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EDITORIAL

Call for Greater Member Initiative

By Dr. William A. Higinbotham
Brookhaven National Laboratory
Upton, Long Island, New York

The purpose of this Journal is to provide a convenient medium for communication throughout the safeguards community, members or non-members, wherever they may be. Any journal of this sort costs money and calls for a lot of effort, most of it by volunteers. As professional journals go, ours has a small circulation and a very small income from advertising. The INMM officers must scrimp and contrive in order to provide this service and keep the dues so modest. Much larger societies such as the American Nuclear Society charge higher membership dues and substantially higher additional charges if a member wishes to receive any of the society's technical journals.

The INMM Journal contains a combination of editorials, notices, technical articles and miscellany. More affluent societies would publish these different categories in different journals. News and comments have only a short-term interest, while some of the technical papers will have lasting values. A small society, like ours, will have to make do with the combination and hope that libraries (an important and lucrative market) will accept the ephemeral in order to have on file the more lasting.

Your officers believe, and last year's membership poll confirmed, that most of the Journal content is valuable to the members. But greater membership initiative would increase the value to members and also to others. In most professional organizations, there are letter-writers, some who disagree with policies, some who criticize articles, and some who offer constructive suggestions. For some reason, this Journal has not had this sort of feedback. Why is this so? Are our readers too busy? Are they lazy? Or are they afraid that they will be ignored?

As you who read the Journal realize, a few interested members contribute frequently what they hope will be of interest. Officers and editors feel required to do so. It would be a relief to us, and undoubtedly more exciting for our readers, if other members were to submit competing essays. Don't be bashful.

For many years the proceedings of the annual meeting contained almost all of the technical articles published by the Institute. In the last few years, the other issues have contained more technical articles. The last issue contained several technical articles of considerable interest,

(Continued on Page 4)

Dr. Higinbotham

Institute Prepares For The Challenge of the 80's

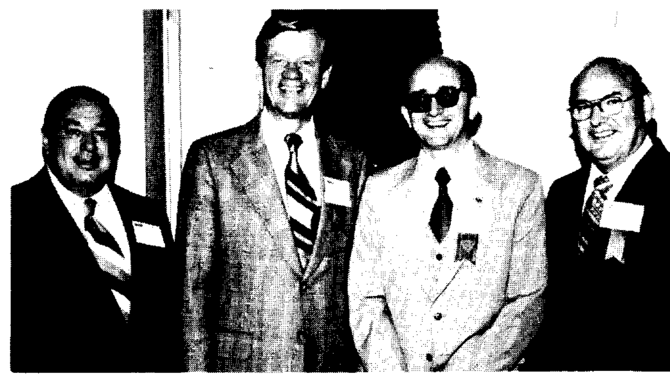
By Dr. G. Robert Keepin, Chairman
Institute of Nuclear Materials Management
Los Alamos, New Mexico

Fiscal year 1979 was clearly a year of significant growth and progress for the Institute despite rather unfortunate events and developments — notably, Three-Mile Island — that have had inevitable repercussions in the US and throughout the world nuclear community. Recognizing the inherently global nature of nonproliferation and safeguards issues, the Institute is expanding its scope, its activities, and its membership to reflect the steadily increasing importance of International Safeguards in the 1980's.

During FY-79, INMM international (overseas) membership increased sharply; the Vienna Chapter was established; the Japan chapter continued to flourish; and INMM members made major contributions to IAEA, ESARDA, and other international conferences in Vienna, Brussels, and Tokyo.

The "International Safeguards" theme of the Albuquerque meeting was clearly both timely and appropriate, as attested by the excellent international representation at the meeting. The special ESARDA session of invited papers by distinguished European safeguards experts is indicative of the increasing cooperation and closer technical interactions that promise important benefits not only to our professional organizations, but to the entire field of safeguards and security, on both the national and the international level.

In keeping with our ongoing thrust in the international area, the INMM Executive Committee recently issued a strong statement of support for the ratification of the US Safeguards Agreement with the International Atomic Energy Agency, currently pending before the US Senate. The recent exchange of letters between the INMM Chairman and US Senator **Claiborne Pell,** Chairman of the Senate Foreign Relations Subcommittee on Arms Control, Oceans, International Operations, and Environment, is covered elsewhere in this issue of the Journal (cf Article by INMM Public Information Chairman, **Herman Miller,** pp. 26). In view of the clear and widespread need for education and better understanding in this vital area, as well as the very positive response to the first INMM Workshop on IAEA Safeguards held last December (1978) in Washington DC, a second INMM Workshop on the Impact of IAEA Safeguards in the US is currently projected for early 1980, i.e., following anticipated Senate ratification of the US/IAEA Agreement. We are most fortunate to have INMM member **Allan Labowitz,** an internationally recognized safeguards expert formerly with the Department of State and currently in private law practice in Washington DC, as Program Chairman for the forthcoming INMM "Workshop II" on IAEA Safeguards.



The four officers of the INMM for the coming year, all re-elected at the INMM Annual Business Meeting on July 17 in Albuquerque, are (from left) Vincent J. DeVito, Goodyear Atomic Corporation, Piketon, Ohio, secretary; Dr. G. Robert Keepin, Los Alamos Scientific Laboratory, chairman; G. F. Molen, Allied-General Nuclear Services, Barnwell, South Carolina, vice chairman; and Edward Owings, Oak Ridge Y-12 Plant, treasurer.

A major area of continuing challenge for 1980 includes the INMM certification, education, and training programs. A pool of some 530 certification examination questions has now been developed, and is currently undergoing the extensive process of validation, which involves having a selected group of safeguards professionals and a control group actually "take the test, " then evaluate the results by screening and modifying the questions appropriately to ensure an effective and equitable examination regimen. In recognition of the key importance of this effort, we are working very hard to ensure that professional validation of the general qualification examination is accomplished expeditiously in order to clear the way for early offering of the first examination in the INMM's new Professional Certification program.

Dr. Keepin

Incoming and outgoing members of the INMM Executive Committee posed for this photo immediately following the INMM Annual Business Meeting on July 17: (from left) A. W. DeMerschman, Richland, Wash.; Dennis M. Bishop, San Jose, Calif.; Dennis W. Wilson, San Jose, Calif.; Roy G. Cardwell, Oak Ridge, Tenn.; Yvonne M. Ferris, Golden, Colo.; Dr Francis A. O'Hara, Columbus, Ohio; and Dr. Samuel C. T. McDowell, Washington, D. C. DeMerschman and Wilson completed their terms June 30. Y. Ferris and McDowell began theirs July 1 and will serve this year and next.

Closely related to this activity is the broad, longer-term effort aimed at developing uniform safeguards performance standards and requirements. Our N-15 Standards Committee under the leadership of **Dennis Bishop** has undergone a period of reassessment of N-15 scope and direction, with emphasis placed on refocussing resources to keep abreast of new developments in the safeguards and materials management area — particularly in today's challenging post-Three-Mile Island era. This has led to the establishment of several new standards writing groups, the designation of a new Measurement Control subcommittee (INMM-5) to deal with safeguards-related measurement control methods, and increased emphasis on international cooperation and exchange in the vital safeguards standards area, e.g., with IAEA and ESARDA.

Another important aspect of professionalism and more effective INMM communication/interaction on technical matters is the formation of Technical Groups. The first such group, covering the major area of physical protection, has been established under the chairmanship of **Tom Sellers** of Sandia Laboratories; (see report of INMM Technical Group for Physical Protection, pp. 28, this issue.) Other INMM Technical Groups are expected to follow soon in the areas of Accountability and Materials Management, Measurement and Measurement Control, System Studies and Statistics, and International Safeguards.

New ideas and fresh approaches have been introduced in the area of communications and public information by INMM Public Information Chairman, **Herman Miller,** who is also planning for a possible press briefing and tour of an operating nuclear facility such as the General Electric fuel fabrication plant in Wilmington, NC, and perhaps in the future its counterpart, the JNF fuel fabrication facility at Yokosuka, Japan.

Turning now to INMM management and administrative affairs, it was just a year ago that we inaugurated a general reorganization of many of the Institute's management and operational procedures. One of these was a functional restructuring of the Annual Meeting Committee into two major committees, the Technical Program Committee under INMM Program Chairman, **John Jaech,** and the Meeting Arrangements Committee chaired by **Joe Stiegler.** Each of these major committees coordinates the activities of a number of appropriate subcommittees. This new arrangement, which is fully set forth in our new INMM "Annual Meeting Handbook," was intended to provide several advantages including clearer delegation of responsibility/authority areas, year-to-year continuity, increased efficiency, and overall effectiveness in meeting planning and management. From all indications the reorganization is working extremely well, and indeed our record-breaking 20th Annual Meeting in Albuquerque must surely go down in the record as our largest and best-organized INMM Annual Meeting ever. We are all deeply indebted to John Jaech, Joe Stiegler, and each one of their respec-

Again in 1979 the Institute received excellent coverage of its meeting by the news media. Discussing a news article are Larry Scheinman (left) of Cornell University and INMM Chairman Bob Keepin of LASL. Special thanks go to John Armistead of LASL and Rod Geer of Sandia Labs who helped with news media contacts.

Call for Greater Member Initiative

(Continued from Page 1)

including two valuable articles from West Germany. But this fall issue will be relatively thin.

It is our hope that the INMM Journal will be of greater service to its members, and become widely recognized as the authoritative technical journal on safeguards. To be considered by libraries as an archival resource (i.e., with binding and filing), a journal should have six issues or more per year, each with ten or more technically respectable articles.

Less than half of the technical articles now published in the Journal, aside from those in the proceedings issue, are volunteered. The rest have been solicited by **Tom Gerdis**, or a few other conscientious members. The Journal would be of much more value to its members and to others if you, dear friends, engaged in developing or applying safeguards would send in the papers you have to write anyhow. Why not take a few hours and write a letter-to-the-editor on safeguards problems as you see them or a first draft of a technical article for consideration and possible amplification?

The program committee of the annual meeting has been overwhelmed by contributions for several years. This is understandable. If a paper is accepted, the agency or company will pay the author to attend, and the paper will be published in the proceedings issue.

After the program committee reluctantly turns down half or more of the offerings, the authors are invited to submit them to the Journal editors. Almost no one ever does. Tom Gerdis and I review the rejects and write a number of the authors. A few recent articles were obtained in this way, not nearly as many as there should have been. If an article deserved to be considered for presentation at the annual meeting, surely it should also be worth offering for publication. Futhermore, there are many technical articles which are more appropriate for publication than for oral presentation at a meeting. A way to correct for self-multiplication in a neutron coincidence detector, or a comparison of esoteric statistical analytical techniques would be of little immediate interest to 20 members at an annual meeting, and perhaps comprehensible to five. A larger number of journal readers, now and in the future, would be interested in such papers and take the time to understand and to make use of them.

This is your society. This is your Journal, your medium for communication. Only you can make it truly effective.

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tive sub-committee chairmen and their hard-working committee members for a job superbly done.

Another important aspect of our Fall '79 functional reorganization was assignment by the Chairman of formal oversight responsibility for designated areas of Institute activity to each Executive Committee member. This new operational procedure also seems to be functioning very well indeed, thanks largely to the dedication and fine spirit of cooperation that has characterized the Executive Committee and Standing Committee chairmen alike. Following are the assigned oversight responsibilities for FY'80 Executive Committee members:

Name	Oversight Responsibilities
D. M. Bishop	N-15 Standards
	Public Information
R. G. Cardwell	Nominating
	Site-Selection and Advanced Arrangements
Y. M. Ferris	INMM Journal
	Constitution and By-Laws
S. C. T. McDowell	Safeguards
	Awards
F. A. O'Hara	Certification
	Education

INMM Vice Chairman, **Gary Molen,** will continue his responsibilities as Annual Meeting Committee Chairman and oversight/coordination of INMM Technical Working Groups.

INMM Secretary **Vince DeVito** will continue his responsibilities for oversight/coordination of INMM Chapter affairs.

Finally, all of us in the Institute are greatly indebted to all those who are working so hard and so productively on the various standing committees of the Institute. A complete, updated listing of all INMM Standing Committees, Chapters, and their Chairmen for fiscal year 1980 is given below:

COMMITTEE	CHAIRMAN
Awards:	**R. F. Lumb,** NUSAC
Certification:	**F. Forscher,** EMC
Education:	**H. L. Toy,** BCL
Journal-Technical Editor:	**W. A. Higinbotham,** BNL
Journal-Managing Editor	**T. A. Gerdis,** Consultant
Meeting Arrangements:	**J. E. Stiegler,** SLA
Communications and Publicity:	**T. A. Gerdis,** Consultant
Exhibits and Displays:	**J. E. Glancy,** SAI
Local Arrangements (1980):	**J. W. Lee,** Consultant
Registration:	**D. A. Dunn,** RF
Membership:	**J. W. Lee,** Consultant
N-15 Standards:	**D. M. Bishop,** GE
N-15 Secretary:	**R. A. Kramer,** NIPSCO
Nominating:	**R. G. Cardwell,** ORNL
Program:	**J. L. Jaech,** EXXON
Contributed Papers:	**R. N. Chanda,** RF
Invited Papers:	**G. A. Huff,** AGNS
Public Information:	**H. Miller,** NNC
Safeguards:	**S. C. Suda,** BNL
Site Selection Advanced Arrangements:	**R. E. Lang,** CHOO
Technical Group for Physical Protection	**T. A. Sellers,** SLA
Vienna Chapter:	**Carlos Buechler,** IAEA
Japan Chapter:	**Yoshio Kawashima,** NMCC
Pacific Northwest Chapter:	**Roy Nilson,** EXXON

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Outstanding Program Planned For 21st INMM Annual Meeting In Palm Beach, Florida

By John L. Jaech, Chairman
INMM Annual Meeting Technical Program Committee
Richland, Washington

Safeguards—Today and Tomorrow. That is the theme selected for the 1980 meeting in Palm Beach. The theme is intended to emphasize not only the importance of current efforts to implement effective safeguards, but also to look to the future. What does it hold for the nuclear industry from a technology viewpoint? from a regulatory viewpoint? Is there a basis for optimism for our embattled industry?

