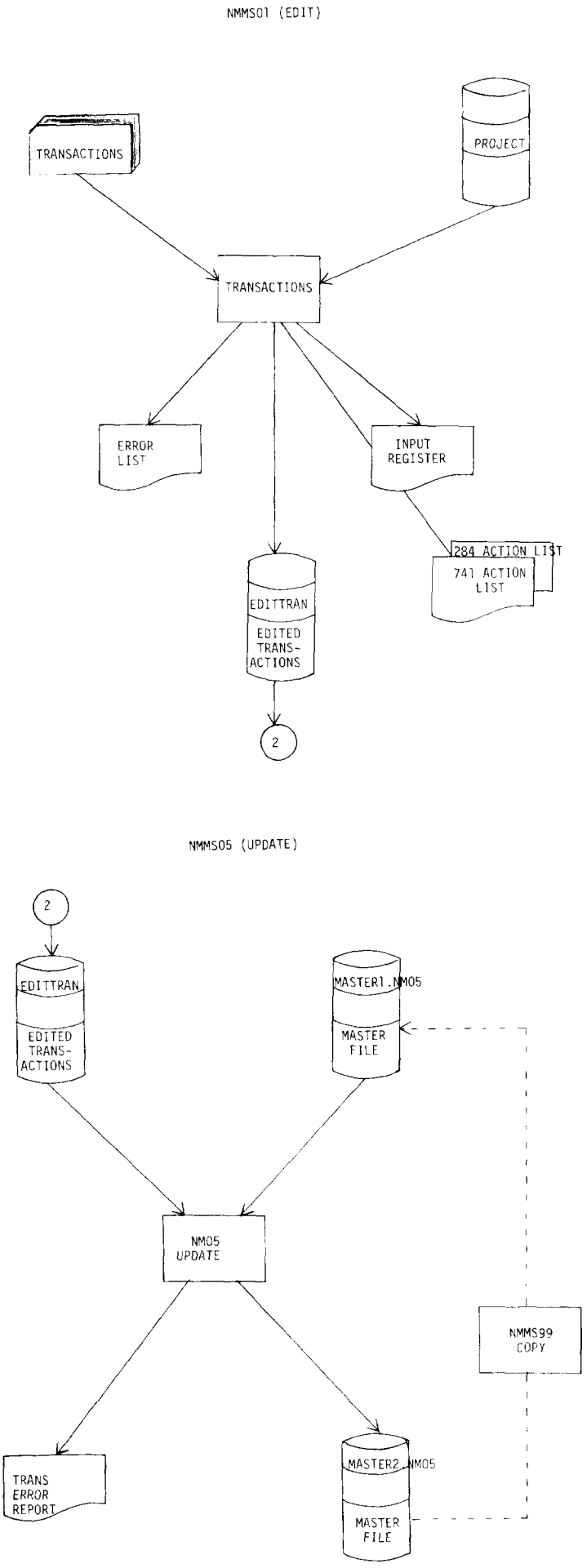
This program also prints a Masterbook Report, on a specific request basis. The Masterbook is a formatted dump of the master file listing all accumulated transactions, by project, listed on the file. If a project has been zero for six months or longer, a message is printed suggesting the movement of the inactive project to the closed, or History File.

PHYSICAL INVENTORY ROLL

A companion program to the Roll program is a Physical Inventory Roll program. The purpose of this program is to save the ending inventory totals, by project, for all RIS locations conducting physical inventories.

The program is run after a physical inventory is complete and all MUF entries posted, by project. The transactions for the physical inventory period (the period from the last inventory to the conclusion of the current inventory) are added to the previous ending inventory balances to arrive at the current ending inventory. The current inventory totals are then saved on the project header records for the RIS experiencing the inventory. A status code 1 is entered in the Physical Inventory status code field for each detail record to indicate that the record has been included in the inventory totals.

A report is generated in the same format as the Masterbook Report and lists the beginning inventory totals, each transaction that occurred during the inventory period, the MUF adjustments and the ending inventory totals, by project.



SELECTED PROJECTS

The next group of programs are the Selected Project Reports. This program gives a complete history of each transaction entered into a project from its starting point to the most recent entry, and eventually to its final entry.

The program can be run against either the master file or the history file and the report may be formatted to print the data grouped by transaction type (eg. shipments, receipts, losses, etc.) or chronologically, keying on the date field and printing the transactions in the order they actually occurred. Projects may be selected for printing on a positive request basis.

We find that these reports are the most popular of the entire system. They are especially useful to financial and project administration personnel who are auditing or resolving problems associated with a specific project and they want to see all of the data before them in one or both of the formats described above.

CLOSED PROJECTS

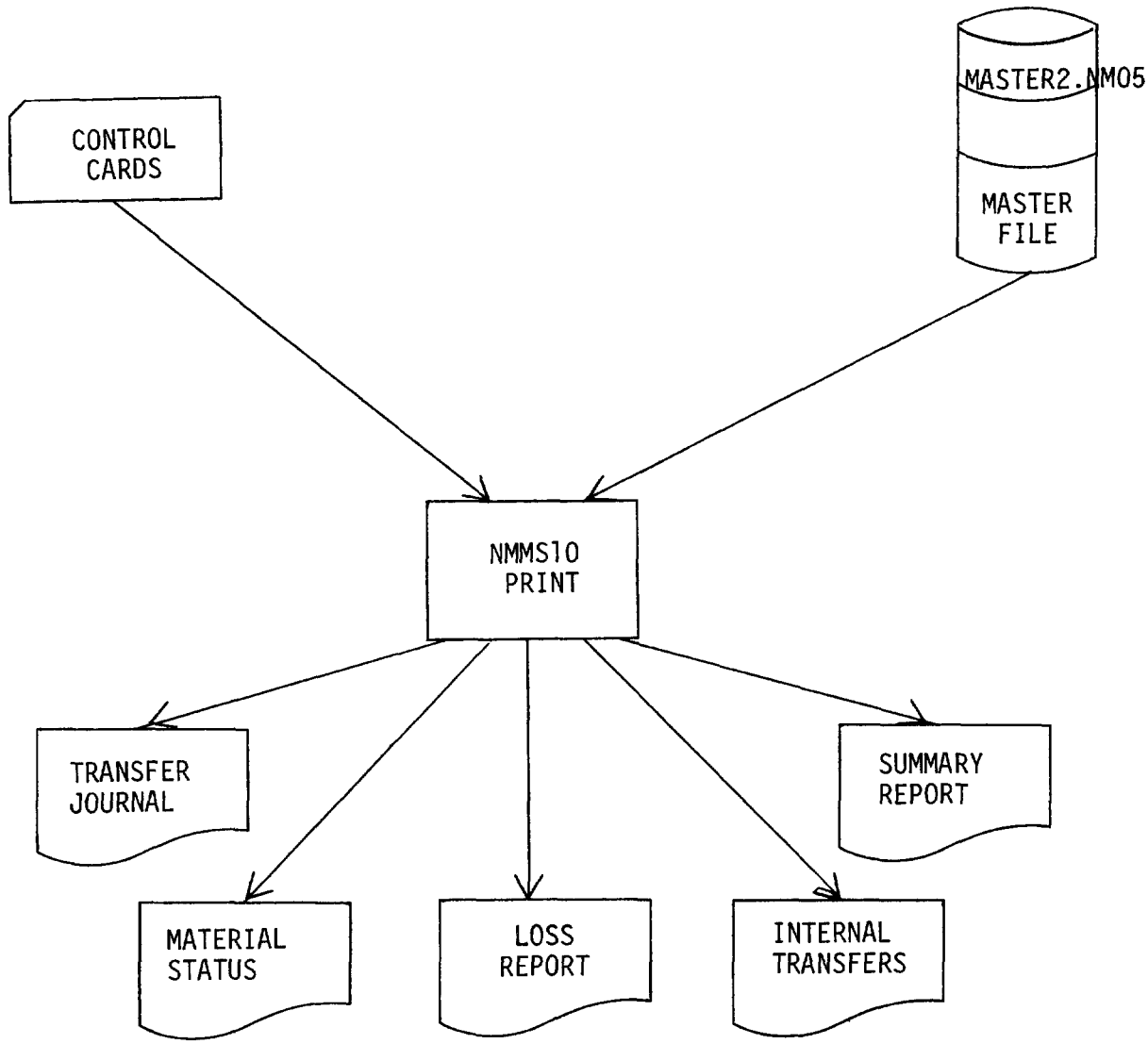
The Closed Project program is utilized to relieve the master file of extraneous historical data. The program moves projects from the current Master File and adds them to the History File. The projects to be moved are selected by means of input cards and each project must have a zero balance before it can be moved from the Master File to the History File.

The program is also utilized to recall a project from the History File to the Master File. This feature was incorporated to avoid the duplication of projects if the need to reopen a project, once it was closed, was ever encountered.