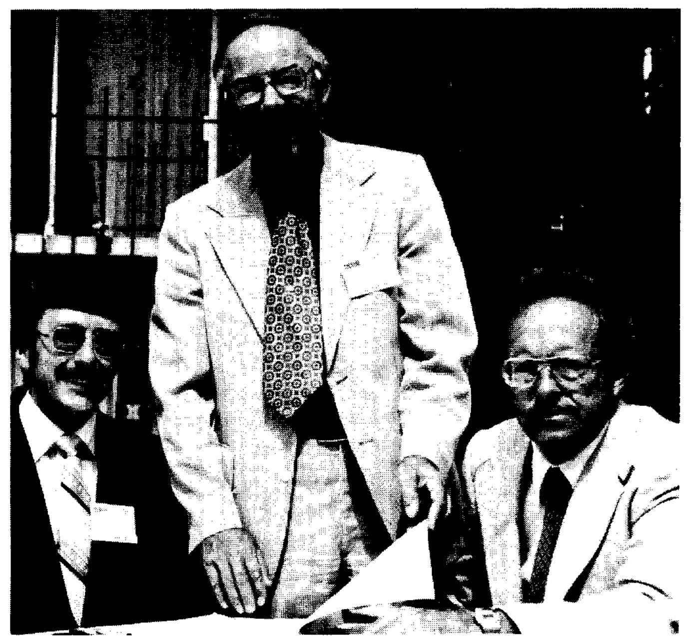
The program theme was selected by the 1980 Technical Program Committee, meeting in Richland on August 30. The members of the Committee, **Dick Chanda, George Huff,** and **Bill DeMerschman,** met on that date with the Program Committee Chairman and also with the INMM Vice-Chairman (and Annual Meeting Chairman) **Gary Molen** and began to formulate plans for the 1980 meeting.

For the 1980 meeting, Dick Chanda will again serve as chairman, Contributed Papers Subcommittee, and will form his own subcommittee later. He has already issued the call for papers. George Huff has agreed to serve as Chairman of the Invited Papers Subcommittee, and is already working hard to firm up that part of the program.

As of this writing, plans are still tentative. Some key decisions have, however, been made. The Plenary Session on opening day will again be one-half day as in Albuquerque and will feature presentations on a broad policy level, but structured toward the program theme. A second plenary session will be held on Tuesday afternoon (the second day). This will feature the Student Award Paper, plus a development of the important topic —waste management. Complete details for this session have not been worked out as of yet, but some innovative ideas are being pursued.

All other sessions will be concurrent, featuring one invited papers session per half day and one or more contributed papers sessions. The Committee was pleased at the fine attendance in Albuquerque and collectively feels that the well attended tri-current sessions played an important part in providing something of interest for all attendees.

Watch this column in the winter issue (Volume VIII, No. 4) for additional meeting developments, and make your plans now to attend the INMM meetings in Palm Beach.



John L. Jaech (center), staff consultant, EXXON Nuclear Co., Inc., Richland, Wash., was chairman of the 1979 INMM Annual Meeting Technical Program Committee. He has been reappointed to this position for the 1980 meeting set for June 30 - July 2 in Palm Beach, Fla. For the 1979 meeting, Dr. Richard N. Chanda (left) was chairman of the contributed papers session subcommittee and A. William DeMerschman (right) was in charge of the invited papers sessions subcommittee.

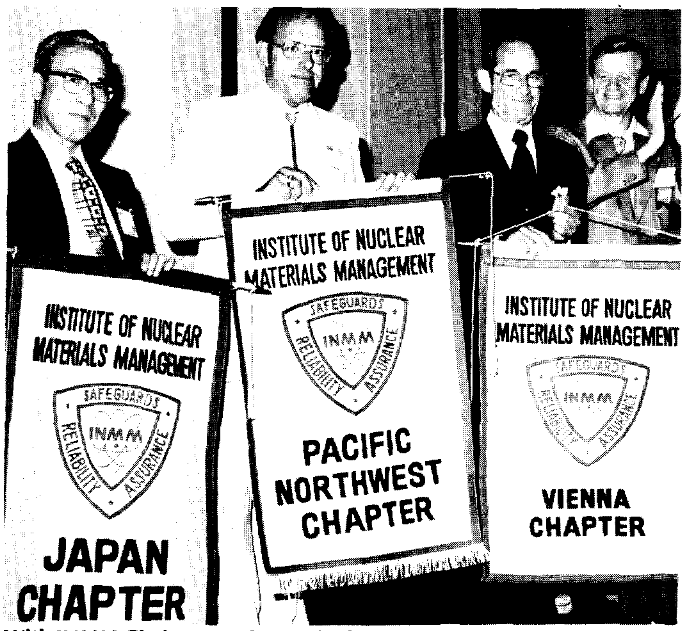
INMM Annual Meeting Has Record 515 Attendance

Dr. Sigvard Eklund, director general of the International Atomic Energy Agency, Vienna, Austria, was the Keynote Speaker at the 1979 INMM annual meeting. Dr. Eklund also gave a seminar at Los Alamos Scientific Laboratory on July 17. He also presented remarks following the buffet dinner Tuesday evening.

George Weisz, director of the Office of Safeguards and Security, U. S. Department of Energy, Washington, D.C., spoke during the Monday morning plenary session. He also spoke following the Tuesday evening buffet dinner in a very effective, extemporaneous and humorous manner — very well received by the more than 600 persons at the buffet (moved indoors at the last instant because of a rain shower which caused the Poolside Buffet to be moved inside).

Dr. Bert Wolfe, vice president of the General Electric Company, Nuclear Energy Division, San Jose, California, was a plenary session speaker the first morning of the annual meeting. Bill Casey, a writer for the Albuquerque Tribune, interviewed Dr. Wolfe and Dr. Eklund and the result was a front page story in the paper July 16.

Dr. Lawrence Scheinman of Cornell University, Ithaca, New York, was a plenary session speaker Monday morning. Dr. Scheinman is a consultant to the U. S. State Department on nonproliferation policy matters related to nuclear safeguards. He spent portions of the summer at Los Alamos Scientific Laboratory in various scholarly activities related to safeguards. Scheinman gave a seminar at Brookhaven National Laboratory on the development of the Administration's nonproliferation policy which appeared in this Journal ("Toward a New Non-Proliferation Regime," Vol. VII, No. 1, Spring 1978, pp. 25-29).

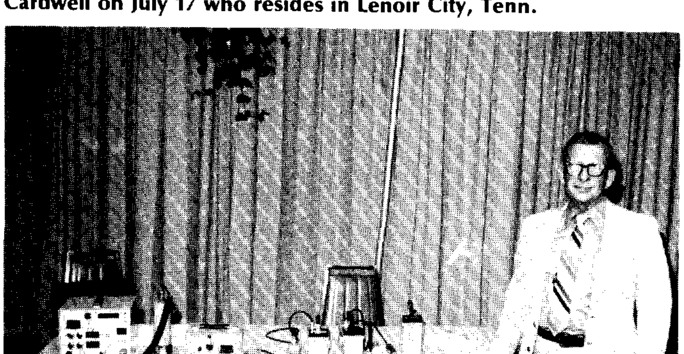


With INMM Chairman Bob Keepin (left) of LASL showing his approval, representatives of the three INMM chapters took time out to pose together with their respective chapter banners (from left): Professor Ryohei Kiyose, vice chairman, Japan Chapter; A. W. DeMerschman, past chairman pro tem, Pacific Northwest Chapter; and Carlos Buechler, chairman, Vienna chapter.

G. F. Molen (seated) of Allied-General Nuclear Services, Barnwell, S.C., was general chairman for the 1979 annual meeting and will have the same post for the 1980 annual meeting in his capacity as vice chairman of INMM. Raymond E. Lang (right) of DOE-Chicago Operations is chairman of the INMM Site Selection and Advanced Arrangements Committee. Program Chairman John L. Jaech (left) and Arrangements Chairman Joseph E. Steigler (with beard) will serve again at the 21st annual meeting of INMM next summer in Palm Beach, Florida.

Roy G. Cardwell (right) of Oak Ridge National Laboratory, immediate past chairman of the Institute, was honored with a special service award during the INMM annual meeting. He was presented two gifts for his dedicated service as chairman, vice chairman, chairman of the Annual Meeting Technical Program Committee, and exhibits chairman. INMM Chairman Bob Keepin of LASL made the presentations to Cardwell on July 17 who resides in Lenoir City, Tenn.

Yvonne M. Ferris of Rockwell International's Rocky Flats Plant recently returned to the U. S. after a two-year assignment with the IAEA in Vienna. She presented a seminar on the IAEA at a meeting August 30 of the student branch of the American Nuclear Society at Kansas State Univerity, Manhattan. Ferris is shown visiting with (from left) Carlos Buechler and James E. Lovett of the IAEA. Buechler is chairman of the Vienna chapter; Lovett is a past chairman of the Institute.



Ludlum Measurments, Inc., 501 Oak Street, Sweetwater, Texas 79556. Phone: 915-235-5494. Jack C. Bentley, Representative.

Video-Tek, Mountain Lakes, N.J. Sy Borys, Representative.

Russell E. Weber (right) NUSAC, Inc., McLean, Va., was chairman of the special INMM Workshop on the Impact of IAEA Safeguards in the U.S. held last December 6-8 (1978) at the Washington Hilton Hotel. Weber, who worked for DOE for many years before joining NUSAC, was presented a gift for his service to the Institute during the 20th annual INMM meeting this past July in Albuquerque.

James M. DeMontmollin (center) of Sandia Laboratories, Albuquerque, enjoyed visiting at the annual meeting with Dr. James R. Lemley (left) and Dr. Jack H. Cusack of the Technical Support Organization for Nuclear Safeguards at Brookhaven National Laboratory. Dr. Cusack is in charge of the BNL group.

Mr. and Mrs. John A. Andersen, Albuquerque, New Mexico. Mr. Andersen is a designer, project leader and systems engineer at Sandia Laboratories, Albuquerque. *He is the author of a technical article,* "New Accident-Resistant Plutonium Package," which appeared in the Winter 1978-1979 (Volume VII, No. 4) issue of Nuclear Materials Management, the journal of INMM.

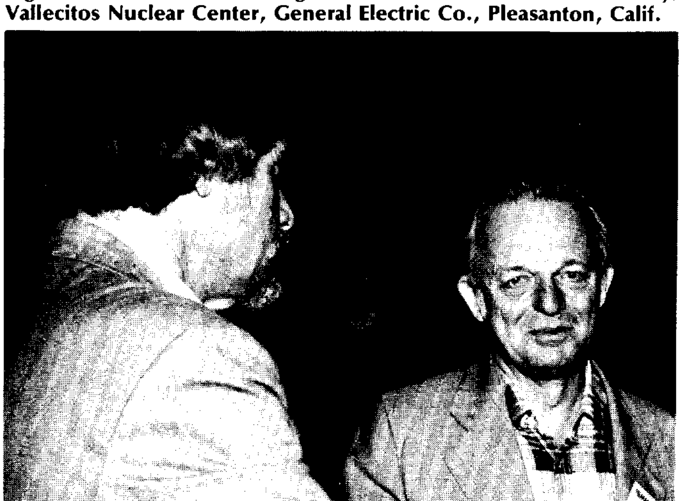
Dennis W. Wilson (center) of General Electric (San Jose) and A. William DeMerschman (right) of Westinghouse (Hanford) were honored during the 20th INMM annual meeting for their service the past two years on the INMM Executive Committee. They were each presented gifts by INMM Chairman Bob Keepin of LASL (left).

Joseph E. Steigler (center) of Sandia Laboratories is chairman of the newly-organized INMM Annual Meeting Arrangements Committee. Mr. Stiegler was assisted at the 1979 annual meeting by (from left) Roy B. Crouch, DOE-Albuquerque Operations, local arrangements chairman; Edward Owings, Oak Ridge Y-12, INMM treasurer; Duane Dunn, Rockwell International-RFP, registration chairman; and Tom Gerdis, consultant, Louisville, Ky., communications and publicity chairman.

Members of the 1979 INMM Annual Meeting Contributed Papers Committee (from left) are Thomas J. Collopy, United Nuclear Corporation, *Uncasville, Conn.; Dr. Richard N. Chanda, committee chair*man, Rockwell International, Rocky Flats Plant; and John E. Glancy, Science Applications, Inc., La Jolla, Calif. Mr. Glancy was also exhibits chairman for the 1979 annual meeting.

The nine-member registration committee headed by Duane Dunn (seated left) of Rockwell International's Rocky Flats Plant did an excellent job of handling the record 515 registrants at the 1979 INMM Annual Meeting. Seated from left: Dunn; Jo Loftis and Theresa Lavato of the DOE Albuquerque Operations Office; and Orville L. (Dusty) Meadors of Lawrence Livermore Laboratory. Standing from left: Price M. Hennan, Sandia Laboratories, Livermore Calif.; Munson (Whitey) Thorpe, Los Alamos Scientific Laboratory, David C. Kein, DOE Albuquerque Operations; E. A. DeVer, Mound Laboratory, Miamisburg, Ohio; Larry E. Wheeler, Oak Ridge National Laboratory; Harvey C. Austin, ORNL; and Luciano Gutierrez, DOE Albuquerque Operations.

Arthur J. Waligura (left) is currently associated with Brookhaven National Laboratory and represented Project ISPO at the annual meeting. Edward F. Kurtz is manager of the Advanced Fuels Laboratory, Vallecitos Nuclear Center, General Electric Co., Pleasanton, Calif.



Charles Beets (right) chaired an invited papers session, "Safeguards in ESARDA," at the 1979 INMM annual meeting. He visited during the annual meeting with Dr. Roy Nilson, Richland, Wash., chairman of the Pacific Northwest Chapter of the Institute. Mr. Beets is a safeguards leader in Belgium and active in the European Safeguards Research and Development Association (ESARDA).

Dr. Joerg H. Menzel (left) has been chief of the nuclear safeguards staff in the Bureau of Non-Proliferation of the U. S. Arms Control and Disarmanent Agency, Washington, D. C., since May. Dr. Menzel, a session chairman at the 1979 annual meeting, is shown visiting with Dr. Harald Bueker of the Karlsruhe Nuclear Research Center in West Germany. Dr. Bueker has presented papers at the last several INMM meetings.

Dr. and Mrs. Joseph P. Indusi, Coram, Long Island, New York. Dr. Indusi is deputy head of the Technical Support Organization for Nuclear Safeguards at Brookhaven National Laboratory. He has been active in activities of the International Safeguards Project Office (Project ISPO) at BNL headed by Leon Green.

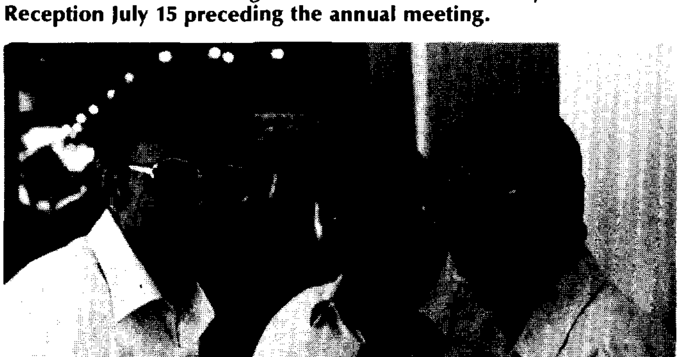
Dr. and Mrs. Howard O. Menlove, Los Alamos, New Mexico. Dr. Menlove is the recently-appointed leader of a new International Safeguards Group Q-5 at the Los Alamos Scientific Laboratory. His group is working in the areas of inspector instrumentation development and implementation, NDA standards and calibration, spent fuel verification techniques, training, IAEA utilization of in-plant NDA, and technology transfer.

Mr and Mrs. Roy B. Crouch, Albuquerque, New Mexico. Mr. Crouch did an excellent job as local arrangements chairman for the 1979 INMM Annual Meeting July 16-18 in Albuquerque. The meeting had a record attendance of 515. Mr. Crouch is with the Albuquerque Operations Office of the U.S. DOE.

Professor and Mrs. Ryohei Kiyose, Tokyo, Japan. Professor Kiyose represented the Japan Chapter of INMM at the 1979 annual meeting. He is the vice chairman of the Japan chapter. A professor of nuclear engineering at the University of Tokyo, Professor Kiyose has presented technical papers at previous INMM annual meetings.

Cesar A. Sastre (left) an INMM member for several years, is on the scientific staff at Brookhaven National Laboratory, Upton, Long Island, New York. E. R. (Ed) Johnson (right) is president of E. R. Johnson Associates, Vienna, Virginia, a consulting firm in the field of nuclear safeguards and materials management. Sastre and Johnson enjoyed a time of interaction during the INMM Chairman's Early Bird Cocktail Reception July 15 preceding the annual meeting.

Frequent participants in recent INMM annual meetings have been Phil Ting of the U.S. NRC Office of Standards Development and Cal Solem, an operations analyst for the U. S. NRC who formerly served at the International Atomic Energy Agency, Vienna, Austria.



Carlos Buechler (right) of the IAEA, chairman of the Vienna Chapter of INMM, is shown visiting with (from left) A. William DeMerschman of Westinghouse (Hanford) and Vincent J. DeVito of Goodyear Atomic during the 1979 annual meeting in Albuquerque.

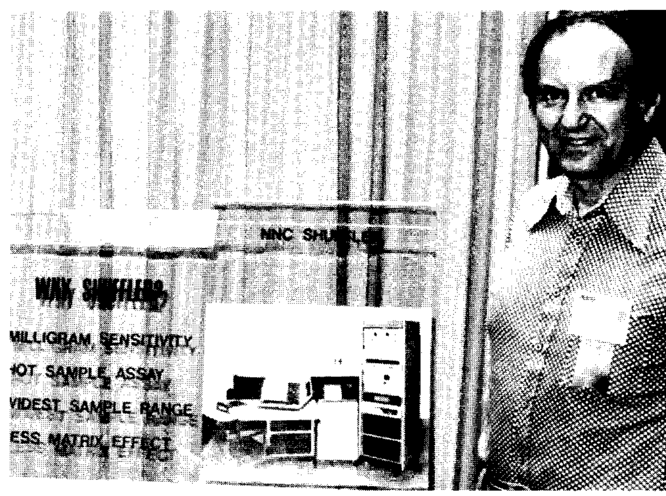
Mr and Mrs. Bernie Gessiness (right) of National Lead Company of Ohio, Cincinnati, posed during the INMM Chairman's Early Bird Reception Sunday evening with Mr. and Mrs. Tom Gerdis, Louisville, Ky. Mr. Gessiness, a past chairman of INMM, was local arrangements chairman for the 1978 annual meeting in Cincinnati. Mr. Gerdis is Journal Editor for INMM.

Jo Loftis (left) and Theresa Lovato of the Albuquerque Operations Office of U. S. DOE volunteered their services at the registration desk July 16-18 for the 20th annual meeting. Both ladies did an outstanding job of working with Registration Chairman Duane Dunn and members of his fine committee to help make the meeting one of the best run ever in the annals of INMM annual meetings.

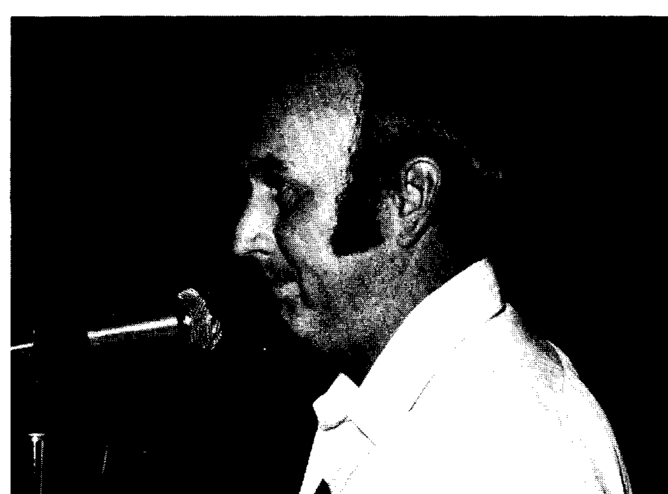
RUSCO Electronic Systems, 1840 Victory Boulevard, Glendale, California 91201. Rick Labowitz (left), Representative.

Ed Johnson spoke to a matter which came up during the INMM Annual Business Meeting on July 17. Mr. Johnson, a consultant on nuclear materials management and safeguards matters, has been named to head the new communication bureau of the INMM Public Information Committee.

Mr. and Mrs. A. William DeMerschman, Richland, Washington, Mr. DeMerschman was a major catalyst in the recent formation of the new Pacific Northwest Chapter of INMM and served on the INMM Executive Committee for the past two years. He was local arrangements chairman for the 1976 INMM Annual Meeting in Seattle, Washington.

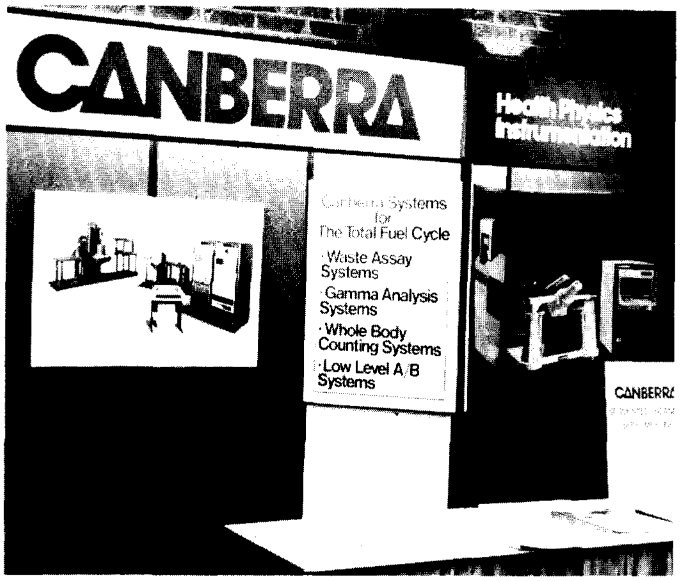


National Nuclear Corporation, 3150 Spring Street, Redwood City, California 94063. Phone: 415-364-2880. Herman Miller, Representative.



Charles M. Vaughan of General Electric — Wilmington NC addressed himself to a topic raised during the INMM Annual Business Meeting. Mr. Vaughan played a key role in the 1978 INMM Workshop on the Impact of IAEA Safeguards in the U. S. held last December 6-8 in Washington, D. C.

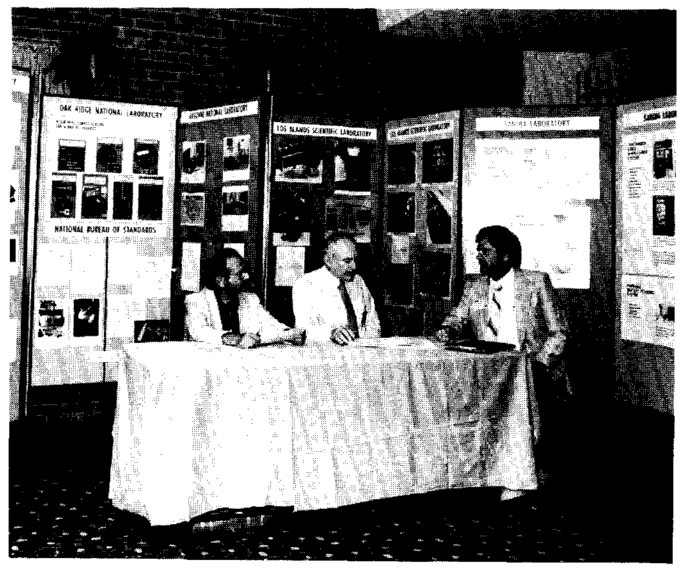
INTEX, Inc., 7101 Wisconsin Avenue, Bethesda, Maryland 20014. Phone: 301-654-4550. Stan Wexler, Representative.



Canberra Industries, 70 Gracey Avenue, Meriden, Connecticut 06450. **Phone: 203-238-2351. Larry East and Rudy Gatti, Representatives.**

Princeton Gamma-Tech, P. O. Box 641, Princeton, New Jersey 08540. Phone: 609-924-7310. Denny Cannon, Representative (Sales Engineer, P. O. Box 36157, Denver, Colorado 80236. Phone: 303-978-0786).

IRT Corporation, 7650 Convoy Court, P. O. Box 80817, San Diego, California 92139. Phone: 714-565-7171. Dr. Tom L. Atwell (left) and Dr. Kenneth R. Alvar, Representatives.



Project ISPO (International Safeguards Project Office), Brookhaven National Laboratory, Upton, New York 11973. Arthur J. Waligura, Representative (not pictured).

U. S. Department of Energy, DOE Research for Nuclear Facilities Safeguards, Oak Ridge Associated Universities, Oak Ridge, Tennessee.

Second Annual Listing

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G. Robert Keepin
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Edward Owings
Dennis M. Bishop
Roy G. Cardwell
Yvonne M. Ferris
Samuel C. T. McDowell
Francis A. O'Hara

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Richard N. Chanda
A. William DeMerschman
George A. Huff

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Duane A. Dunn
Thomas A. Gerdis
John E. Glancy
James W. Lee

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James W. Lee
Herman Miller

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Sylvester Suda, Chairman
Petr Beckman
Carl A. Bennett
Hans Bethe
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Bernard Cohen
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Samuel C. T. McDowell
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Ronald E. Tschiegg
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Richard Wilson

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James P. Patterson

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Herman Miller, Chairman
G. Anthony Adams
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Elroy Diatikar, Jr.
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Fred C. Olds
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Carleton D. Bingham
Robert Brooksbank
Dipak Gupta
John L. Jaech
Yoshio Kawashima
John F. Lemming
James E. Lovett
William C. Myre
Roger M. Smith
Roddy B. Walton
George H. Winslow
H. Thomas Yolken

Certification
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Thomas Bowie
Joseph Britschgi
Ken Duffy
Nicholas Roberts
Stan Turel

Education
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Vincent J. DeVito
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Nominating
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R. A. Kramer, Secretary

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Howard Menke, Chairman

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Rodney Hand
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Munson M. Thorpe

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Anton Kraft
Richard Schneider

INMM-7. Audit, Records and Reporting Techniques
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Dennis A. Conrad
Dean B. James
Sheldon Kops
Robert A. Kramer
Thomas I. McSweeney
Marvin F. Schnaible
L. Cal Solem

INMM-8. Calibration Techniques
Lou Doher, Chairman

Operating Contract Signed For Chemical Processing Programs At INEL . . .

DOE has signed a contract with Exxon Nuclear Idaho Company, Inc. (ENICO), a wholly-owned subsidiary of Exxon Nuclear Company, Inc., of Bellevue, Washington, for operating the Idaho Chemical Processing Plant at DOE's Idaho National Engineering Laboratory west of Idaho Falls.

The contract, effective July 30, 1979, extends through September 30, 1984. Estimated total cost over the contract period is $250 million for work currently involving approximately 900 employees.

John X. Combo, Deputy Manager for DOE's Idaho Operations Office, signed the contract on behalf of the agency. Signing for ENICO was **Robert W. McCullugh,** President and Chief Executive Officer.