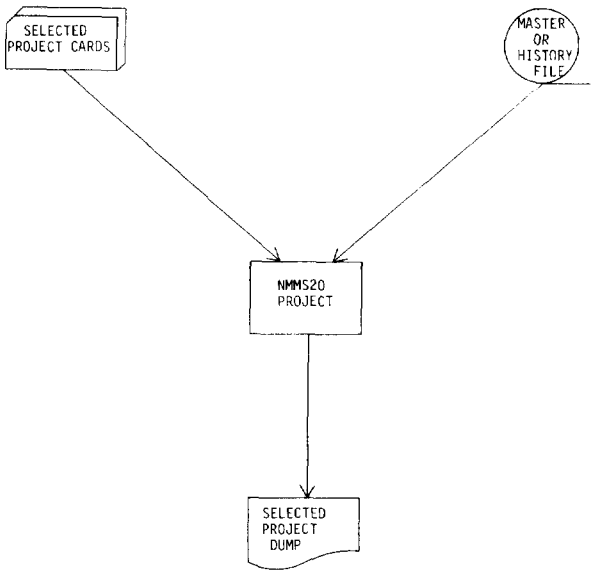
The program also produces a printing of the following:

1. Active Projects Listing
2. Project Transfer Listing
3. Closed Projects Listing.

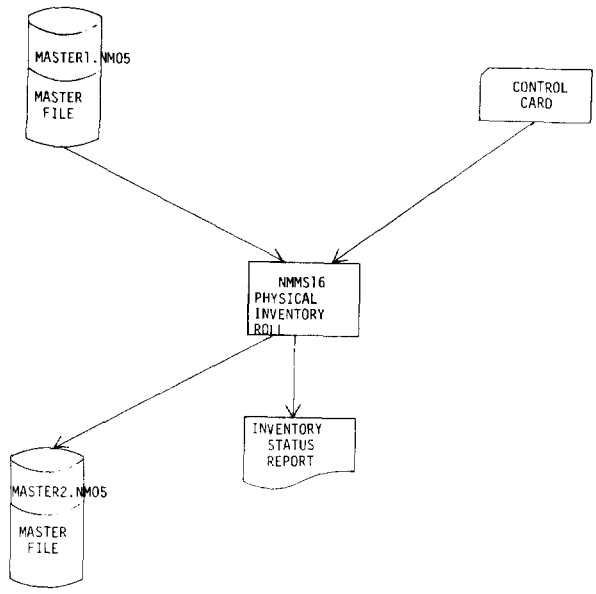
NMMS10 (PRINT)



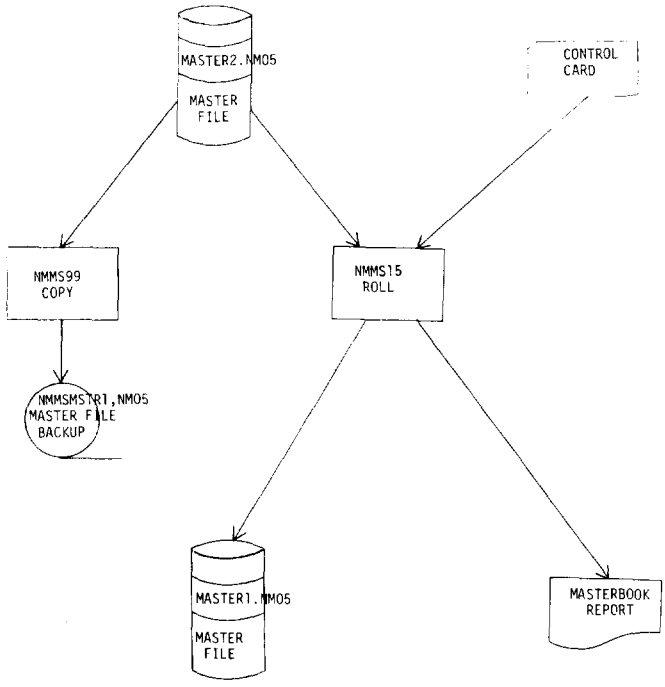
NMMS20 PROJECT SELECT



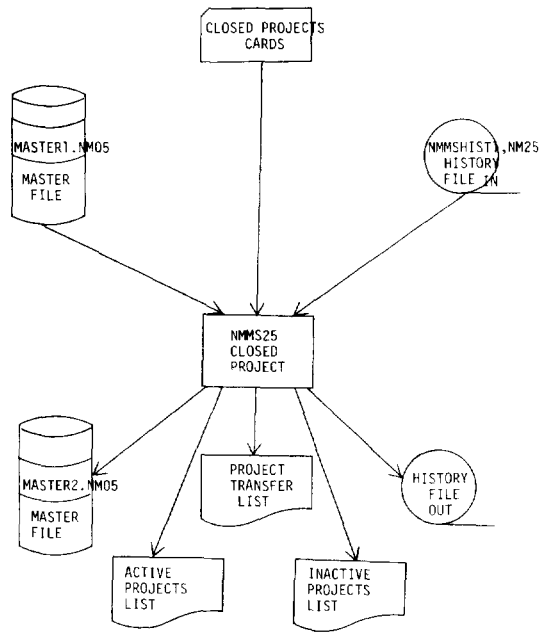
NMMS16 PHYSICAL INVENTORY ROLL



NMMS15 ROLL (MONTHLY)



NMMS25 - CLOSED PROJECT



THE INVISIBLE MAN(AGERS)

EUGENE J. MILES
Manager, Uranium Financial Planning
Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

Editor's Note: This article written by Gene Miles of Westinghouse was the keynote address at the 15th annual meeting of the Institute of Nuclear Materials Management, Inc., held June 19-21, 1974, at the Riviera Hyatt House, Atlanta, Georgia.

It was probably not too difficult to determine from the title of my speech that I would be talking about **you**, **me** and the **Institute of Nuclear Materials Management.** Yes, we in INMM are the invisible men and the invisible managers of the nuclear industry. If this were not true, there would be a lot **less** unfavorable written and spoken comments about diversions of nuclear material, hijackings and homemade atomic bombs. If this were not true, there would be a lot **more** written and said about the security systems and nuclear material management techniques that **do exist** right now to prevent diversions, hijackings and other security threats. There would be more publicity which would tell the general public what the nuclear industry and the AEC are planning to do to improve nuclear protection in the near future. Yes, if it were not true that we are invisible managers, there would be more people within the nuclear industry itself who would know about INMM—what we are and what we do.

Up to now I think we can all agree that as a group we have kept a too-low profile. And by doing this, we have failed to obtain proper recognition for our efforts, our talents and, yes, even our problems. We have failed to gain the attention and the support—not only of the general public—but we have often failed to get our message through to nuclear industry management, the AEC, and some of our allied organizations like Atomic Industrial Forum (AIF) and American Nuclear Society (ANS).

Nuclear energy is definitely in the news spotlight today. Unfortunately, the spotlight seems to shine, most of the time, on the problems and the faults of the nuclear industry. The opponents of nuclear energy get more headlines than its supporters mainly because the opponents of nuclear energy get their point across by expounding on the basic fears of **atomic** energy. Nuclear opponents can get a great deal of press mileage out of scare tactics. Thus, newspapers and magazines are virtually dominated by people who write articles criticizing the nuclear industry for the design and construction of power plants and chastising industry and government for poor protection of nuclear materials.

We, in INMM, cannot adequately respond to the critics of power plant design and construction, but, we have an obligation to the U. S. public and the nuclear industry to let everyone know what is being done to protect and safeguard nuclear materials. To do this, we in INMM, and all nuclear materials managers in the industry must stop being invisible managers.

The first step towards increasing the visibility of INMM and improving our organization requires that you make a self-examination. Ask yourself what value did you get from the last annual meeting? And more important what did you contribute to the last meeting? And what have you done since the previous annual meeting? If you do not like the answers you must give to these questions, **resolve now** that it will not be the same story for **this** annual meeting and for the entire coming year.

There are several things you can do, and you can start right at this meeting in Atlanta. For example, the Program Committee is attempting something different this year to gain your interest and your participation. On Thursday, the Committee has scheduled concurrent sessions. There will be expert speakers on a variety of subjects, and the Program Committee has grouped related topics so that you can attend sessions that appeal to you. Go to these sessions, listen to the speakers, and then participate in the discussions and make them better meetings because of your participation.

The Program Committee also tried a new approach during this annual meeting to deal with American National Standards Institute committee work. Several days were devoted to standards writing committee work. This year INMM made the ANSI standards activity a definite part of our preliminary program. You might want to locate some of the standards committee chairmen during the next three days and discuss their activities and volunteer your input and support.

And, active participation here in Atlanta should only be the beginning for you. During the next 12 months, we will need your expert contributions for our Institute magazine, and INMM will need your contributions for next year's annual meeting. Yes, it is not too early to resolve to write and deliver a paper next year. And it's not too early to suggest ways to improve our annual meetings. The Executive Committee and the Program Committee will welcome new, creative suggestions.

Actually, it should be a simple task for Tom Gerdis, our

Institute magazine's Managing Editor, to obtain articles. But, he has to beat the bushes for each issue, and it is not an easy job. We need to get industry people in the various companies to tell more about their sophisticated security systems and accountability/safeguards techniques. I'm sure Tom Gerdis would be pleased if, for each issue, he could obtain one good article that would tell the industry side of the nuclear material protection story.

The subject of magazine articles and speeches causes me to recall that Roy Cardwell, our Program Chairman, told me about an alarming trend. There are fewer papers being submitted for each annual meeting. We must reverse this trend. We should receive two times the number of papers we need for the annual meeting. Then, the program committee can turn the unused papers over to Tom Gerdis for possible publication in future issues of our Institute magazine. If some of you sitting in this audience today will resolve to help, the trend **can** be reversed for next year's meeting.