INMM-8.1. Mass Calibration
John Murrell, Chairman
Joseph M. Cameron
B. T. Kramer
J. Mal McKibben
Paul E. Pontius
Stanley P. Turel
Charles M. Vaughan
James R. Whetstone

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L. G. Anderson
J. M. Crawford
Y.M. Ferris
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M. W. Hume
G.J. Lebaron
C. C. Thomas
D. F. Shepard
F. W. Spraktes
J. R. Whetstone
A. M. Krichinsky
J. M. McKibben
P. E. Pontius

INMM-8.3. Nondestructive Assay Calibration
Darryl B. Smith, Chairman
Richard N. Chanda
Albert E. Evans
Robert O. Ginaven
Merle Parker

INMM-8.4. Nuclear Calorimetry Calibration
Walter W. Rodenburg, Chairman
David A. Ditimars
John E. Glancy
Ken C. Jordan
Wilfred M. Mann
Frank L. Oetting
Francis A. O'Hara, Consultant
Walter W. Strohm
Richard Hamilton
Charles Roche
James Lechner

INMM-9. Nondestructive Assay
Darryl B. Smith, Chairman

INMM-9.1. Material Categorization
Richard N. Chanda, Chairman
Richard L. Bramblett
Albert E. Evans
John Gray
Francis X. Haas
Michael J. Jump
Herbert E. Smith
Stanley Turel

INMM-9.2. Container Standardization
Thomas L. Atwell, Chairman
John Birden
W. S. Cowan
John H. Gray
Ron Hawkins
James Rushton
Thomas E. Shea
Dale Smay
Charles N. Tesitor

INMM-9.3. Physical Standards
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S. Carpenter
R.A. Harlan
T. L. Hardt
M. J. Jump
T. L. McDaniel
W. P. Reed
D. Reilly
W. Rodenburg
D. B. Smith
P. Ting
N. M. Trahey

INMM-9.4. Measurement Controls
Darryl B. Smith, Chairman
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Willard Borwn
John M. Crawford
Edward Eckfeld
Richard Hagenauer
Robert M. Hellen
James Lechner
Gavin Mallet
Robert M. McCord
Charles M. Vaughan

INMM-9.5. Techniques
John P. Stewart, Chairman
Norman S. Beyer
Keith O. Johnson
James Griggs
Thomas Crane
Lynn K. Hurst
Herman Miller
Merle A. Parker
Hans Weber

INMM-9.6. Automation
Walter W. Strohm, Chairman
Ronald W. Brandenburg
Larry East
Kenneth Johnson
Norman E. Hall
James L. Lawless
Nicholas J. Roberts
David E. Rundquist
Phillip Ting

INMM-10. Physical Security
T. A. Sellers, Chairman
John L. Bastin
M. J. Cooney
H. M. Dixon
Mark Elliott
W. E. Gilbert
Edward F. Kurtz
E. L. Musselwhite
H. C. Paxton
James Prell
Don Six
A. E. Winblad

INMM-11. Certification
Fredrick Forscher, Chairman

INMM-12. Site Response Planning
Edward R. Young, Chairman

INMM-13. Transportation (Advisory Group)
Robert Wilde, Chairman

INMM-14. International Safeguards (Advisory Group)
Robert Sorenson, Chairman

Holding to the Spirit of Nonproliferation

By Chris FitzGerald, Editorial Director
NUCLEAR NEWS
American Nuclear Society
LaGrange Park, Illinois

Editor's Note: The following editorial report on the 20th INMM Annual Meeting July 16-18 at the Albuquerque Hilton Hotel appeared in the September 1979 issue of **Nuclear News** (p. 29). "Holding to the spirit of nonproliferation" by **Chris FitzGerald** is reprinted with the permission of the American Nuclear Society.

It was back in 1967 that President **Lyndon Johnson** offered to place U.S. nondefense nuclear facilities under the same international safeguards to which non-nuclear weapon states are asked to submit themselves under the terms of the Nonproliferation Treaty. The offer, magnanimous in its intent, if slow in its fulfillment, was in keeping with the strong, consistent support that the United States has given over the years to the cause of nonproliferation and to the safeguards role of the IAEA.

Support for the U.S.-IAEA treaty is far from universal. Nuclear utility managers are understandably wary of yet another layer of reporting requirements and inspection processes. Suppliers are naturally concerned about disclosure of proprietary information.

Still, the arguments in support of effective nonproliferation — and of doing all one can to make it equitable among nations—appear to override lesser concerns, and the U.S. Senate is expected at long last to ratify the treaty this year or early next year. Among those urging ratification is the executive committee of the Institute for Nuclear Materials Management, as announced at the organization's annual meeting in mid-July in Albuquerque, N.M. In a letter to Sen. **Claiborne Pell** (D., R.I.), who heads the subcommittee of the Committee on Foreign Relations having jurisdiction on the matter, INMM chairman **G. Robert Keepin** of Los Alamos Scientific Laboratory expressed the belief that "as smooth and rapid a transition as possible to the implementation of international (IAEA) safeguards in the spirit of the Nonproliferation Treaty is in the best interests of safe — and safeguarded — nuclear energy, in an increasingly energy-hungry world." Keepin quoted IAEA Director-General **Sigvard Eklund** as asserting, in his keynote remarks at Albuquerque, that "an effective international safeguards regime is an absolute condition for the future viability of international trade in nuclear materials, plant, and equipment."

This trade aspect of nonproliferation policy is of crucial importance. **Bert Wolfe** of General Electric reminded those at the INMM meeting that the proliferation question predated commercial nuclear power development. The United States offered to share nuclear technology for peaceful purposes as an express inducement to other nations to forgo weapons.

As Eklund pointed out at the INMM meeting, the Indian nuclear explosion of May 1974 prompted restrictive approaches to nonproliferation policy — on the one hand, the restrictiveness exemplified by the so-called London Suppliers Club of 1976 and by the (U.S.) Nuclear Nonproliferation Act of 1978, and, on the other hand, the effort to promote international "technical fixes," such as proliferation-resistant fuel cycles, to inhibit the military uses of nuclear facilities and programs. Eklund commented, "Is it hopefully not presumptuous to expect that the International Nuclear Fuel Cycle Evaluation (INFCE), presently formulating its conclusions, will reveal the limitations of technical fixes and place the emphasis again on the fact that proliferation is, in the first instance, a political — I repeat, a political — problem, the solution of which lies in appropriate policies of consensus and cooperation based on the goodwill and determination of all nations."

Other recommendations made at the INMM meeting concerning U.S. policy included these by Wolfe: (1) greater realism, with recognition that the United States no longer has a monopoly in any part of nuclear technology; (2) abolition of the Nuclear Nonproliferation Act and its replacement by general guidelines to the executive branch; (3) rescission of the executive order requiring environmental statements on nuclear exports; (4) a general effort to make dealing with the United States attractive; and (5) recognition that "a strong U.S. nuclear industry . . . is an essential ingredient to successful nuclear power nonproliferation programs." — *Chris FitzGerald.*

FitzGerald

Education Committee Plans Accounting-Auditing Techniques Course in Early 1980

By Harley L. Toy, Chairman
INMM Education Committee
Columbus, Ohio

In fiscal '80 the Institute's educational program will focus on expanding formal course offerings. Immediate plans call for the presentation of a formal Accounting and Auditing Techniques course. The 5-day course will be conducted by **Shelly Kops** of the DOE Chicago Operations Office. Target date for this course is in early 1980. Our Selected Topics Statistics course was presented in Columbus in October 1979. The statistics course along with the accounting and audit techniques course will round out our program for the first four months of F. Y. 1980.

Discussions are currently underway with **Joe Stiegler** of Sandia Laboratories to explore the feasibility of presenting a formal course in physical security. Our first task will be defining the needs and the target audience for such a physical security course. As most of you know, Stiegler has had direct involvement in DOE's physical security educational programs. His expertise in this area is sorely needed if the Institute is to provide a meaningful physical security course. According to Steigler, our first step is to define our objective in terms of the target audience which could be managers, supervisors, or implementers. Our current plan is to continue discussion leading to a finalized objective for evaluation by the Executive Committee with input from the Certification Committee. The Education Committee will keep the membership advised of our progress in this area.

As noted in our annual report the Education Committee will be assisting in the Institute's Certification Program. Such assistance will be advisory and implementation of course offerings designed to enhance the Certification Program. Dr. **Frank O'Hara**, who has oversight responsibility for the Education Committee, is coordinating these efforts.

Our next report will address our progress in assisting the Certification Program and update the status of the physical security course. In the meantime you will be receiving information on the upcoming Accounting and Audit Techniques course.

Harley Toy (left) and Art Brown, both of Battelle Columbus Laboratories, enjoyed themsleves during the Chairman's Reception Sunday evening. Toy, chairman of the INMM Education Committee and a past chairman of the Institute, is NRC-DOE coordinator at Battelle. Brown is the supervisor of plant security.

Three NUSAC Appointments

McLEAN, Va. — NUSAC, Inc., a wholly-owned subsidiary of The Wackenhut Corporation of Coral Gables, Florida, has announced the appointments of three professionals to its staff.

James P. Duffy, Jr., has recently joined the firm as manager, computer security division. Under Duffy's direction, NUSAC has begun offering a wide variety of computer security and continuity of operations services to government and industry.

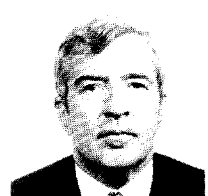
Mr. Duffy comes to NUSAC from The Defense Intelligence Agency where he managed their total data processing operations and activities as these related to the security environment.

Dr. **Jack E. Pevenstein** is the firm's new director of marketing. His duties include management of all NUSAC business development operations, new product and service development, and long-range marketing strategy planning.

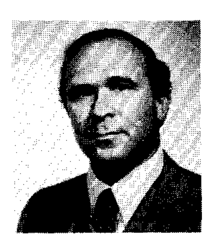
For nearly seven years prior to joining NUSAC, he was employed by Planning Research Corporation. In 1974, he cofounded and was deputy director of PRC's applied research group.

A new senior technical associate with the McLean firm is Dr. **John A. Rohrabacher** from South Dakota State University, Brookings, and from his own consulting firm. His duties will include contributing to the social aspects of all environmental impact statements as prepared by the NUSAC Environmental Assessment Division.

He holds a B. S. Degree from Michigan State University, M.A. from the University of Texas, Austin, and the Ph.D. from the University of Wisconsin, Madison. All three degrees are in geography.



Duffy



Pevenstein

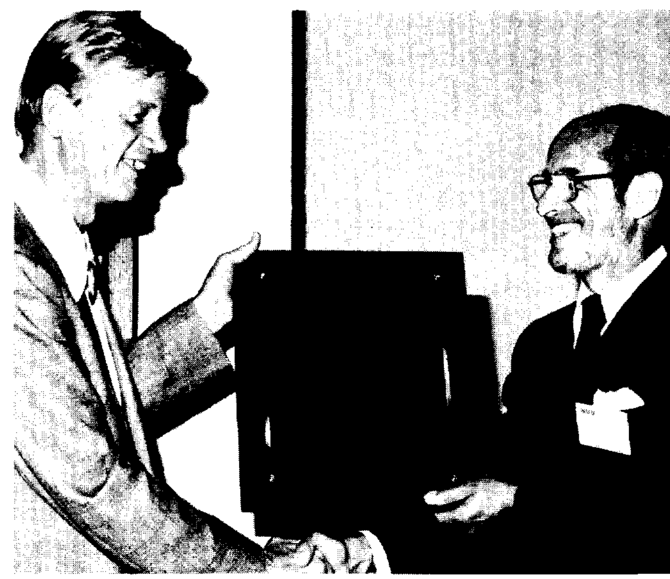
Rohrabacher

Buechler Sees INMM Adopting Greater Interest in International Safeguards

The Vienna Chapter was represented at the Albuquerque meeting by **J. Nardi, D. Rundquist, J. Lovett,** and myself. In addition, the IAEA was represented by its Director General, Dr. **Sigvard Eklund.** To all of us, the meeting was an unqualified success. While this view may be shared by many, the reasons for holding it may not be the same for all. For the Vienna contingent it showed a strong trend for the INMM to adopt a greater interest in the international aspects of Safeguards. The (relatively) large non-US participation in the meeting insured that the international point of view on Safeguards was articulately expressed. The other side of the picture was just as important. The non-American participants had an opportunity to be appraised of the emphasis which is placed in the US on different aspects of Safeguards and physical security. As such emphasis does not necessarily coincide with the prevailing one outside the US, the meeting provided an excellent opportunity for the nature and cause of such differences to be better understood by all concerned.

We are glad that the Director General of the IAEA could become better acquainted with the Institute, its work, its problems and its membership, and hope that this meeting may make the beginning of a closer cooperation between the IAEA and the INMM. Apart from all this we enjoyed the informal atmosphere in which the meeting took place.

In October the IAEA moves to its new Headquarters, the Vienna International Center built by the Austrian Government on the banks of the Danube. On 23 August the VIC was officially transferred to the United Nations, for an annual rent of one Austrian Schilling. Future "Letters from Vienna" will be mailed from the VIC, using the newly issued United Nations postage in Austrian Schilling denominations. In the meantime we send you greetings from a Vienna in which the late summer already is beginning to bring us the cool, crisp mornings which are a premonition of the winter to come — **C. Buechler.**



INMM Chairman Bob Keepin (left) of LASL presented an engraved charter to Carlos Buechler, chairman of the Vienna Chapter, at the annual meeting in July.

Battelle Names Dr. James Perrin As Senior Research Leader ...

Dr. **James S. Perrin,** an international expert on nuclear materials technology, has been named a senior research leader at Battelle's Columbus Laboratories.

In this position, he will lead a number of research projects involved with nuclear materials. He was recommended for the post by his associates and selected by Dr. **Edward W. Ungar,** Battelle-Columbus director.

Since joining the Battelle staff in 1966, Dr. Perrin has been involved in studies concerned with the effects of radiation on the physical and mechanical properties of nuclear fuels, cladding, and structural materials.

Most recently, he has directed a program on pellet-clad interactions in nuclear fuel rods and has been involved in a study of structural materials for an advanced nuclear reactor. He also is directing a series of programs on nuclear pressure vessel surveillance that are used to help ensure the safety of pressure vessels under both normal and accident conditions.

Dr. Perrin's International reputation has led to appointments as U.S. delegate to international meetings on nuclear materials held in Austria, Czechoslovakia, and Germany.

Dr. Perrin received his B.S. (1958) in metallurgy from the Massachusetts Institute of Technology; M.S. (1960) in metallurgy from the University of Illinois; and Ph.D. (1969) in materials science from Stanford University.

Only INMM Domestic Chapter Now Lists 50 Members

Compiled by Thomas A. Gerdis, Editor
Nuclear Materials Management
Journal of INMM
Louisville, Kentucky

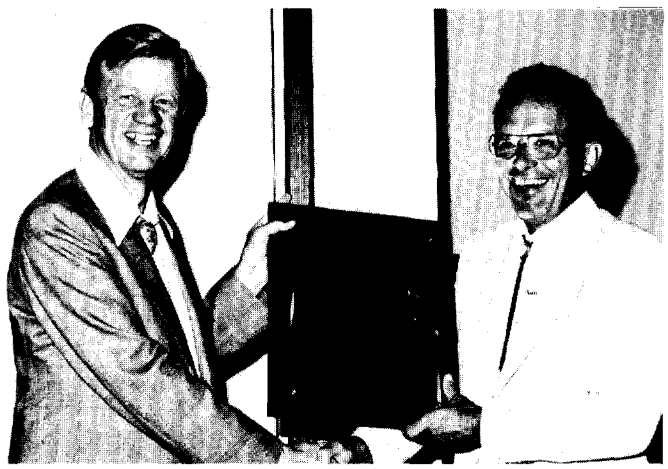
The Pacific Northwest Chapter of the INMM now lists about 50 members and at press time for this journal had planned its first meeting sometime in October. A number of officers and members of the chapter were in attendance at the 1979 INMM Annual Meeting July 16-18 at the Hilton Inn in Albuquerque, New Mexico.

According to **A. W. (Bill) DeMerschman,** chairman pro tem for the chapter, the chapter's petitioners solicited and received favorable response from the following individuals to serve as officers for the first year. Effective this past August 1, the following assumed office:

Office Held	Name	Affiliation
Chairman	**Roy Nilson**	EXXON Nuclear
Vice Chairman	**Bob Sorenson**	Pacific Northwest Laboratories
Secretary-Treasurer	**Barbara Wilt**	Department of Energy
Executive Committee Member	**Etoy Alford**	Washington Public Power
Executive Committee Member	**Curt Colvin**	Rockwell Hanford Operations
Executive Committee Member	**Dean Engel**	Westinghouse Hanford

According to DeMerschman, "with the success of the Albuquerque meeting and the enthusiasm exhibited at our initial chapter meeting, I believe we will have a successful and beneficial organization."

Dr. Nilson indicates that "one of the objectives of our chapter will be information exchange between the many and varied nuclear components in the Hanford area. These include several government contractors in both defense and peaceful nuclear applications, a commerical fuel supplier, a large utility complex, research laboratories, DOE, and several smaller research companies. Much work in safeguards is going on, but the information exchange between the groups is small — hopefully our chapter can strengthen this weakness."



INMM Chairman Bob Keepin (left) of LASL presented the Official Charter for the new INMM Pacific Northwest Chapter to Bill DeMerschman of Westinghouse Hanford. DeMerschman was chairman pro tem of the chapter and served on the INMM Executive Committee the past two years.

The first chairman of the new Pacific Northwest Chapter of INMM is Dr. Roy Nilson (left), manager of licensing for EXXON Nuclear Co., Inc., Richland, Wash. He shared a happy moment during the 1979 INMM Annual Meeting with Tom Gerdis, Editor of Nuclear Materials Management.

INMM Sponsors Reception For Visiting Students

By John L. Jaech, Staff Consultant
EXXON Nuclear Co., Inc.
Richland, Washington

A training course on advanced systems of accounting for and control of nuclear materials was held in Richland from July 23 to August 3.

The 10-day course, sponsored by the International Atomic Energy Agency in cooperation with the U.S. Government, was designed to provide practical training in accounting and control systems for facilities handling bulk quantities of nuclear materials.

Exxon Nuclear Company, Inc., and the Department of Energy's Pacific Northwest Laboratory, operated by Battelle Memorial Institute, were contracted to host the course. It was co-directed by Battelle's **Robert J. Sorenson** and Exxon Nuclear's **Richard A. Schneider.**

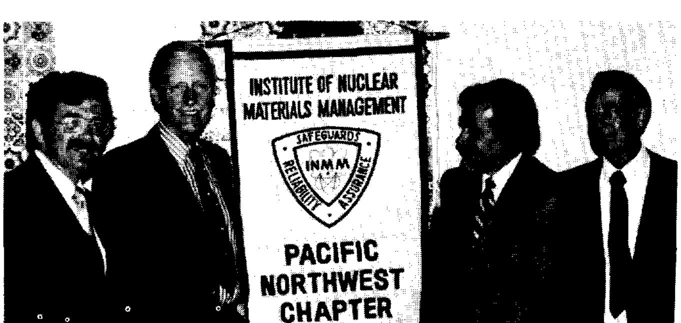
Instructors from Exxon Nuclear lectured on nuclear material accounting measurement techniques, physical inventory methods and statistics. They also demonstrated all key nuclear material accountability measures at Exxon Nuclear's fuel fabrication facility in Richland, which was used as the model plant and generic example for the course.

Battelle staff memebers gave lectures on recent advances in material accountability research and applying nondestructive assay techniques to material control, and demonstrated a mobile verification and measurement system.

Class participants at opening night cocktail party sponsored by INMM. The Pacific Northwest Chapter banner is the focal point.

This advanced training course is part of an international effort to better control nuclear materials by enhancing safeguards systems worldwide. It was attended by 21 professionals representing 16 countries.

At a reception on the Sunday evening preceding the course, the INMM served as host. The INMM sponsorship was made visible by the banner of the Pacific Northwest Chapter that was displayed prominently at the reception. The Founding Chairman of the PNW Section of the INMM, **Bill DeMerschman,** spoke briefly on the work and purposes of the INMM, and especially on its increasing interest in international safeguards. He also introduced to the group his successor as Chairman, **Roy Nilson.**



Bob Sorenson (left) of Battelle Northwest posed for this photograph with (from left) Iain Hutchinson, IAEA; Roy Nilson, EXXON Nuclear; and Dick Schneider, EXXON Nuclear. Sorenson and Schneider were course directors; Hutchinson was the IAEA representative in charge of training. Nilson is chairman of the Pacific Northwest Chapter, INMM, and represented the Institute along with Bill DeMerschman, the chapter's founding chairman.


View of the INMM-sponsored cocktail party. Sampling the hors d' oeuvres is Juan Carlos Herrera Toro of Chile. Richard Keefe of Canada is next in line.

Three Areas of Activity Identified At Meeting in Albuquerque By Safeguards Committee Members

By Sylvester Suda, Chairman
INMM Safeguards Committee
Upton, New York

At the annual meeting of the INMM Safeguards Committee held in Albuquerque July 17, 1979, a number of timely issues were addressed and deliberated.

The Committee welcomed Dr. **S. C. T. McDowell,** newly-elected to INMM Executive Committee, who has been assigned oversight responsibility for Safeguards.

The importance of the Safeguards Committee function to provide resource material to the Public Information Committee, chaired by **Herman Miller,** was stressed. This is an area in which little has been accomplished in the past. The primary goal of the Safeguards Committee for the coming year is to get more involved in programs that will lead to better public and political awareness of nuclear material safeguards. However, one lesson learned this past year was that operationally the Safeguards Committee is not organized in a way that makes it possible to react to fast moving issues such as the accident at the Three Mile Island Nuclear Plant in Pennsylvania. The issues peak, shift, and wane before the expertise of the Committee can be brought to bear.

Three areas of future activity were identified:

1. Public Information.

The Committee will undertake the preparation of a technical paper on the definition of safeguards. The Committee noted the absence of a reference document that clearly presents the objectives of safeguards and the differences between domestic and international safeguards, reactor safety, waste disposal and other nuclear issues.

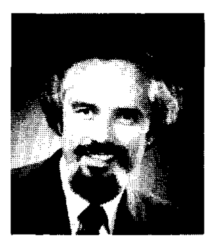
2. Safeguards Objective and Criteria.

The Committee will prepare a report on domestic safeguards objectives and criteria. The report will present the scope, purpose and basis of an engineering study that would look at the relative and comparative risks of processing various forms and types of nuclear material. The hoped for follow-on is either a DOE or NRC program to fund the engineering study.

3. Rule Change for Low-Enriched Uranium Safeguards.

The Committee will draft a "Petition for a Rule Change" to licensee regulations. This item is related to 2 above and will request a review of the licensee requirements for low-enriched uranium (LEU). Many regulations make no distinction between low-enriched uranium and plutonium. It is the consensus of the group that there are areas where relaxed requirements for LEU are justified.

The next meeting of the Safeguards Committee will involve a one-day working session at Kiawah Island, South Carolina, to be held in conjunction with the joint ANS, NBS, and INMM sponsored conference on measurements set for November 26-29, 1979.



Suda

Fireproof Cask

ALBUQUERQUE, N. M. — A spent nuclear fuel shipping cask designed to survive an 800°C fire for 30 minutes — a federal requirement — has been developed by Sandia Laboratories and awarded a U. S. patent (4,147,938). Inventors are **Marvin Moss** and **Richard Heckman.**

Because spent nuclear fuel generates heat from decay of radioisotopes, shipping casks frequently have cooling fins extending radially from the center container.

The new Sandia cask has concentric bimetallic bands located between these cooling fins. Each band consists of an inner strip of stainless steel bonded to an equal thickness of Kovar.

The bands, which employ the same principle used in thermostats, expand when exposed to a fire, forming a tight barrier near the outer diameter of the fins, reducing the amount of heat reaching the central container.

When the fire subsides, the bands automatically retract to their original positions, whereupon the cooling fins resume the dissipation of internally generated heat.

When test casks were heated for 30 minutes with butane torches, surface and center area temperatures of the protected cask reached 180°C and 115°C respectively, compared with 295°C and 145°C for the unprotected cask.

Thermal Reactor Safety

There will be an American Nuclear Society topical meeting on thermal reactor safety April 8-11, 1980, at the Hyatt Regency, Knoxville, Tennessee.

General Chairman for the meeting is **William B. Cottrell** of Oak Ridge National Laboratory (P.O. Box Y, Oak Ridge TN 37830). The technical program committee co-chairmen are **Mario H. Fontana** of ORNL and **Dwight R. Patterson** of TVA (400 Commerce Avenue, Knoxville, TN 37902).

Summaries of 1,000 words were sought on the following topics:

1. Understanding response of nuclear steam supply systems to design basis events.
2. System structural response (primarily invited survey papers).
3. Diagnostics and in-service inspection.
4. Fire protection.
5. Safety-related equipment qualification.
6. Man-machine interactions.
7. Issues with respect to improved safety.
8. New trends in licensing.
9. NRC unresolved safety issues.
10. Risk and cost comparison of energy technologies for central electric power generation.
11. Three Mile Island incident.

Papers are being sought in all areas of thermal reactor safety, but the program committee has identified the above 11 areas of special interest.

John Mahy Succumbs

John F. Mahy, 47, a Department of State nuclear safeguards expert, died of a cerebral hemorrhage, Thursday, September 20, in Vienna, Austria. Mr. Mahy was a senior technical adviser with the U. S. Mission to the IAEA.

He was one of the first American experts in international safeguards matters, having entered this field with the U. S. Atomic Energy Commission in the late 1950's. Before moving to Austria in 1975 to assume his duties with the State Department, he lived on Pear Hill, Clarksburg Road, Clarksburg, Md., where he was prominent in social, church, and civic activities of Upper Montgomery County. He was a long-time active member of INMM and one of the founders of the Vienna chapter. He was born July 12, 1932, in Quincy, Massachusetts, and graduated from Iowa State University, Ames, as a chemical engineer in 1956.

He is survived by his wife, Marjorie, and four children — Sara, Lisa, Todd, and Mary, now in Vienna, his sister, Evelyn Dash, and his mother, Ruth Mahy, Elnora, N. Y.

A memorial service was held in Vienna September 25. The family requested that no flowers be sent. Those wishing to make a memorial contribution should contact Joe Lafleur, 14701 Poplar Hill Road, Germantown, Maryland, 20767 — Phone: (301) 492-7131.

Mahy

INMM Continues to Grow As Membership Reaches 640

By James W. Lee, Chairman
INMM Membership Committee
North Palm Beach, Florida

Despite the large amount of "gloom and doom" talk which has pervaded newspaper reports about the nuclear industry the past two years, the total net membership of the Institute continues to increase each year, we are happy to report.

Immediately following the Annual Meeting in Albuquerque in July, the INMM membership reached a record total of 640, reflecting the growing importance people in the nuclear industry place on safeguards and, in a way, acting as a barometer of the increasing quality and depth of the Institute's programs. The Membership Committee maintains a continuing effort to interest new members, but the real drawing power is provided by the quality of the Institute's services to its members, as demonstrated by the expertise, planning and untiring efforts that are put into its Annual Meeting program, the extremely high quality offerings of the Journal, and in the dedication of its officers and committee members.

Annual Meeting Membership Desk

An innovation at the Albuquerque meeting was the establishment of a Membership Committee Desk in the reception area during the three days of the meeting. Staffed by members of the Membership Committee, including **Vince DeVito, Ed Owings, Tom Gerdis** and **John Barry,** and ably assisted by past-Chairman, **Roy Cardwell** and his wife, Barbara, the desk did a land office business.

Continuing another innovation introduced a few years ago, the Institute offered a $5.00 discount on the first year dues for anyone who joined INMM during the Annual Meeting. Some 37 new members applied and were accepted during the meeting. It is planned to continue both practices at future annual meetings.

New Members STILL Wanted

Before you finish reading this column, stop for a moment and think over the names of your colleagues and friends who do not belong to INMM — but should. Send me their names, c/o Tom Gerdis, Journal Editor, and I will mail them a personal invitation to join the Institute.

James W. Lee (second from left) is the chairman of the INMM Membership Committee. Mr. Lee, a transportation consultant to Tri-State Motor Transit Co., Joplin, Mo., is shown with three members of the committee (from left): Vincent J. DeVito, Goodyear Atomic, Piketon, Ohio; Lee; Thomas A. (Tom) Gerdis, consultant, Louisville, Ky. (formerly of Kansas State University, Manhattan); and Edward Owings, Y-12 Plant at Oak Ridge, Tenn. Two other committee members are John Barry, Gulf States Utilities, Beaumont, Tex., and James Patterson, U. S. NRC Region VII, Glen Ellyn, Ill.

New Members

The following 61 individuals have been accepted for INMM Membership during the period of June 1 to August 31, 1979. To each, the INMM Executive Committee extends its welcome and congratulations. New members not mentioned in this issue will be listed in the Winter 1979-1980 (Volume VIII, No. 4) issue to be sent out beginning February 1, 1980.