Recently, I have taken to clipping articles out of magazines and newspapers. These articles concern the hazards of the nuclear industry. Perhaps, you have also noticed how much more frequently that articles of this type are appearing.

In the **Pittsburgh Press**, in the span of eight days, I clipped out four such articles. They had titles like "AEC Admits Hazards in New A-Plants" and "Nuclear Risk Taking." Even my township's local weekly newspaper had an article on May 2, 1974, titled "Nuclear Theft Potential Demands Better Security." Drs. Gofman and Taylor were quoted extensively in the article, and W. A. Kriegsman of the AEC was mentioned.

The way the experts were presented in the article unnerved me. Dr. John Gofman was "a nationally recognized nuclear physicist," Dr. Theodore Taylor was "President of International Research and Technology Corp.," William Kriegsman was identified simply as an "AEC member." And unfortunately, no nuclear industry experts were mentioned or quoted in the article.

Dr. John Gofman and Dr. Theodore Taylor are receiving as much press space as Liz Taylor and Richard Burton. Why? Because they **speak** out and they **write** about the possibilities of nuclear theft, hijacking and poor security. Where are the industry and INMM spokesmen to rebut these allegations? Are they sitting quietly in this audience?

I have never doubted the sincerity of Drs. Gofman and Taylor and their colleagues; but I sometimes wonder if they are not planting the seeds for a future problem into the head of a would-be terrorist or hijacker simply because they are telling them, **it would be so easy to steal nuclear material.** Gentlemen, we have a moral obligation to tell people **it ain't so—it won't be easy** to steal nuclear material. Then, we must back up our oral pronouncements with continued and ever-improving nuclear security.

Maybe, you have also noticed that the newspapers and the magazines have started to use nuclear industry items as filler material. You know what "filler" is—it's the small one-inch or two-inch item that fills out column space. I saw one recently that read like this—"ATOMIC WASTE LEAKS—Richland, Wash (UPI)—Some 2,500 gallons of radioactive waste has leaked from an underground storage tank at the Hanford Atomic Works in the 17th such accident since 1958, officials said." *Pittsburgh Press*—3/14/74.

Now there was no "filler" item the next day that said there was no significant radioactivity release and no danger to the public in Richland, Washington. Instead, the reader was left with the impression that a serious leak had occurred for the 17th time, and that's a very serious problem. The reader might even think that's typical nuclear industry safety and protection.

INMM, AIF, ANS, and AEC better start sending "filler" items (and answers to fillers) to newspapers and magazines. We better start telling the public about the nuclear industry's strong points. For example, the new plants starting up—new fabrication and reactor plants with sophisticated and modern equipment—the best in the world—plants that will protect employes and the public from nuclear hazards.

You can see there is a leadership vacuum that must be filled. INMM and its members can help to fill the void. We have the organization and the individual expertise to do it. Let's talk a little about how to do this. Bernie Gessiness, a previous INMM Chairman, wrote an editorial for the Winter issue of the Institute magazine. He mentioned some of the points I want to stress to you today. I am not going to try to evaluate or sell any of these suggestions. I want you to consider their merit and evaluate them for youself. Discuss them with other INMM members here in Atlanta.

1. Volunteer to speak to local civic groups, high school groups and college student groups.
2. Organize regional meetings of INMM; this could be especially successful around large cities like Washington, D.C., Pittsburgh, Chicago, San Diego, and New York. If one or two people will volunteer to start regional meetings, the INMM could supply a list of members by area.
3. Plan for joint meetings with AIF or ANS—start small at first—maybe on a committee basis to see if there is a mutual interest.
4. Help American National Standards Institute by joining one of the committees involved in the nuclear program. Let me quote from a letter written by the Director of the ANSI Nuclear Program.

   "The very rapid growth that is now underway in the nuclear industry standards development program has resulted in many new opportunities for participation by people who have not previously taken part in ANSI activities."

The list of suggestions could grow and grow in length, but adding to the list would not get the job done. It's going to take people—INMM members—to do the job that has to be done. It will require work by many of you.

Ladies and Gentlemen, Will Rogers once explained what an administrator was. He said that "During World War One, the German submarines were devastating Allied shipping, and someone in the War Department came up with an idea to eliminate the submarines from the Atlantic Ocean. First thing we have to do, the suggestor said, was to heat up the Atlantic Ocean to the boiling point. Then all the submarines will pop to the surface, and we can pick them off one by one. Now some of you folks may be wondering how we're going to heat up the Atlantic Ocean. Well, I can't be bothered with those details. I'm an administrator."

Which kind of sums up our present position; the INMM does not need administrators or critics. What we need are members willing to work; people who can heat up the Atlantic Ocean. INMM needs its young and new members to supply fresh and creative ideas and to implement them. In other words, the young and new members can stimulate and revitalize our Institute. But, INMM also needs the wealth of experience and expertise that rests in the minds of our long-time members. This is a very important asset of INMM, and you "old timers" must be willing to distribute this wealth to the many people who can use it; the nuclear industry, the AEC, and the general public.

KANTER'S ANALYSIS

Mr. Kanter

SAFEGUARDS BACK TO FOREFRONT AT ANNUAL MEETING

BY MANUEL A. KANTER

The Institute held its fifteenth annual meeting at the Riviera Hyatt House in Atlanta, Georgia on June 19-21, 1974. The meeting came in the midst of renewed public interest in safeguards engendered by the Taylor articles, the explosion of a nuclear device by India, and President Nixon's offer of nuclear assistance to Egypt and India.

The renewed interest showed itself in a program which was almost completely devoted to safeguards, reversing last year's trend to other nuclear materials management subjects. The interest in safeguards matters came to the surface in an Executive Board proposal to the membership for the adoption of a resolution indicating the INMM position calling for stringent safeguards to be applied to the materials going to the Mideast. It was quite clear that the majority favored taking such a position although there was much disagreement over specific proposals. However the membership finally voted to adopt the resolution which is printed elsewhere in the Journal.

Technical sessions were always crowded with interest focused on new instrumentation for nuclear material assay, real time information systems, and physical security measures.

New applications of NDA instrumentation were reported with significant advances since last year. Of particular note was the paper of T. Gozani on a leached hull monitor, that of Norman Beyer on a fast response rod calorimeter and that of T. L. Atwell on assay of HTGR fuel using a random driver.

The paper by William M. Murphey of the National Bureau of Standards on diversion path analysis gave participants a look into the future of safeguards planning. It would appear that this approach perhaps in somewhat less analytical form is going to be needed if the public is to be given assurance that the safeguards applied to our nuclear industry are effective and comprehensive.

Those who attended found the arrangements for the meeting to be exceptional and much credit is due to Jim Joyner and his wife Dot for a job well done.

In line with its interest in professional nuclear materials management, the Institute is sponsoring a series of four courses to be given by the Argonne Center for Educational Affairs in the period October 28-November 20, 1974.

Upon the conclusion of the USAEC program of training in Safeguards and Nuclear Materials Control, an Institute Committee chaired by Armand Soucy and consisting of Richard Alto, Vincent DeVito, Bernard Gessiness, and Ralph Jones studied the needs of the profession for additional training and defined an Institute role. As a result INMM has contracted with the Argonne Center to present four courses which its *ad hoc* committee felt were needed. Manuel A. Kanter who directed the USAEC program during its five-year existence will organize and direct the courses. Fees have been set at a level which will hopefully be self-sustaining.

The four courses are scheduled in sequence to be taken by those who are new to the field. However, each is intended to be taken separately by those with more narrow interests.

Dr. Norman Beyer of ANL will be the principal organizer of the one-week laboratory-oriented course on "Measurements in Nuclear Material Control" to be given October 28-November 2, 1974.

John L. Jaech, Exxon Nuclear Co., will be the principal lecturer in a course based on his recent book "Statistical Methods in Nuclear Material Control" to be given in the week of November 5th.

Dr. Manuel Kanter will direct the course "Advanced Concepts in Nuclear Material Control" during the week of November 11th. It will be concerned with planning for control, new approaches to inventory, real-time data collection, physical security, analysis of safeguards criticism, and a survey of current government programs.

Finally a three-day short workshop in Nuclear Material Control at Power Reactors will be offered on November 18th.

Fees are set at $400 for the week-long courses and at $240 for the three-day course. Applications and detailed information are available from

Manuel A. Kanter
Argonne Center for Educational Affairs
Argonne, Illinois 60439
312-739-7711 x 5104

Testing for Normality When the Data Are Grouped Due to Rounding

BY JOHN L. JAECH
Staff Consultant
Exxon Nuclear Company, Inc.
Richland, Wash.

Introduction

A recent ANSI standard addressed the problem of assessing the assumption of normality using the W-test for normality (1). This same statistical test was presented in a TID publication devoted to statistical methodology in nuclear material control applications (2).

Although the W-test has been demonstrated to be a superior test for normality against unspecified alternatives (3), this does not mean that the user is free to apply the test indiscriminately without considering the structure of a given data set. This statement, of course, is not restricted to application of this particular test; an all too frequent occurrence in data analysis and interpretation is the misapplication of statistical techniques to sets of data unsuited for such applications. This is because the user sometimes tends to overlook the assumptions underlying the use of each technique for one or more of a number of reasons, but often because of ignorance as to the crucial nature of some of the assumptions.