Lawrence D. Barnes, Manager, Advanced Systems Department, Allied-General Nuclear Services, P. O. Box 847, Barnwell, SC 29812.

James W. Behrens, Physicist, National Bureau of Standards, Center for Radiation Research, Washington, DC 20234.

E. L. Bellisario, Manager, Nuclear Materials Control and Accounting, Babcock & Wilcox — NM & MD, 609 North Warren Avenue, Apollo, PA 15613.

Charles W. Benson, Safeguards and Special Nuclear Materials Management Department, Oak Ridge national Laboratory, Oak Ridge, TN 37830.

Paul E. Blanchard, Director, Radwaste Disposal and Support Services, Hittman Nuclear & Development Corporation, 9190 Red Branch Road, Columbia, MD 21045.

Robert E. Brooksbank, Section Head, Pilot Plants, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, TN 37830.

Rodney O. Buchanan, Corporate Director, Nuclear Safeguards, Burns International Security Services, 320 Old Briarcliff Road, Briarcliff Manor, NY 10510.

Dr. **Christopher P. Cameron,** Technical Staff Member, Sandia Laboratories, Division 1761, Albuquerque, NM 87185.

Dr. **David Camp,** Director, Safeguards Technology Program, Lawrence Livermore Laboratory, Livermore, CA 94550.

Riley D. Carver, Supervisor, Lawrence Livermore Laboratory, P. O. Box 808, L-347, Livermore, CA 94550.

Curtis A. Colvin, Manager, Plutonium Analytical Chemistry, Rockwell International, P. O. Box 800, Richland, WA 99352.

William E. Cooper, Accountant, Union Carbide Corporation, Bldg. K-1007, MS 057, Oak Ridge, TN 37830.

Fredrick L. Crane, Senior Consultant, International Energy Associates, LTD., 600 New Hampshire Avenue N.W., Washington, DC 20037.

Dr. **Leslie C. Davenport,** Senior Research Scientist, BATTELLE Pacific Northwest Laboratory, P. O. Box 999, Richland, WA 99352.

William J. Desmond, Chief, Security Operations and Inspection Branch, U.S. Department of Energy, Savannah River Operations Office, P. O. Box A, Aiken, SC 29801.

Michael J. Eaton, Division Supervisor, Sandia Laboratories, Div. 1759, Albuquerque, NM 87185.

Jon E. Fager, Research Scientist, BATTELLE Pacific Northwest Laboratory, P. O. Box 999, Richland, WA 99352.

Clifford D. Fry, Officer, Traffic Branch, Tennessee Valley Authority, 630 Commerce Union Bank Building, Chattanooga, TN 37401.

William E. Groome, Senior Engineer, Video Tek, 8 Morris Avenue, Mountain Lake, NJ 07046.

Noe E. Guerra, Engineering Security Services Supervisor, Stone & Webster, 245 Summer Street, Boston, MA 02107.

Dr. **Ray Gunnink,** Section Leader, Lawrence Livermore Laboratory, L-233, Livermore, CA 94550.

Sin Tao Hsue, Staff Member, Los Alamos Scientific Laboratory, MS 540, Los Alamos, NM 87545.

Robert D. Hurt, Nuclear Engineer, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, TN 37830.

Edwin G. Johnsen, Chief, Development Automation and Control Technology (DACT), U.S. National Bureau of Standards, Washington, DC 20234.

Charles S. Johnson, Staff Member, Sandia Laboratories, Div. 1754, Albuquerque, NM 87185.

Dr. **Jacqueline E. Kent,** Mathematical Statistician, U.S. Nuclear Regulatory Commission, Office of Standards Development, Washington, DC 20555.

Richard A. Kish, Senior Planning Control Engineer, Westinghouse Advanced Reactors Division, Cheswick Avenue, Cheswick, PA 15024.

Peter J. Koppel, Executive Vice President, Mitsubishi Nuclear Fuel, Westinghouse Electric Corporation, P. O. Box 355, Pittsburgh, PA 15230.

Dr. **Herbert J. C. Kouts,** Chairman, Department of Nuclear Energy, Brookhaven National Laboratory, Upton, Long Island, NY 11973.

Alan M. Krichinsky, Associate Development Engineer, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, TN 37830.

Dr. **Tien Keh Li,** Staff Member, Los Alamos Scientific Laboratory, MS 539, Los Alamos, NM 87545.

Sarah Ann Malone, Chemist, U.S. Department of Energy, New Brunswick Laboratory, Building 350, 9800 South Cass Avenue, Argonne IL 60439.

Dr. **Jack T. Martin,** Staff Member, Los Alamos Scientific Laboratory, Los Alamos, NM 87545.

Erick L. May Jr., Senior MC&A Staff, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

Christopher D. McDonald, Acting Chief, Physical Security, Law Enforcement Division, U.S. Department of Army, STEWS-SO-ES, White Sands Missile Range, NM 88002.

Dr. **Douglas E. McGovern,** Technical Staff (Safeguards), Sandia Laboratories, Albuquerque, NM 87185.

Joseph A. Nardi, Jr., Head, Data Processing Department, International Atomic Energy Agency, P.O. Box 645, A-1011 Vienna, Austria.

Clifford E. Nordeen, Staff Member, Los Alamos Scientific Laboratory, MS 505, Los Alamos NM 87545.

John A. Oakberg, Computer Analyst, Union Carbide Corporation, P. O. Box P, ORGDP, Oak Ridge, TN 37830.

Robert G. Olson, Senior Scientist, Lawrence Livermore Laboratory, P. O. Box 808, L-369, Livermore, CA 94550.

J. Harding Owen, Site Safeguards Coordinator, E. I. duPont de Nemours and Company, Savannah River Plant, Aiken, SC 29801.

Dr. **Jack L. Parker,** Staff Member, Los Alamos Scientific Laboratory, Los Alamos, NM 87545.

Paul J. Persiani, Physicist, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439.

William M. Reffit, Process Supervisor, Goodyear Atomic Corporation, P. O. Box 628, Piketon, OH 45661.

Annabelle S. Risher, Accounting/Auditing Technician, U.S. Department of Energy, P. O. Box 550, Richland, WA 99352.

Carl R. Robertson, Physical Scientist, U.S. Department of Energy, Idaho Operations Office, 550 — 2nd Street, Idaho Falls, ID 83401.

Jack W. Savage, Safeguards Systems, Lawrence Livermore Laboratory, P. O. Box 808, L-154, Livermore, CA 94550.

Mound Participates In Health Studies

MIAMISBURG, Ohio — Mound Facility will participate in three separate, government-sponsored health studies related to workers at nuclear materials handling facilities. The studies, which are authorized by the U. S. Department of Energy, are being conducted by Oak Ridge Associated Universities and Los Alamos Scientific Laboratory. Oak Ridge is conducting a "Health and Mortality Study" and a "Radiation Workers Follow-Up," while Los Alamos will conduct a "Plutonium Workers Study."

The announcement was made by **Patrick C. Adams,** Health Physics Operations Manager for Mound, which is operated by Monsanto Research Corporation for the U. S. Department of Energy.

According to Mr. Adams, the studies are a continuation of data collection in which Mound has participated since 1972. "The fundamental purpose of these studies is to afford additional safety and protection to all employees having the potential for occupational exposure to radiation. They can be a key part of the comprehensive, ongoing medical monitoring program routinely practiced by Mound and others in the nuclear industry," Mr. Adams said.

The Oak Ridge "Health and Mortality Study" will compile data on workers from three plants at Oak Ridge National Laboratory, from National Lead of Ohio and from Mound. The "Radiation Workers Follow-Up" will be a nationwide study of all Department of Energy (formerly Atomic Energy Commission) sites.

The Los Alamos "Plutonium Workers Study" involves DOE's Hanford, Rocky Flats, Oak Ridge, Los Alamos and Mound sites. The Los Alamos study will look particularly at the element plutonium, while the Oak Ridge studies will include all radioisotopes where occupational exposure is involved.

According to Mr. Adams, Mound is in the process of contacting all current, retired and former employees to notify them of the studies and to urge them to participate.

Dean D. Scott, Senior Engineer, Westinghouse Hanford Co., P. O. Box 1970, Richland, WA 99352.

Lewis C. Solem, Operations Analyst, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

David W. Swindle Jr., Engineer II, Oak Ridge National Laboratory, P. O. Box X, Building 7601, Room 242, Oak Ridge TN 37830.

Dr. **Robert G. Thomas,** Biophysicist, Los Alamos Scientific Laboratory, MS 880, Los Alamos, NM 87545.

Dr. **John W. Wachter,** Staff Member, Oak Ridge National Laboratory, P. O. Box X, Building 7601, Oak Ridge, TN 37830.

Ivan G. Waddoups, Supervisor, International Safeguards Division, Sandia Laboratories, Div. 1754, Albuquerque, NM 87185.

William P. Walsh, Research Scientist, BATTELLE Pacific Northwest Laboratory, P. O. Box 999, Richland, WA 99352.

David G. Ward, Consulting Engineer, NUS Corporation, 4 Research Place, Rockville, MD 20850.

Luther Welsh, President, National Nuclear Corporation, 3150 Spring Street, Redwood City, CA 94063.

George A. Westsik, Chemist, Rockwell Hanford Operations, 234-5 200 West, Richland WA 99352.

William J. Whitty, Systems Engineer, Los Alamos Scientific Laboratory, Nuclear Safeguards Program, Los Alamos, NM 87545.

Floyd E. Williamson, Manager of Security, Westinghouse Hanford Company, P. O. Box 1970, Richland, WA 99352.

Clifford M. Zarecki, Safeguards Engineer, Atomic Energy of Canada, Pinawa, Manitoba, Canada.

Address Changes

The following changes of address have been received by the INMM Publications Office (Phone: 502-895-3953) at P. O. Box 6247, Louisville, Kentucky 40207, as of August 31, 1979.

Carl M. Fink, Defense Apparel, 285 Murphy Road, Hartford, CT 06114.

Thomas A. Gerdis, Editor, INMM Publications Office, P. O. Box 6247, Louisville, KY 40207.

Mark H. Killinger, U.S. Nuclear Regulatory Commission, NMSS, Washington, DC 20555.

Joseph Olivier, 526 Carr Avenue, Rockville, MD 20850.

Dr. **Sanda Onnen,** Ortelsburger Str. 4, 7500 Karlsruhe 1, West Germany.

R. G. Page, U.S. Nuclear Regulatory Commission, Division of Safeguards, NMSS, Washington, DC 20555.

Dr. **James Allen Powers,** Teknekron, Inc., 1483 Chain Bridge Rd., McLean, VA 22101.

Barry L. Rich, U.S. Department of Energy, Office of Safeguards & Security, MS A2-1016, Washington, DC 20545.

N. Roberts, 490 Grand Canyon, Los Alamos, NM 87544.

John C. Schleter, National Bureau of Standards, B 109/245, Washington, DC 20234.

David B. Sinden, P.E., Atomic Energy Control Board, P. O. Box 1046, Ottawa, Ont., Canada KIP 559.

Dr. **G. Dan Smith,** 9060 Centerway Rd., Gaithersburg, MD 20760.

Marta D. Tarko, International Atomic Energy Agency, P. O. Box 645, A-1011 Vienna, Austria.

Marvin R. Schneller, Route 1, Box 66BB, Medical Lake, WA 99022.

Dr. **C. D. W. Thornton,** Executive Office, Environmental Affairs, Leverett Saltonstall Building, 100 Cambridge St., Boston MA 02202.

L. W. Vaught, Security, South Carolina Electric and Gas Co., P. O. Box 764, Columbia, SC 29218.

Neil R. Zack, EXXON Nuclear Co., Inc., 550 - 2nd St., Idaho Falls, ID 83401.

Johnson to Direct Communication Bureau; Collopy Leads Speakers Bureau

By Herman Miller, Chairman
INMM Public Information Committee
Redwood City, California

You should read this article, think about it, and decide whether and how you can commit some of your time to the INMM, and the well being of the Nuclear Industry and the countries it serves. Selfish motives alone dictate a dedication by each of us to devote time to provide reliable information which can be used to establish a sound energy policy which the U. S. so badly needs.

Activities in our recent past include news coverage of our annual meeting, news coverage of the action by the Executive Committee in endorsing U.S. ratification of the US-IAEA Safeguards Agreement, and establishment of two new bureaus.

News coverage at the annual meeting in Albuquerque was very good. The photo montage on Page 27 shows the coverage we received in the New Mexico papers. Some of the stories were carried on the wire services with, as yet, unreported results. All three Albuquerque TV Stations covered the meeting and until the uranium tailings dam broke and preempted the INMM, the pictures were looking good.

Senator Pell responded in a very positive way to the letter from **Bob Keepin** (cf. P. 44). He was assured by the INMM view that the problems of carrying out the proposed Agreement are manageable. He feels that the credibility of our nuclear non-proliferation policy is involved in our readiness to accept safeguards. Quoting Senator Pell: "As we understand safeguards, as a practical matter they can improve the prospects for detecting diversion and possibly make diversion more difficult. In my view, this is by no means an unworthy goal."

Acceptance by **Ed Johnson** and **Tom Collopy** to head the Communications Bureau and Speakers Bureau bodes well for these activities. Elsewhere in the Journal you will find a form to express your interest in participating in the stimulating activities Ed and Tom are planning. Help them and yourselves by volunteering.

A new activity is being launched in this issue with the publication of our first of a series of cartoons on nuclear safeguards and nuclear power. We would like to develop a loveable character for these cartoons. If you have any ideas, send them to **Dennis Bishop**, who is pushing this idea.

Through the good offices of LASL, the INMM now has available a videotape on the DYMAC system. This is an excellent description of the use of NDA equipment, data terminals, and a computer based system for safeguarding nuclear materials. These tapes are available for use in discussions and presentations on safeguards. Send your requests to me.

Another item we would like to include in future publications is "Notable Quotes." These could be succinct statements that really make the point with a minimum of words and maximum effect. These could come from the great and the small. Send us the worthy ones you see or generate.

The success of the INMM Public Information program depends on you. Support it in every way you can.

Herman Miller (seated) of National Nuclear Corporation is the current chairman of the INMM Public Information Committee. Working with Miller this year (from left standing) will be Tom Gerdis, consultant, Louisville, Ky.; Tom Collopy, United Nuclear Corporation; and Ed Johnson of E. R. Johnson Associates.

'79 Meeting Coverage

N-Accident Called Safety Boon

The head of the International Atomic Energy Agency said he feels the Three Mile Island nuclear reactor accident in Pennsylvania will make nu... safer and will not set ... energy.

... ede who has ...

Safeguards Issue Important

ALBUQUERQUE (AP) — Development of safeguards for nuclear energy is an important task facing the United States and the world because the use of nuclear power to produce energy is here to stay, says a Department of Energy official.

George Weiss, security director of the DOE's Office of Safeguards Security, said in his keynote address ... 20th annual meeting of the Institute ... Management that it's ... facilities will ...

... of State, indicated that the ... also are important ...

Nuclear safeguards plan receives group's backing

The world's leading nuclear safeguards professional society has come out in favor of ratification of a safeguards agreement, now pending in the U.S. Senate, between the United States and the International Atomic Energy Agency.

The ... holding its annual meeting in Albuquerque this week, has sent a letter explaining its support to Sen. Claiborne Pell, chairman of the subcommittee on arms ... of the Senate ...

Keepin, nuclear safeguards program director at Los Alamos Scientific Laboratory, is chairman of the institute ...

Conferees warned on N-prote...

By BILL CASEY
Tribune Staff Writer

Anti-nuclear demonstrations are bound to increase and the nuclear industry should prepare for them, a former FBI agent said today.

... W. Woessner said ... of the annual ... Inn speaking to some of the more than 500 delegates attending the conference, which is focusing on international safeguards.

Woessner said every situation is different, and companies must be flexible in dealing with anti-nuclear demonstrators. But the firms, especially the power ... that seem most ...

✔ Decide whether to allow newsmen on the property.

✔ Decide whether to arm your own security people.

✔ Remember that one person has to be in charge.

REMEMBER that the demonstrators may not be the only ones causing problems, he said.

For instance, at Woessner's first ... with the ... the local ... re-election ... insisted o... fence, too, ... the gate. ... And the ...

... rights stateme... ly to each of 3 ... arrested, whi... stood around ...

THE REA... was not ev... that type c... did general... ty, Woessr... news pec... pictures" ... ing the ri...

Nuclear group: Carter policy hinders proliferation goals

By R. BEHNKE
New Mexican Staff

... out of its leadership role in ... actions imposed by the ... ports associated ... have ... restric...

... scheduled to speak, but canceled at the last minute. No official reason for his cancellation was given.

More than 400 people from the United States and 12 foreign countries are attending the session which has the general theme of international safeguards of nuclear materials.

Much of the three-day session will deal with safeguarding special nuclear materials, accounting for those materials and ways of stopping proliferation of nuclear materials.

On Thursday many of the participants will have a chance to tour the Los Alamos Scientific Laboratory.

Morning and afternoon sessions with papers on varied topics will continue until Wednesday evening here.

... nation... body ... lif...

... blishing the ... ation Act and ... utive order re... onmental impact ... nuclear reactor ... ates is no longer the ... of nuclear reactor and ... and in trying to main... rol it has lost it." ... eary deputy secretary of ... rtment of Energy, also was ... eyond the ... w.

Tighter Security Urged At Nuclear Industries

ALBUQUERQUE (AP) — The Institute of Nuclear Materials Management wants the U.S. Senate to ratify an agreement that would provide tighter security at the nation's non-defense nuclear industries.

Under the U.S. Safeguards Agreement, the industries would be checked periodically ...

... of the agreement Pell, as chairman of the Committee on Foreign Relations subcommittee on arms control, oceans, internati... operations ...

Keepin Renamed N-Management Institute Head

Dr. G. Robert Keepin of Los Alamos Scientific Laboratory was re-elected national chairman of the Institute of Nuclear Materials Management during the institute's 20th anniversary this week in Albuquerque. ... director of nuclear ... programs at ... been chairman of the ... for the past ... vice chairman ... '77.

... is an international ... of 600 ... various ... in govern... and aca... where ... e used ... ment ...

U.S. should get cracking on nuclear, conferees told

By BILL CASEY
Tribune Staff Writer

The United States once again should take the world lead in nuclear energy development, one of the main speakers at the Institute of Nuclear Materials Management annual meeting said today.

The meeting at the Hilton Inn is focusing on international safeguards, especially concerning non-proliferation (preventing the spread of nuclear weapons).

"The U.S. position now is not one of technical leadership," said Dr. Bertram Wolfe, vice president of the nuclear energy division of General Electric.

"IT IS ONE of technical abstention (from reprocessing and breeder reactors), hoping that if we abstain others will also. This, of course, is not the case. Other countries are proceeding independently with reprocessing and breeder reactors."

Besides, Wolfe added, the spread of nuclear weapons is not a problem resulting from development of nuclear power for energy or other peaceful uses. In fact, a strong nuclear energy industry "has played a very strong role in limiting proliferation."

IN RELATED remarks, an international nuclear safeguards expert said, he and Europe are "astonished" that President Carter did not mention nuclear energy in his address to the nation Sunday.

Dr. Sigvard Eklund, director general of the International Atomic Energy Agency in Vienna, Austria, said, "Nuclear can play a very important role for the immediate and near future. It is immediately available to provide energy."

The International Atomic Energy Agency is the world body that polices the 106 nations that agreed to the nuclear non-proliferation treaty.

EKLUND ALSO said development of nuclear energy has not caused spread of nuclear weapons. Since 1945 the number of nuclear power plants in the world has grown to more than 220, but only six nations have nuclear weapons (United States, Great Britian, France, China, India and Russia).

Eklund and Wolfe gave two of the introductory speeches to about 500 representatives from throughout the world attending the annual session. It continues through Wednesday.

... y has about ... s member na... scientists who ... years and then ... countries. The ... budget of about ...

... Eklund addressed is ... athering of about 500 ... clear safeguards and ... ials management.

Dr. Sigvard Eklund

Dr. Bertram Wolfe

Nuclear Materi... experts meet

EMPHASIZING international ... tions, the Institute of the Nucle... Management, the world's lea... sional organization devoted ex... nuclear safeguards and security ... its 1979 annual meeting at the A... Hilton Inn Monday through Wedn... 16-18.

The INMM is expected to draw to ... querque meeting more than 400 to ... safeguards and nuclear materials man... specialists from Europe, the Far E... North America.

This will be the first INMM annual ... held in Albuquerque.

Nuclear safeguards, international ... tion and verification, and nonproliferat... among key issues expected to be aired ... 21st annual INMM meeting, says ... Robert Keepin, Los Alamos, chairman ... 600-member professional society.

The keynote address for the conference ... be given by Dr. Sigvard Eklund, dire... general of the International Atomic Ene... Agency, Vienna, Austria. He plans to disc... nonproliferation and safeguards.

Group Plans Special Workshop On Intrusion Alarms December 5-7, 1979, in Florida

By T. A. Sellers, Chairman
INMM Technical Group on Physical Protection
Albuquerque, New Mexico

Because of the increased emphasis during the past few years that has been placed on the physical protection of nuclear facilities indicated both through the upgrading of protection at government facilities and the more stringent regulations that licensed facilities must meet, a large increase in the number of users of physical protection systems and components has been generated. In order to provide a forum for the exchange of technical information relative to the design, installation and test, operations, and maintenance of systems and components and the training and use of associated response forces the INMM has established a Technical Group for Physical Protection. It is envisioned that this group will be the first of several that will be organized by the INMM to address in detail the technical aspects of special interest areas.

Sellers

The purpose of physical protection systems at nuclear facilities is to detect and delay unauthorized activities and provide an adequate response force to terminate the unauthorized action before an undesired event takes place. These systems normally consist of intrusion alarms and assessment (both interior and exterior), personnel identification systems (photo badges, hand geometry, voice print, finger prints), explosive and metal detectors, data collection and display systems, barriers (fences, doors, walls), and associated response forces.

The activities of this group will be focused on the technical aspects of these systems and components with the objective of assisting in the attainment of reliable and effective physical protection systems with a minimum of cost and operational impact through an increased awareness by the users of the experiences and lessons learned throughout the industry.

The initial activity of the technical group will be to sponsor a workshop on Exterior Intrusion Detection Systems to be held at the Grenelefe Resort, Cypress Gardens, Florida, on December 5 through 7, 1979. This workshop will be held to discuss specific technical and

Mail to:
T. A. Sellers, 1761
Sandia Laboratories
P.O. Box 5800
Alburquerque, NM 87185

I would like to become active in the technical group for physical protection.

Name ______________________________

Affiliation ______________________________

Address ______________________________

City ______________________________

State ______________________________ Zip __________

Subjects of Interest:

____

____

____

operational problems related to intrusion alarms, data links and displays. The program will provide all participants the opportunity to present, discuss and exchange information on the problems associated with day-to-day operation of alarm and display systems. It will consist of a series of small informal group discussions on specific subject matters such as performance testing, equipment maintenance and repair, display system for alarm stations, etc., and will encourage direct participation by the attendees. Moderators in each group will open discussions on generic problems and provide in-depth technical expertise to the session subject matter.

Other subjects such as physical protection of facilities handling low enriched uranium, guard procedures and training, and entry control are now being discussed and appropriate activities will be initiated in the near future.

This technical group offers an opportunity to individuals involved in physical protection to utilize the expertise and experiences of others in a direct way. All members of the INMM who have this involvement are urged to return the enclosed card and become active in this group.

BOOK REVIEW

Material Accountability: Theory, Verification, and Applications, by Rudolf Avenhaus. John Wiley and Sons, 1977.

By J. B. Sanborn
Technical Support Organization
Brookhaven National Laboratory
Upton, Long Island, New York

The subject here is material accountability, and the language is mathematics. Interestingly, the book treats a broad range of subjects under the unifying principle of the "material balance concept," ranging from the disposition of carbon dioxide in the biosphere to the distribution of goods in socialist economies. A major thrust of the material, however, is the development of mathematical models for nuclear material accountancy, primarily in the context of international safeguards.

The book is the second in a series on systems analysis released by the International Institute for Applied Systems Analysis. This unique organization, which coincidentally is located just a short drive from IAEA Headquarters in Vienna, is an international organization "devoted to gaining an understanding and contributing to the resolution, through systems analysis, of the important problems facing mankind today" (from the cover). This orientation, which appears to stress the development of broadly applicable mathematical methods, is reflected in the style, subject matter, and format of the book, in which the first four chapters can be classified as "methodology" and the latter chapters as "applications". This orientation may strike the reader as refreshing and reasonable or as academic and impractical depending on his point of view. Those who are looking for "everything you always wanted to know about material accountancy . . ." will be disappointed; the book is a monograph which carefully develops a limited set of mathematical tools aimed at problems of a general (systems-level) nature.

Following a short introduction (chapter 1), the second chapter introduces the concept of the material balance and the MUF equation; this is accompanied by the usual apparatus of random and systematic measurement errors, detection probabilities, and false alarm probabilities. The author then proceeds to tackle the problem of combining a set of MUF statistics, either in the form of a time series for a single material balance area, or in the form of results from a number of material balance areas during a single time period. The interesting and somewhat surprising conclusion he comes to is that, from the point of view of the probability of detecting the removal of material from a given material balance area over a fixed time interval, it is counterproductive to either subdivide the material balance area into smaller units or to subdivide the time interval so as to draw a more frequent material balance. (This, of course, does not mean that frequent material balances may not be useful in detecting diversion more quickly.)

Sanborn

Chapter 3 is entitled "Data Verification" and deals with the problem of the detection of falsification in material accountancy data. Such a problem exists when an authority (such as the IAEA) is responsible for the detection of the removal or diversion of material by those who are in control of a facility. Because the authority does not, in general, have the resources to make enough measurements to determine completely its own material balance, it requires the facility operator to report his own measurements and material balance, and attempts to verify that these are in fact correct. This usually involves the authority inspector measuring a random sample of the items involved, and some type of comparison between the operator's and inspector's results. The statistic primarily suggested for this comparison in this chapter is the so-called "D" statistic, which is a weighted sum of the differences between the operator's and inspector's values for the items that the inspector has sampled. The author describes how the statistic is used for data verification and what type of strategies a diverter might attempt to use to avoid detection.

A number of topics are discussed in the fourth chapter, but the major theme is the problem of welding the mathematical tools and parameters discussed earlier into a coherent system with well-defined capabilities. This is a theme which probably has not been stressed enough in the international safeguards area; while much attention is focussed on data gathering activities, relatively little effort is expended on formalizing the manner in which this data is reduced to a final finding that material is (or is not) missing.

International nuclear materials safeguards is the subject of the fifth chapter. General background on the International Atomic Energy Agency and the nuclear fuel cycle is followed by a long section consisting of a detailed example of material accountancy verification methods for a reprocessing facility. The variance of the MUF and D statistics are derived along with sampling plans and detection probabilities. Some of the results presented are counter-intuitive and will be discussed further below.

The book then goes on to cover a large number of subjects more or less related to the concept of material balances, including "Material Accountability in Technology and Economics" which includes a description of material accountability at the federal mint in the Federal Republic of Germany (where sigma MUF is 36 kg of silver per year), "Environmental Accountability," which discusses carbon dioxide accountability on a world scale and sulphur dioxide pollution at a regional level, and finally "Arms Control," whose connection with material accountancy seems somewhat tenuous and speculative, but interesting nonetheless.

A significant portion of the text is in the form of mathematics and equations, and it is doubtful that the

Firms Selected For Centrifuge Production

The Department of Energy (DOE) has selected three industrial firms, subject to contract negotiations, for initial manufacture of gas centrifuge machines for use in two uranium enrichment facilities.

The firms selected are:

Boeing Engineering and Construction Co., Seattle, Washington.

The Garrett Corporation, Inc., Los Angeles, California.

Goodyear Aerospace Corporation, Akron, Ohio.

The centrifuge machines will be used in DOE's Centrifuge Plant Demonstration Facility (CPDF) at Oak Ridge, Tennessee, and the Gas Centrifuge Enrichment Plant (GCEP) which will be constructed near Portsmouth, Ohio. The GCEP will be completed on a schedule that will meet the continuing demand for enriched uranium for fueling nuclear power plants, both domestic and foreign.