The important assumption underlying the W-test for normality is that, under the null hypothesis, the data represent observations drawn from a normal distribution. In the strict sense, this implies that the measurements are made along a continuous scale, although in practice, all measurements are actually discrete in nature because of limitations of the measurement system.

In many applications, this discrete nature of the data poses no problems when applying statistical procedures that assume continuity. However, in some applications, the limitations of the measurement system are such that the discreteness is quite severe, and failure to take this into account can give grossly misleading results.

The purpose of this paper is to caution the user to use care in the application of the W-test to data that exhibit a discrete nature due to rounding imposed by the limitations of the measurement process. At the same time, it is hoped that the reader will be motivated to become more aware of the assumptions underlying statistical tests in general as he applies them, both from point of view of what these assumptions are and, perhaps more importantly, with respect to their effect on the conclusions suggested by the test outcomes.

Example Problem

The problem treated here is best introduced by means of an example. Percent uranium values for five UO_2 pellets sampled at random from a production lot are reported as follows:

88.11%, 88.09%, 88.09%, 88.11%, 88.09%

Test these data for normality of the population values by applying the W-test for normality. The test is applied by following steps 1-5 on page 76 of Reference (2).

Step 1: 88.09, 88.09, 88.09, 88.11, 88.11
Step 2: $(n - 1)s^2 = 0.000480$
Step 3: $b = 0.6646(.02) + 0.2413(.02) = 0.018118$
Step 4: $W = 0.000328/0.000480 = 0.683$
Step 5: The 1% critical value is 0.686. Since W is less than this value, we conclude that there is evidence of non-normality at the 1% level of significance.

Before proceeding further, we remark that the above five values were rounded from the following actual data points.

88.106%, 88.093%, 88.087%, 88.107%, 88.094%

Application of the W-test to these data gives $(n - 1)s^2 = 0.000305$, $b = 0.016188$, and $W = 0.859$ which is well above the critical value at even the 10% level of significance, leading to a conclusion in conflict with that for the rounded set.

This example clearly illustrates the effect of rounding this particular data set on the W-test for normality and suggests that the test should be applied only on the unrounded data. Unfortunately, it leaves unanswered the problem of what to do in the most commonly encountered situation in which one has access only to the rounded data. It does suggest, indeed, that the W-test can lead to incorrect conclusions, but does not offer an alternate procedure for testing for normality when the rounded data are all that are available to the analyst. We turn now to a test procedure that will apply in this instance.

Basis for Test Procedure

Consider the situation in which n observations are rounded to the extent that each observation appears in one of m cells, where the end cells each have a non-zero number of observations in them, but where intermediate cells may have zero observations. The cell definition depends on the degree of rounding.

To fix ideas, in the example first given with the data being 88.11, 88.09, 88.09, 88.11, and 88.09, it is apparent that the data are rounded to the nearest hundredth. Here, $n = 5$, and $m = 3$ with three observations in cell 1, zero in cell 2 (corresponding to 88.10), and two in cell 3.

It should also be apparent that as far as testing for normality is concerned, the above data could just as well read 3, 1, 1, 3, 1, rather than 88.11, 88.09, etc. That is, we can always speak in terms of a random variable x, where $x = 1$ for cell 1, $x = 2$ for cell 2, . . ., and $x = m$ for cell m. Then, for a given data set, the data may be presented as $f_1, f_2, \ldots, f_m$, where f_i is the number of observations in cell i, with $\sum_{i=1}^{m} f_i = n$. Again to fix ideas, in the example $f_1 = 3$, $f_2 = 0$, and $f_3 = 2$. (Note: obviously, the same result is obtained if $f_1 = 2$, $f_2 = 0$, and $f_3 = 3$.)

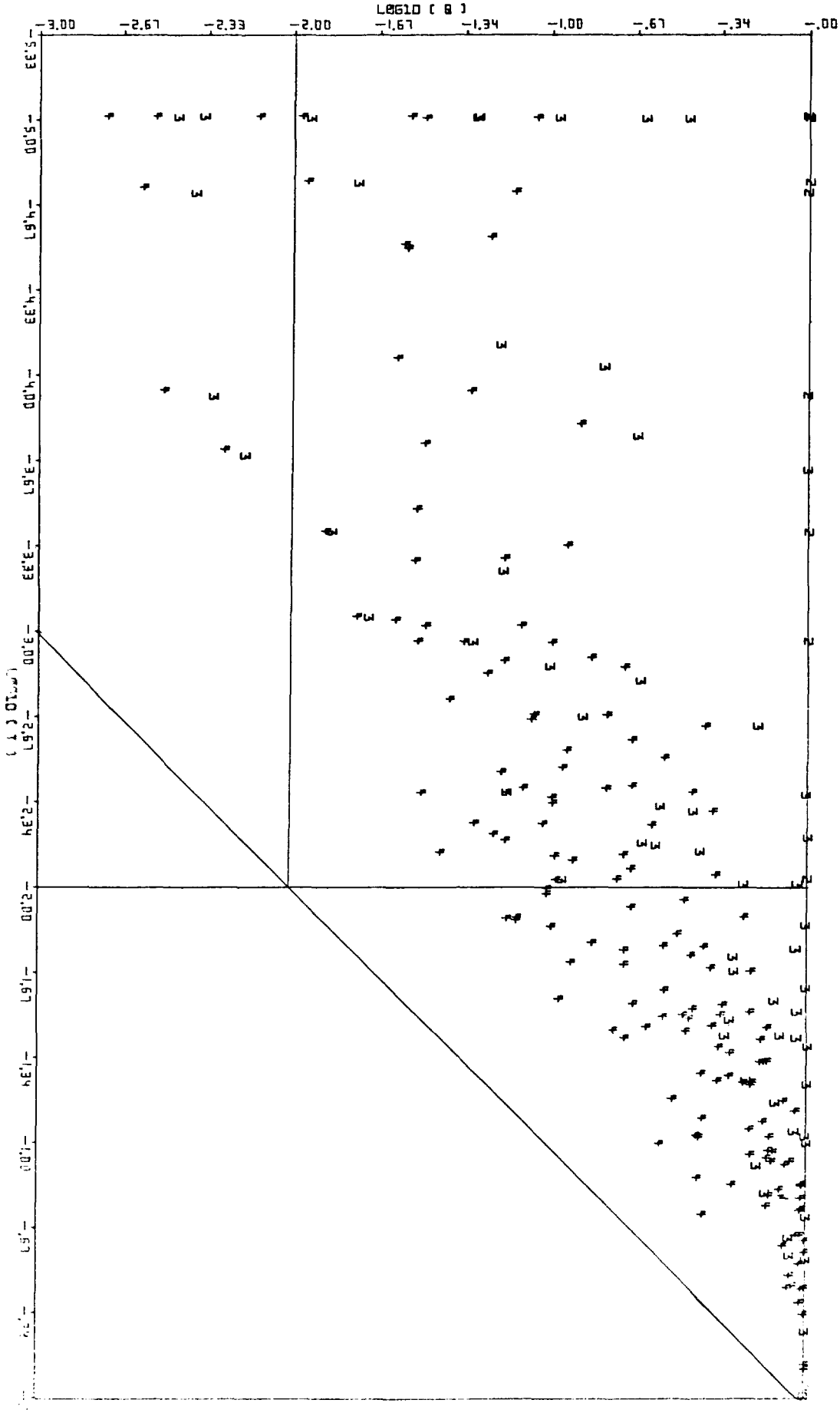
Now, an "exact" test for normality is developed based on the following procedure:

(1) Calculate a mean and a standard deviation for the data. The mean will be simply the sample mean, $\bar{x}$. The standard deviation will be the maximum likelihood estimate of the standard deviation for grouped data (4).

(2) Under the null hypothesis that the random variable in question is normally distributed, compute the probability p_i that an observation will fall in cell i for all i. For example for cell 2, this is the area under the normal curve between 1.5 and 2.5 units since it is assumed that if a given true value falls in that interval, it is recorded as 2. For the two "end" intervals, extend the tails to $-\infty$ and $+\infty$, respectively.

(3) Compute the likelihood ratio

$$\lambda_0 = n^n \prod_{i=1}^{4} (p_i/f_i)^{f_i}$$



where a given factor is unity if $f_i = 0$. (Note: Calculations are performed only for m = 2, 3, and 4. The computational effort for m > 4 becomes excessive.)

(4) Similarly, compute λ values for all possible combinations of f_i values corresponding to a given n, and up to m = 4.

(5) For <u>all</u> cases for which $\lambda \leq \lambda_0$, compute the multinomial probability for case j

$$q_j = \frac{n!}{f_1^{(j)}! \ldots f_4^{(j)}!} \prod_{i=1}^{4} p_i^{f_i^{(j)}}$$

where $f_i^{(j)}$ is the cell i frequently under case j.

(6) Sum the q_j values computed in Step (5), and call this Q. This is the probability of observing the frequency set f_i or all other frequency sets that give smaller λ values.

To clarify this procedure, a small λ value is evidence of non-normality. Thus, a λ value is computed for the <u>observed</u> set of data, and λ values must also be computed <u>for all</u> other possible data sets which would provide <u>less</u> evidence of normality than for the observed data set. The probabilities of observing all of the data sets are then found by repeated application of the multinomial distribution, and summed to give the overall significance level.

Example

It should be quite apparent that the procedure outlined involves considerable calculational effort, and is tractable only with the aid of a computer. However, to gain an appreciation of the procedure, it is illustrated for the very simple case of n = 3 and m = 3.

Consider

$$f_1 = 1$$

$$f_2 = 0$$

$$f_3 = 2$$

The steps are as follows:

(1) $\bar{x} = 0.3333$

$s = 0.8922$ *(from Reference (4))*

(2) $p_1 = \frac{1}{\sqrt{2\pi}s} \int_{-\infty}^{1.5} \exp\left(\frac{-(x - \bar{x})^2}{2s^2}\right) dx = 0.176$

$p_2 = 0.399$

$p_3 = 0.330$

$p_4 = 0.095$

(3) $\lambda_0 = 3^3\left(\frac{.176}{1}\right)^1(1)\left(\frac{.330}{2}\right)^2(1) = 0.1294$

(4) There are 20 possible configurations, which give λ values as follows.

	$f_i^{(j)}$				
x_i =	1	2	3	4	λ
j=1	3	0	0	0	.0055* (= $3^3\left(\frac{.176}{3}\right)^3$)
j=2	2	1	0	0	.0834*
3	2	0	1	0	.0690*
4	2	0	0	1	.0199*
5	1	2	0	0	.1891
6	1	1	1	0	.6257
7	1	1	0	1	.1801
8	1	0	2	0	.1294*
9	1	0	1	1	.1490
10	1	0	0	2	.0107*
11	0	3	0	0	.0635*
12	0	2	1	0	.3546
13	0	2	0	1	.1021*
14	0	1	2	0	.2933
15	0	1	1	1	.3377
16	0	1	0	2	.0243*
17	0	0	3	0	.0359*
18	0	0	2	1	.0698*
19	0	0	1	2	.0201*
20	0	0	0	3	.0009*

Note that case number 8 corresponds to the base case. The λ values that are marked with asterisks are those that are equal to or smaller than λ_0. That is, if the data had appeared as in those cases, there would have been <u>less</u> evidence of normality than for case 8, the observed case.

(5) The multinomial probabilities are:

Case j	q_j
1	.0055
2	.0371
3	.0307
4	.0088
8	.0575
10	.0048
11	.0635
13	.0454
16	.0108
17	.0359
18	.0310
19	.0089
20	.0009

(6) Q = .0055 + . . . + .0009 = 0.3408

Thus, the probability is 0.3408 that, were the observations drawn from a normal population, they would be grouped as 1-0-2 or "worse" when rounded. The conclusion is that there is no evidence of non-normality based on these data.

Results

A computer program was written and results computed for all combinations of cases corresponding to n = 3, 4, 5, 6, 8, 10, and m = 2, 3, 4. The computer printout included in this paper gives, for each case, the Q value which may be considered as the significance level for the "exact" test. It also gives the W value based on the W-test for normality, and the corresponding significance level, T, for this W test, where T is given by the formula in Section 4.2.6 of (1). The original example treated corresponds to case 15, where T from the W-test is 0.0094, while Q from the exact test is 0.111.

The Q and T values marked with an asterisk are those that are smaller than 0.01. It is evident that the W-test is far more likely to detect non-normality than the exact test, as seen by the large number of asterisks that appear in the T column relative to the number than appear in the Q column. This tendency of the W-test to label grouped data as being non-normal is emphasized by the computer plot of the tabled results where Q is plotted against T on a log-log scale. Without exception, the exact test gives much higher significance values than does the W-test.

Summary

One should be circumspect when applying the W-test for normality to data that are grouped as a result of limitations of the measurement process. Exact tests of normality are given for all combinations of n = 3, 4, 5, 6, 8, 10, and m = 2, 3, 4. It would appear that for values of m larger than 4, there are still problems with the W test, and in the absence of exact results, one should interpret the W-test results with some degree of caution. If anything, the W-test is inclined to be over-aggressive in detecting non-normality in the case of rounded data.

Acknowledgement

I am indebted to Anton Kraft who performed the computer programming for this study.

References

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(3) Shapiro, S. S., Wilk, M. B., and Chen, H. J., "A Comparative Study of Various Tests for Normality," Jour. of the Amer. Stat. Assoc., 63, 1343 (1968).

(4) Jaech, J. L., "Estimation of Standard Deviation for Severely Grouped Data," (unpublished).

TEST OF NORMALITY WITH GROUPED DATA

	CASE	F 1	2	3	4	Q	W	T	
N = 3 M = 2									
	1	0.	1.	2.	0.	1.000000+00	7.499856-01	0.000000	*
N = 3 M = 3									
	2	1.	0.	2.	0.	3.407078-01	7.499856-01	0.000000	*
	3	1.	1.	1.	0.	9.999999-01	9.999808-01	9.987944-01	
N = 4 M = 2									
	4	0.	1.	3.	0.	1.000000+00	6.296584-01	0.000000	*
N = 4 M = 3									
	5	1.	0.	3.	0.	2.303337-01	6.296584-01	0.000000	*
	6	1.	1.	2.	0.	8.645746-01	8.547536-01	2.381680-01	
	7	1.	2.	1.	0.	9.999999-01	9.444877-01	9.524997-01	
N = 4 M = 4									
	8	1.	1.	1.	1.	9.999999-01	9.939557-01	9.655811-01	
N = 5 M = 2									
	9	0.	1.	4.	0.	1.000000+00	8.521164-01	7.970161-29	*
	10	0.	2.	3.	0.	9.999999-01	6.938790-01	9.362981-03	*
N = 5 M = 3									
	11	1.	0.	4.	0.	1.067830-01	8.521164-01	7.970161-29	*
	12	1.	1.	3.	0.	9.909389-01	7.707719-01	5.773667-02	
	13	1.	2.	2.	0.	8.728626-01	8.408822-01	2.807584-01	
	14	1.	3.	1.	0.	9.999999-01	8.833843-01	2.498871-01	
	15	2.	0.	3.	0.	1.108535-01	6.838790-01	9.362983-03	*
	16	2.	1.	2.	0.	6.479625-01	8.206548-01	1.245749-01	
N = 5 M = 4									
	17	1.	0.	0.	4.	8.767792-02	8.521164-01	8.007947-29	*
	18	1.	0.	1.	3.	3.449845-01	7.346576-01	3.007430-02	
	19	1.	0.	2.	2.	9.171829-01	8.526120-01	1.475307-01	
	20	1.	0.	3.	1.	9.785715-01	8.281747-01	1.386415-01	
	21	1.	1.	1.	2.	8.891597-01	9.018486-01	3.661907-01	
	22	1.	1.	2.	1.	9.999999-01	9.407041-01	7.452316-01	
	23	2.	0.	0.	3.	1.051243-01	6.838790-01	9.362981-03	*
	24	2.	0.	1.	2.	3.848217-01	8.225145-01	9.587498-02	
	25	2.	0.	2.	1.	9.994931-01	8.517440-01	1.916168-01	
	26	3.	0.	1.	1.	9.924837-01	7.665696-01	5.378698-02	
N = 6 M = 2									
	27	0.	1.	5.	0.	9.999999-01	4.962931-01	0.000000	*
	28	0.	2.	4.	0.	9.999999-01	4.399142-01	1.113859-03	*
N = 6 M = 3									
	29	1.	0.	5.	0.	5.139153-02	4.962931-01	0.000000	*
	30	1.	1.	4.	0.	3.869714-01	7.213892-01	7.334269-03	*
	31	1.	2.	3.	0.	9.913980-01	8.210125-01	9.140256-02	
	32	1.	3.	2.	0.	9.999998-01	8.564219-01	1.976408-01	
	33	1.	4.	1.	0.	9.999998-01	8.271552-01	1.018110-01	
	34	2.	0.	4.	0.	4.964026-02	6.399142-01	1.113859-03	*
	35	2.	1.	3.	0.	4.809409-01	7.745871-01	5.834355-02	
	36	2.	2.	2.	0.	8.970279-01	8.532217-01	1.589925-01	
	37	3.	0.	3.	0.	6.709650-02	6.814836-01	4.294154-03	*
N = 6 M = 4									
	38	1.	0.	0.	5.	5.239017-02	4.962931-01	0.000000	*
	39	1.	0.	1.	4.	2.084206-01	6.659593-01	2.688264-03	*
	40	1.	0.	2.	3.	5.395926-01	7.723970-01	3.671435-02	
	41	1.	0.	3.	2.	5.954571-01	8.139430-01	8.056444-02	
	42	1.	0.	4.	1.	7.554925-01	7.701120-01	3.506999-02	

43	1.	1.	0.	4.	1,925008-01	7,021800-01	7,485903-03	*
44	1.	1.	1.	3.	7,192332-01	8,307605-01	1,084377-01	
45	1.	1.	2.	2.	9,532910-01	9,074961-01	3,785686-01	
46	1.	1.	3.	1.	9,474117-01	9,156858-01	4,268944-01	
47	1.	2.	0.	3.	3,001105-01	8,043272-01	6,763689-02	
48	1.	2.	1.	2.	8,567843-01	9,062841-01	3,705170-01	
49	1.	2.	2.	1.	9,990999-01	9,594448-01	7,786726-01	
50	1.	3.	0.	2.	2,671250-01	9,277120-01	1,015671-01	
51	2.	0.	0.	4.	4,576733-02	6,399142-01	1,113859-03	*
52	2.	0.	1.	3.	2,797482-01	7,543029-01	2,533029-02	
53	2.	0.	2.	2.	3,737079-01	9,227495-01	9,425817-02	
54	2.	1.	0.	3.	2,748056-01	7,658386-01	3,216851-02	
55	2.	1.	1.	2.	7,067277-01	8,601677-01	1,783639-01	
56	3.	0.	0.	3.	6,714942-02	6,316836-01	4,294153-03	*

N = 8 M = 2

57	0.	1.	7.	0.	9,999999-01	4,189909-01	0,000000	*
58	0.	2.	6.	0.	9,990999-01	5,662310-01	1,787031-05	*
59	0.	3.	5.	0.	9,990999-01	6,405316-01	4,182918-04	*

N = 8 M = 3

60	1.	0.	7.	0.	1,166950-02	4,189909-01	0,000000	*
61	1.	1.	6.	0.	1,600460-01	6,015789-01	9,411425-05	*
62	1.	2.	5.	0.	3,612447-01	7,234353-01	5,097693-03	*
63	1.	3.	4.	0.	9,205894-01	7,960391-01	3,091483-02	
64	1.	4.	3.	0.	9,999998-01	8,267832-01	6,016658-02	
65	1.	[illegible]	2.	0.	9,999997-01	[illegible]	[illegible]	
66	1.	6.	1.	0.	9,999998-01	7,325341-01	6,470532-03	*
67	2.	0.	6.	0.	1,754281-02	5,662310-01	1,787031-05	*
68	2.	1.	5.	0.	1,347338-01	6,928150-01	2,187777-03	*
69	2.	2.	4.	0.	5,338079-01	7,517848-01	2,185891-02	
70	2.	3.	3.	0.	7,714542-01	8,349346-01	7,176931-02	
71	2.	4.	2.	0.	9,999996-01	8,493465-01	9,755543-02	
72	3.	0.	5.	0.	1,419832-02	6,405316-01	4,182918-04	*
73	3.	1.	4.	0.	2,318944-01	7,349897-01	6,894613-03	*
74	3.	2.	3.	0.	5,135849-01	8,306645-01	3,371502-02	
75	4.	0.	4.	0.	1,996231-02	6,635920-01	9,012523-04	*

N = 8 M = 4

76	1.	0.	0.	7.	7,405281-03 *	4,189909-01	0,000000	*
77	1.	0.	1.	6.	7,330429-02	5,681780-01	1,978519-05	*
78	1.	0.	2.	5.	1,466776-01	6,754310-01	1,305632-03	*
79	1.	0.	3.	4.	2,093795-01	7,441245-01	5,704611-03	*
80	1.	0.	4.	3.	1,966779-01	7,736756-01	1,800404-02	
81	1.	0.	5.	2.	2,097997-01	7,575706-01	1,217188-02	
82	1.	0.	6.	1.	6,654203-02	6,761853-01	1,336030-03	*
83	1.	1.	0.	6.	4,910950-02	6,077544-01	1,181708-04	*
84	1.	1.	1.	5.	4,383406-01	7,240594-01	5,182512-03	*
85	1.	1.	2.	4.	6,748538-01	8,303599-01	4,026777-02	
86	1.	1.	3.	3.	8,855570-01	8,598194-01	1,714863-01	
87	1.	1.	4.	2.	[illegible]	[illegible]	[illegible]	
88	1.	1.	5.	1.	5,795958-01	9,264407-01	5,972014-02	
89	1.	2.	0.	5.	1,028835-01	7,193755-01	4,575156-03	*
90	1.	[illegible]	1.	4.	[illegible]	[illegible]	[illegible]	
91	1.	2.	2.	3.	9,598988-01	8,814083-01	1,894498-01	
92	1.	2.	3.	2.	9,990908-01	9,171407-01	3,806267-01	
93	1.	2.	4.	1.	9,564898-01	9,053690-01	3,039942-01	
94	1.	3.	0.	4.	1,223826-01	7,782477-01	2,008920-02	
95	1.	3.	1.	3.	6,194796-01	8,967610-01	1,142249-01	
96	1.	3.	2.	2.	8,823768-01	9,112342-01	3,403260-01	
97	1.	3.	3.	1.	9,990997-01	9,301556-01	4,833179-01	
98	1.	4.	0.	3.	1,095819-01	7,922236-01	2,782597-02	
99	1.	4.	1.	2.	7,474405-01	9,593194-01	1,214863-01	
100	1.	5.	0.	2.	7,536274-02	7,612270-01	1,331470-02	
101	2.	0.	0.	6.	1,142494-02	5,662310-01	1,787029-05	*
102	2.	0.	1.	5.	1,027984-01	6,709366-01	1,136880-03	*
103	2.	0.	2.	4.	1,853127-01	7,475019-01	9,501113-03	*
104	2.	0.	3.	3.	2,146257-01	7,943272-01	2,919751-02	
105	2.	0.	4.	2.	1,788800-01	8,046441-01	3,688748-02	
106	2.	1.	0.	5.	8,683724-02	6,923756-01	2,159993-03	*
107	2.	1.	1.	4.	4,324527-01	7,802508-01	2,107373-02	
108	2.	1.	2.	3.	6,958282-01	8,425921-01	8,507976-02	
109	2.	1.	3.	2.	7,281207-01	8,747654-01	1,652812-01	
110	2.	2.	0.	4.	1,478218-01	7,707033-01	1,676071-02	
111	2.	2.	1.	3.	6,192260-01	8,459562-01	9,080347-02	
112	2.	2.	2.	2.	8,291417-01	8,971292-01	2,588019-01	
113	2.	3.	0.	3.	1,966030-01	8,077716-01	3,956231-02	
114	3.	0.	0.	5.	1,349330-02	6,405316-01	4,182918-04	*
115	3.	0.	1.	4.	1,035528-01	7,213547-01	4,825519-03	*
116	3.	0.	2.	3.	1,965609-01	7,792249-01	2,046583-02	
117	3.	1.	0.	4.	9,422173-02	7,281461-01	5,771370-03	*
118	3.	1.	1.	3.	4,766937-01	7,986427-01	3,221223-02	
119	4.	0.	0.	4.	1,791340-02	6,635570-01	9,012518-04	*

N = 10 M = 2

120	0.	1.	9.	0.	9,999999-01	3,659569-01	0,000000	*
121	0.	2.	8.	0.	9,990999-01	5,094306-01	2,004062-07	*
122	0.	3.	7.	0.	9,999999-01	5,942440-01	1,986413-05	*
123	0.	4.	6.	0.	9,990999-01	6,401501-01	1,245135-04	*

N = 10 M = 3

124	1.	0.	9.	0.	4,526196-03 *	3,659569-01	0,000000	*
125	1.	1.	8.	0.	5,271842-02	5,320082-01	5,466359-07	*
126	1.	2.	7.	0.	2,188178-01	6,498820-01	1,773214-04	*
127	1.	3.	6.	0.	6,542966-01	7,307599-01	2,417467-03	*
128	1.	4.	5.	0.	9,525262-01	7,806183-01	9,945221-03	*
129	1.	5.	4.	0.	9,168950-01	8,020535-01	1,779951-02	
130	1.	6.	3.	0.	9,999997-01	7,943003-01	1,443601-02	
131	1.	7.	2.	0.	9,990997-01	7,521495-01	4,493108-03	*
132	1.	8.	1.	0.	9,990998-01	6,587224-01	2,425280-04	*
133	2.	0.	8.	0.	3,569786-03 *	5,094306-01	2,004062-07	*

	134	2.	1.	7.	0.	6.432730-02	6.278160-01	7.827998-03 *
	135	2.	2.	6.	0.	2.266757-01	7.172353-01	1.613406-03 *
	136	2.	3.	5.	0.	5.808484-01	7.807943-01	9.994392-03 *
	137	2.	4.	4.	0.	7.640964-01	8.196975-01	2.842303-02
	138	2.	5.	3.	0.	9.246489-01	8.328171-01	3.993060-02
	139	2.	6.	2.	0.	9.999996-01	8.154090-01	2.940606-02
	140	3.	0.	7.	0.	4.187749-03 *	5.942440-01	1.986413-05 *
	141	3.	1.	6.	0.	6.634080-02	6.854251-01	5.990231-04 *
	142	3.	2.	5.	0.	2.727278-01	7.556858-01	4.967695-03 *
	143	3.	3.	4.	0.	5.312570-01	8.049642-01	1.919997-02
	144	3.	4.	3.	0.	8.027871-01	8.319416-01	3.903623-02
	145	4.	0.	6.	0.	4.902048-03 *	6.401501-01	1.245136-04 *
	146	4.	1.	5.	0.	1.002925-01	7.129053-01	1.414245-03 *
	147	4.	2.	4.	0.	2.611991-01	7.681801-01	7.054212-03 *
	148	5.	0.	5.	0.	6.475396-03 *	6.947497-01	2.107753-04 *
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	156	1.	0.	7.	2.	9.811006-02	7.009854-01	9.772516-04 *
	157	1.	0.	8.	1.	2.689773-02	6.049491-01	3.135449-05 *
	158	1.	1.	0.	8.	1.100618-02	9.394213-01	1.305657-06 *
	159	1.	1.	1.	7.	1.338848-01	8.478034-01	1.888966-04 *
	160	1.	1.	2.	6.	4.114382-01	7.305771-01	2.404456-03 *
	161	1.	1.	3.	5.	5.867207-01	7.913759-01	1.333507-02
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	164	1.	1.	6.	2.	9.826805-01	8.209585-01	2.929376-02
	165	1.	1.	7.	1.	1.634331-01	7.510322-01	4.352308-03 *
	166	1.	2.	0.	7.	9.938499-02	6.514880-01	1.891292-04 *
	167	1.	2.	1.	6.	2.815020-01	7.403312-01	3.198997-03 *
	168	1.	2.	2.	5.	6.215591-01	8.094748-01	2.173739-02
	169	1.	2.	3.	4.	9.229996-01	8.807830-01	7.728130-02
	170	1.	2.	4.	3.	9.715584-01	8.962028-01	1.516149-01
	171	1.	2.	5.	2.	9.702472-01	8.953751-01	1.493364-01
	172	1.	2.	6.	1.	6.904343-01	8.404462-01	4.918860-02
	173	1.	3.	0.	8.	4.102945-02	7.224940-01	1.890586-03 *
	174	1.	3.	1.	7.	3.180726-01	7.971176-01	1.959799-02
	175	1.	3.	2.	6.	8.291449-01	8.550640-01	7.038231-02
	176	1.	3.	3.	5.	9.663841-01	8.943696-01	1.865353-01
	177	1.	3.	4.	4.	9.999996-01	9.109665-01	2.752991-01
	178	1.	3.	5.	3.	9.629959-01	8.905002-01	1.691123-01
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	187	1.	6.	0.	3.	3.179724-02	7.509929-01	4.347428-03 *
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	226	3.	2.	2.	3.	6.443570-01	8.514058-01	6.417505-02
	227	3.	3.	0.	4.	1.016562-01	7.837536-01	1.083635-02
	228	4.	0.	0.	6.	3.278803-03 *	6.401501-01	1.245136-04 *
	229	4.	0.	1.	5.	9.436237-02	7.027647-01	1.033913-03 *
	230	4.	0.	2.	4.	8.275422-02	7.514805-01	4.408295-03 *
	231	4.	1.	0.	5.	3.197171-02	7.072099-01	1.187083-03 *
	232	4.	1.	1.	4.	2.614043-01	7.635443-01	6.194022-03 *
	233	5.	0.	0.	5.	5.666808-03 *	6.947497-01	2.107754-04 *

MOUND LABORATORY: A LEADER IN NUCLEAR MATERIALS MANAGEMENT

BY E. A. DeVER AND W. W. RODENBURG
Monsanto Research Corporation, Mound Laboratory
Miamisburg, Ohio

Editor's Note: Mr. DeVer is the Mound Laboratory SS Representative. Dr. Rodenburg is Group Leader of Calorimetry Development. Mound Laboratory is operated by Monsanto Research Corporation for the U.S. Atomic Energy Commission under Contract No. AT-33-1-GEN-53.

Monsanto Research Corporation operates Mound Laboratory under contract for the Atomic Energy Commission. The Miamisburg, Ohio, facility was the first permanent AEC installation and pioneered in the use of various radioisotopes. Presently there are 14 source and special nuclear materials (SS) for different uses at Mound which must be controlled and accounted for. As a result, Mound personnel have long been active in all areas of nuclear materials management.

Nuclear Materials Management

As an operating unit, the Nuclear Materials Management group at Mound Laboratory is responsible for maintaining current documentation of receipts, shipments, and inventories of SS materials. A system of control records is maintained and pertinent reports are prepared as required by the AEC. In order to fulfill this responsibility, records must be maintained, such as analytical or production results, as they relate to or are applicable to accountability control.

It is also the responsibility of the Nuclear Materials Management group to reconcile on a weight basis all physical inventory statements with the corresponding end of the month account balances, to calculate the MUF (Material Unaccounted For) resulting from such reconciliations, and to investigate and report factors contributing to significant MUF.

All processing MBA's (Material Balance Areas) are covered by MUF Control Charts indicating MUF's which are significant.

Regular Internal Audit Procedures Used

The Nuclear Materials Management group performs an internal audit of the SS material reported monthly before submission of the Material Status Report to the AEC. A random sampling procedure is used.

All SS material physical inventories are combined, and each item is assigned a number. When the total population has been established, a single sampling plan for normal inspection is used to obtain the sample size for verification.

If the item listed on the inventory report has been processed or transferred, the custodian must present a signed MTR (Material Transfer Sheet) or a processing batch sheet in order to identify the item in its new location or the batch in which it was processed.

Some MBA's may be selected at random for a wall-to-wall inventory. Every item reported must be inventoried or accounted for during the audit.

In order to establish the validity of reported inventory weight values, samples are selected for a remeasurement during the internal audit.

Paperless System

A comprehensive study of the SS material record system was made by personnel of the Information Systems and Applications group and Nuclear Materials Management group. It was proposed that an automated, real-time system be implemented which identifies any quantity of SS material and records all transactions and changes which occur against any unit during processing by inputting the data to a data base via remote terminals placed throughout the plant. The Nuclear Materials Management group will be able to monitor all transactions through a Master Terminal.

The system will function entirely as a "paperless system." Hard copy will be obtainable at designated terminals which are required for audit purposes.

The developed system will offer a new tool to provide timely, rapid information on:

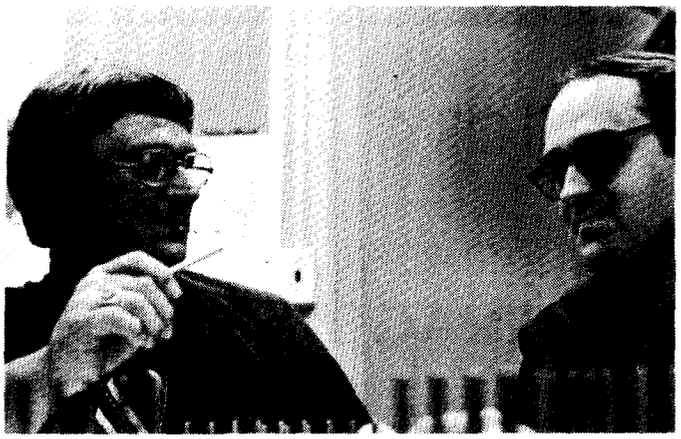
A. Production
B. Cost Estimation
C. Budget Projections
D. Activity Profiles

The system can be easily expanded to serve other applications such as:

A. Criticality Control
B. Health Physics
C. Waste Management
D. Non-SS Materials
E. Accounting & Financial Information

Safeguards R&D

Calorimetry has been the primary assay tool for SS material since the inception of Mound Laboratory as the Dayton



Authors, DeVer (L) and Rodenburg checking Mound heat standard library. Such plutonium-238 standards are available for calorimeter calibration for members of the nuclear industry.

Walt Strohm, Safeguards Project Leader, checks the identification on an in-coming canister of PuO^2 for verification. The automatic Data Acquisition System in the background makes possible rapid turnaround on such samples.

Project in 1943. As a result, Mound is a nationally recognized center of excellence in the area of radiometric calorimetry and most of the safeguards work is centered around this area of expertise. An automated plutonium assay system is now being developed for the AEC Division of Safeguards & Security and Directorate of Regulatory Standards. This system features in-line calorimetric heat measurements and high resolution gamma-ray isotopic measurements. All aspects of the system will be computer controlled including sample handling, data acquisition, and data processing. The system is being developed for plutonium processing and reprocessing facilities. Throughput rate is two 1-kg samples of plutonia or plutonia/urania blends per hour on a 24-hour/day basis. The system is to be operational in 1975 and discussions are being held with several facilities regarding installation and in-plant testing.

Mound is coordinating a program in cooperation with LASL, LLL, ANL, and Dow-Rocky Flats for measuring the half-lives of the plutonium and americium isotopes of interest to the nuclear industry. The present half-life value for plutonium-239 as determined by counting techniques is 1.4% longer than that determined by calorimetry. The goal of this program is to provide a consistent set of accurate half-life values for all methods of plutonium analysis.

Plutonium Verification and Standards Program

In addition to the Safeguards work being done for the AEC Division of Safeguards & Security, Mound also provides the AEC Albuquerque Operations Office with an independent assay of plutonium samples selected at random from various contractor inventories. Samples selected include oxides, metals, fluorides, and scrap from recovery operations.

The calorimetric measurements are used to verify the limits of error of the contractor assay measurements. On completion of the measurements, the materials are returned intact to the contractors. In many cases, these samples are used as calibration sources for other nondestructive analysis (NDA) equipment. Calorimetry alone among NDA techniques is capable of tracing the assay back to the national measurement system. The heat measurement is traceable through the use of electrical standards to the National Bureau of Standards, and the isotopic measurements are traceable by comparison with the NBS-supplied plutonium isotopic standards. Thus working and/or secondary standards for other NDA techniques can be made from actual in-process material. This is particularly useful for heterogeneous scrap categories. These verification and standards capabilities are available now to the nuclear industry.

Mound also has a program for fabrication and calibration of heat standards for calorimeters. As a result, a standard heat reference is available to all laboratories using radiometric calorimetry. To date, 11 laboratories have acquired permanent heat standards for their own use and standards are available for loan to those laboratories having only intermittent needs. In addition to being calibrated against certified electrical standards, two heat standards are now being measured by the National Bureau of Standards in an ice calorimeter. Thus the heat standards have a second direct route of traceability to the national measurement system.

Shipping Radioactive Materials

Procedures for shipping radioactive materials have undergone significant changes recently, particularly in the areas of documentation, assurance of compliance with regulations, and quality control in all phases of shipping container design, testing, procurement, and use.

Mound Laboratory has long been involved in shipping container design and development, particularly for applications involving high thermal wattage (associated with plutonium-238). A testing facility is in operation at Mound capable of handling 55-gallon drums. The Mound quality control program has been extended to include certification of vendors for both single-trip (drums) and reusable containers. The first vendor-certification of a drum manufacturer was implemented by Mound.

Mound DoT Special Permit containers, particularly those based on the DoT 6M specification, are widely used by the AEC and commercial contractors. Mound is continuing to develop containers and procedures in response to particular programmatic needs.

Waste Management

In July of 1972, Mound Laboratory established a Waste Management function as a separate entity within the organization. This function has the responsibility for providing advice, expertise, and counsel on waste management problems; providing innovative methods and

Bill Rodenburg (L) and Ken Jordan, Senior Research Specialist, discuss assembly details of a Mound-produced calorimeter.

concepts for reduction in waste generation; and coordinating the many existing programs that assure proper control, handling, and disposal of all wastes (e.g., radioactive waste, explosives, hazardous chemicals).

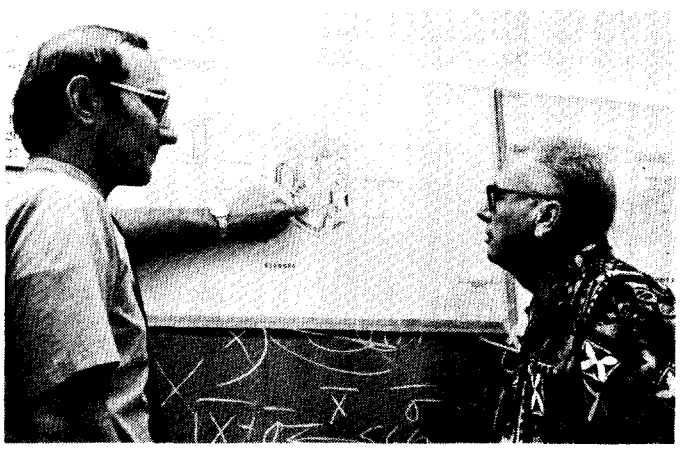
This strong management emphasis and the effective utilization of in-house and Corporate Monsanto expertise has fixed the Laboratory as a leader in management of nuclear, as well as other, wastes. Advanced concepts have been developed and implemented in areas such as: 1) Volume reduction (e.g., incineration of high and low level radioactive wastes, compaction, administrative procedures for minimizing the introduction of materials into radiation areas, drastic reduction in waste water generation, and dismantling of equipment where appropriate); 2) Materials and facility/equipment for use in solidifying inorganic and organic liquids; 3) Advanced chemical processing of liquid waste; and finally 4) Innovative concepts of tritium waste processing, control, and absolute containment.

Studies are currently under way in such areas as: 1) Techniques and equipment design for large scale monitoring of radioactive waste to determine exact levels of all types of contaminates; 2) Vendor usage of packaging materials and substituting materials which are more compatible with current and proposed incineration and compaction techniques; 3) Data generation, compilation, and analysis techniques; and 4) Criticality safety and thermal analyses of waste packages and storage areas using computer codes.

Inquiries Invited

The technology developed in these areas is available to the nuclear industry. Anyone interested in more detailed information should contact the authors.

Mose Baston (L), Task Force Leader, and Ev DeVer scan the cathode-ray terminal that is a primary ingredient in the new inventory system. This sytem is now being developed to provide an instant inventory of SS materials.



Warren Smith (L), Manager, Applied Physics, and John Birden, Task Force Leader, go over details of the automated Plutonium Assay System.

N.F.S. APPOINTS LORING MILLS

ROCKVILLE, MD. — Appointment of Loring E. Mills as manager of quality assurance for Nuclear Fuel Services, Inc. has been announced by Robert V. Curry, executive vice president.

In this position, Mr. Mills will administer the company's quality assurance program which includes engineering, construction and manufacturing operations and assures compliance with company quality policy as well as government requirements and regulations.

Mr. Mills has been with NFS since August 1971, and has served in various planning and project assignments.

He received his B.S. degree in engineering from Union College, Schenectady, N.Y., in 1950, and his M.B.A. in production management from the University of Washington in 1962. A native of New York State, Mr. Mills presently resides with his wife and four children in Rockville. His professional activities include memberships in the American Nuclear Society, American Welding Society, and American Society for Metals.

New I.A.E.A. Publications Catalog

Publications on atomic energy and its peaceful uses in medicine, agriculture, industry, earth and environmental sciences, and power production are described in the fully annotated catalog just issued by the International Atomic Energy Agency.

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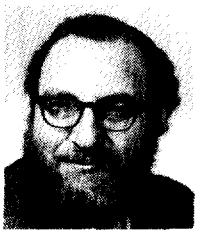
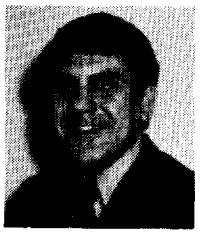


M. A. Kanter



E. J. Miles

H. J. Weber

ABOUT THE AUTHORS

John L. Jaech (B.S., Mathematics, M.S., Mathematical Statistics, University of Washington). Staff Consultant, Statistics, Exxon Nuclear Company, Richland, Wash. A statistical consultant in the nuclear field for 20 years, Mr. Jaech is the new ANSI N15 Chairman of your Institute. He has been Chairman of the INMM-sponsored ANSI Subcommittee on Statistics. He has authored 16 open literature publications on statistical methods and applications in various journals.

Manuel A. Kanter — Manny, to any INMM members, has been a chemist on the staff of Argonne National Laboratory since 1946. For the majority of this time, he was engaged in research in high temperature materials of interest to the Atomic Energy Commission. For the past five years, he has directed the AEC-sponsored Safeguards Training Program in the Argonne Center for Educational Affairs — a program which has trained over 300 persons from government to industry both here and abroad in many phases of nuclear materials control. He holds a Ph.D. in chemistry from Illinois Institute of Technology.

E. J. (Gene) Miles (B.B.A., M.B.A., Industrial Management, University of Pittsburgh) is Manager, Uranium Financial Planning, for the Nuclear Fuel Division, Westinghouse Nuclear Center, Monroeville, Pa. He has been a member of INMM since 1971 and is a member of the Atomic Industrial Forum Subcommittee of Safeguards. He is Chairman of Task Group INMM 1.3 which prepared ANSI Standard N15.9, "Nuclear Material Control Systems for Fuel Fabrication Facilities." A member of the INMM program planning committee for the Institute's 1974 annual meeting in Atlanta, Miles was Assistant to the Manager of Operations of the Nuclear Fuel Division during 1972-1973. From 1968-1971, he was Assistant to the Manager of Manufacturing, Nuclear Fuel Division, Westinghouse Electric at both Cheswick, Pa., and Columbia, S.C., plants.

R. E. Tschiegg is Manager, Nuclear Materials Safeguards, Nuclear Energy Systems, Westinghouse Electric Corporation. Mr. Tschiegg is a graduate of the Ohio State University majoring in Business Administration. He served in the U.S. Army as a commissioned officer in the Counter Intelligence Corps. Since joining Westinghouse in 1956, Mr. Tschiegg has held various positions involving physical and personnel security, license administration and nuclear materials management and safeguards. He had been a member of INMM since 1964 and was named a Certified Nuclear Materials Manager in 1967.

Hans J. Weber (M.A., Physics, San Diego State University, 1968). A staff physicist with Intelcom Rad Tech, San Diego, Calif., Mr. Weber prepares proposals for the development of custom-made and existing instrumentation. He also manages programs of building and developing non-destructive assay instrumentation. Mr. Weber presented two papers at the 15th annual INMM meeting June 19-21 in Atlanta, one on a PU Barrel Scanner, the other on doorway monitors.

INMM Adopts Resolution

(Continued from page 19)

Mr. Harley L. Toy, Chairman
Mr. Armand R. Soucy, Vice Chairman
Institute of Nuclear Materials Management

Dear Mr. Toy and Mr. Soucy:

Chairman Price has asked me to respond to your telegram offering the services of the Institute in evaluating the adequacy of the safeguards to be applied to the provision of nuclear materials to Middle East nations. The Committee will keep your organization in mind during its consideration of the proposed agreement. The Committee staff will contact you if a need for assistance develops.

Sincerely,

Edward J. Bauser
Executive Director
Joint Committee on Atomic Energy
Congress of the U.S.