The procurement of the machines will be carried out under two phases. The initial phase will be under cost-type contracts and will include the total number of machines for CPDF and a limited number of machines for the Portsmouth plant. The first phase also will include engineering and manufacturing studies to support later full-scale production of centrifuges to complete the total requirements for the Portsmouth plant. It is anticipated that the production experience involved in the first phase will permit the machines manufactured under the second phase to be provided on a fixed price basis by two of the three initial manufacturers.

The cost-type contracts are expected to be signed this year and to extend through 1983 with a total estimated cost of $235 million. The cost for the second phase is estimated to be about $1 billion.

The CPDF, scheduled for completion in 1982 at an estimated cost of $60 million, will be used to test centrifuges and other equipment and systems required for the Portsmouth gas centrifuge plant.

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reader who is unwilling to tackle at least some of these will get much out of the book. The aspect of the mathematics which distinguishes this work from others in the field is the consistent use of formal game theoretic models to describe the inspector-diverter situation. This makes a good deal of sense in the international safeguards context where one must make the assumption that the diverter will try to conceal his diversion, and the conflicting role of the inspector is to detect it.

In order to define a game, the strategies available to the two players must be described, as well as the "payoff function" which determines the reward or penalty to each player for every given pair of strategies. The game is solved by finding the pair of strategies which are optimal from the point of view of both players (if this is possible). The payoff function that is used here is the detection probability, while the total amount of material diverted and false alarm probability are generally held fixed. The sets of strategies available to each side depend upon the situation under analysis. In considering a multi-time period situation, for example, the diverter has a choice of the amount of material he wishes to remove in each time period, and the inspector can choose values of MUF in each period which he considers acceptable.

While the game-theoretic approach is, in one sense, the most rigorous way to model a situation involving conflict, it is often difficult to construct a game which is both sufficiently subtle to capture all the important elements of the real situation under consideration and sufficiently simple to solve. Hence the importance of justifying the particular choice of the game-theoretic model used. More discussion of this type of question would have been beneficial in this book.

For example, in the discussion of the data-verification problem in chapter three, the author considers in detail the "D" statistic mentioned above. The issue of why this statistic is useful, or whether there exist better statistics altogether, is never considered. In fact, the exclusive consideration of this type of statistic, which is a single number calculated on the basis of all items or batches sampled, ignores the possibility that paired comparisons between operator and inspector measurements may reveal falsification. The strategy of making paired comparisons at very small significance levels is a technique accepted by the IAEA, and generally referred to as "attributes testing."

This type of issue arises again in the fifth chapter in relation to the reprocessing plant example. The author chooses to use a D statistic in which concentration measurements in different units are summed together. The use of this statistic would appear to de-emphasize the importance of items or batches (in the input stream) whose concentrations of plutonium (in grams per liter) are low in comparison to those items (on the output stream) whose concentration (in grams per kilogram of solution) are orders of magnitude higher, even though the amounts of Pu per batch are comparable. The results seem to be sampling plans in which only one batch from the input stream is measured per year (out of 125) with all the rest of the effort going into sampling the output stream. It is hard to understand why a diverter could not simply falsify data for one or two input batches (each containing 7 kg of Pu) and escape undetected with a probability of 124/125 or 123/125, instead of the worst-case detection probability of about .5 claimed by the author. It is also unclear (despite the author's explanation, which appears to neglect the cost-dependence of certain terms) why the inspector should adopt an inspection strategy whose detection probabilities decrease as his inspection effort (in terms of the number of samples taken) increases.

Despite these foggy areas, the book is useful as a unified study of a large number of issues in material accountancy from a particular viewpoint. This type of work is all too rare in a field primarily characterized by narrowly defined reports on specialized applied topics.

Boots Randolph provided entertainment at rally.

Massive Pro-Nuclear Rally Near Denver Captures Mid-America Support*

A massive pro-nuclear rally, called a tremendous success by those attending, will be the first of several activities sponsored by Citizens for Energy and Freedom, a grassroots organization dedicated to promoting the continued development of nuclear power.

The August 26 rally was the largest of its kind ever held in the U.S. and attracted about 16,000 nuclear supporters who represented almost every segment of American life.

"We just feel it was a terrific success, we had a real cross section of middle America," said chairman **Art Benjamin.** "I think the rally opened the door for people to express their pro-nuclear feelings and they responded overwhelmingly."

Enjoying the festive and positive atmosphere of the gathering, many attending sported T-shirts with the rally's slogan, "Power for the People." As they arranged their picnic blankets and lounge chairs on the 10 acre site, mariachi, rock and country band traded entertainment spots. When media helicopters panned overhead for aerial shots, the crowd spontaneously cheered and waved the American flags they were handed when they entered the rally.

Master of ceremonies, Dr. **Dennis Floyd,** opened the event with a statement that seemed to be an unofficial theme for the day.

"Today is a day for positive thinking. Today is a day for being in favor of things. Today is a day all of us will look back on with pride for our participation in the most massive rally of its kind ever held not just in Colorado but in America," he said.

Internationally famous saxophonist **Boots Randolph** was the major entertainment attractive for the rally, but the main emphasis of the rally was speaker presentations which emphasized the safety and practical economics of nuclear power.

Local resident Dr. **Peter Beckman,** a professor of electrical engineering at the University of Colorado, was cheered enthusiastically when he referred to nuclear opponents as "kooks." He said, "they're strutting around as if they were the only people concerned for the people's health." Beckman pointed out that he is not for nuclear because its cheaper or because we have uranium deposits; but is pro-nuclear because it saves lives. As an example he contrasted the nuclear indus-

*This article has been exerpted from The Rockwell News. The author is **Syl Morgan-Smith,** Public Affairs Manager with Rockwell International.

NRC Amends Regulations on Protection Of Nuclear Materials And Facilities

The Nuclear Regulatory Commission is amending its regulations for the protection of nuclear materials and nuclear facilities other than power reactors and independent spent fuel storage installations.

The amendments are designed to provide a level of protection against theft of special nuclear material of low and moderate strategic significance equivalent to that recommended in Information Circular/225, which was published by the International Atomic Energy Agency in June 1977.

Special nuclear material of low and moderate strategic significance is not directly usable in the manufacture of a nuclear weapon, but nevertheless could be of assistance in such a project.

Material of moderate strategic significance includes (1) between 500 grams and 2 kilograms of plutonium or uranium-233, (2) between 1 and 5 kilograms of uranium-235 enriched to 20§ or more, and (3) 10 kilograms or more of uranium-235 enriched to at least 10% but less than 20%.

Material of low strategic significance includes (1) between 15 and 500 grams of plutonium or uranium-233, (2) between 15 grams and 1 kilogram of uranium-235 enriched to 20% or more, (3) between 1 and 10 kilograms of uranium-235 enriched to at least 10% but less than 20%, and (4) 10 or more kilograms of uranium enriched above its natural state but to less than 10%.

The NRC's new physical protection measures for special nuclear material of low strategic significance basically require that licensees use and store the material in a controlled access area, monitor the controlled access area to detect unauthorized activities, and transport the material under controlled and planned conditions.

The requirements for material of moderate strategic significance are similar, except that licensees are additionally required to limit access to the material to individuals who have been specifically authorized to have such access.

More specific guidance to licensees on the types of physical security plans for material of low and moderate strategic significance that are acceptable to the NRC staff is contained in a regulatory guide that is being published concurrently with the amendments. Single copies of the guide, entitled "Standard Format and Content for the Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate or Low Strategic Significance," are available without charge by written request to the Director, Division of Technical Information and Document Control, Nuclear Regulatory Commission, Washington, D.C. 20555.

Interested persons are invited to submit comments on the guide within the next 60 days. Comments should be addressed to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch.

After consideration of the comments received, the guide will be reissued and the amendments, which are to Parts 70, 73 and 150 of the Commission's regulations, will become effective. Licensees will then have 120 days to submit their physical security plans to the NRC for approval. The plans would have to be implemented 30 days after approval by the NRC or 360 days after publication of the amendments in the Federal Register on July 24, 1979.

The amendments were published in proposed form on May 24, 1978, for public comment. Some details of the amendments were changed as a result of the comments received (plutonium-beryllium sealed sources and plutonium containing more than 80% plutonium-238 were exempted from the requirements, and the time period for submission of physical security plans was extended from 60 days to 120 days).

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try's zero death record to the many deaths known to arise from black lung disease among coal miners.

Juliette Zivic, president of Americans for More Power Sources, called upon the predominantly middle class crowd to "use the trademark of the American people — common sense."

"The anti-nukes are careful to ignore the facts and scientific and medical experts. Make sure they don't intimidate the majority of the intelligent people," she said.

Former Secretary of Labor **Peter Brennan** also called upon the working man and woman to protect the rights each has earned by insuring the country will have an adequate energy supply to provide employment.

"Only one side is being told by a small vociferous group who are trying to shape our way of life to theirs. We want to stay free. To do that, we need a strong economy and a strong economy is tied to a strong energy supply. Our studies show we need 20 per cent of our energy to be supplied by nuclear," he stated.

Other speakers at the rally were **Llewllyn King,** editor of Energy Daily; **Michael May,** associate director-at-large, Lawrence Livermore Laboratories; and **John Stoessinger,** professor of political science, City University of New York.

WIDE FUNDING SUPPORT

The funding of the CEF underscored the wide base of support the group has received since its formation two months ago by 1500 persons who were concerned about the attention anti-nuclear proponents were receiving and the unreliable information being publicized. Although many of the CEF members are Rockwell employees at the Rocky Flats Plant, more than 7000 contributions were received from organized labor, small and large businesses, veteran groups and other outside community organizations.

If anyone is interested in organizing a similar rally, you may obtain information from **Mr. Art Benjamin,** Chairman, or **Mr. Pat Kelly,** Treasurer, Citizens For Energy and Freedom, 941 E. 17th Avenue, Suite 3, Denver, Colorado 80218.

State-of-The Union Message On ANSI INMM N15 Activities

By Dennis M. Bishop, Chairman
N15 Standards Committee
(Nuclear Materials Control)
San Jose, California

Following a highly successful series of working group meetings in Albuquerque, the N15 Standards Committee has much progress upon which to report.

Because of the tremendous influx of both new members and friends of the Institute, it is appropriate to periodically report on the overall status of apecific N15 activities. So, at the risk of telling you more than you want to know about the N15 Standards Committee, this column attempts to provide a brief but comprehensive review of where N15 is today, and where we are going tomorrow. The goal is to update new and old Institute members alike. It is hoped that this information will inspire additional support for the application of current INMM-ANSI standards, and stimulate the development of additional standards where needed.

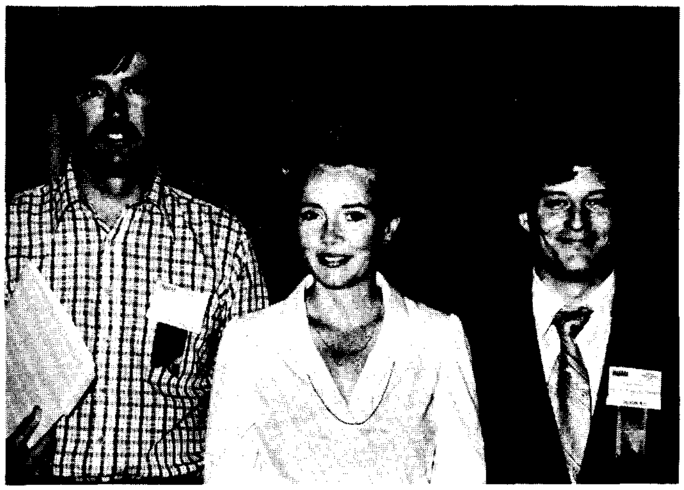
The INMM-N15 Standards Committee is authorized by ANSI to develop standards within a specific charter:

NUCLEAR MATERIALS CONTROL

> "Standards for the protection, control, and accounting of special materials in all phases of the nuclear fuel cycle, including analytical procedures where necessary and special to this purpose, except the physical protection of special nuclear material within nuclear power plants."

Within this charter, N15 has established 12 subcommittee and advisory group activities. Each group addresses a high priority area of the current safeguards program, including responsibility for over 42 ANSI-INMM standards in various stages of development and use. This all-volunteer organization is shown in Table 1. These subcommittee activities are further subdivided into over 20 individual writing groups consisting of approximately five to ten contributors. Thus, the INMM N15 Standards Committee represents a significant resource of nearly 200 dedicated engineers and scientists from all segments of the nuclear industry. This broad-based participation has been the key to the high number of standards developed and the equally high rate of acceptance and implementation of INMM N15 standards. If you are interested in participating in any of the indicated N15 activities, please feel free to contact the designated subcommittee chairman.

An overview of currently defined activities within each N15 subcommittee is provided in the following



On July 19, Mary Crehan Vaca of the American National Standards Institute, New York City, met with INMM N15 Standards Committee leaders and members the day following the INMM annual meeting. She posed for this photo by Dick Ruddy of Albuquerque along with Dennis M. Bishop (left), N15 Chairman of General Electric (San Jose) and Bob Kramer, N15 Secretary of Northern Indiana Power (Chesterton).

discussion. A summary and status report for all standards currently under N15 auspices is provided in Table 2. Based on your experience as a safeguards professional, if additional standards are needed, please don't hesitate to contact any appropriate member of the N15 organization.

INMM-1 (Accountability and Control Systems)

Primary emphasis during 1979 and 1980 will be directed at revising six standards developed between 1970 and 1974. Efforts to revise and expand N15.1 (Uranium Scrap Classification) and N15.10 (Plutonium Scrap Classification) have been initiated. Similar efforts to update N15.4, N15.8, N15.9 and N15.13 (all dealing with defining nuclear material control systems in various types of facilities) have also been initiated. Such standards have historically provided the primary bases for defining an acceptable accountability system. In light of the many changes in requirements since these standards were originally initiated, this update program represents a major task. **Howard Menke** (Westinghouse), INMM-1

TABLE 1
INMM - N15 STANDARDS COMMITTEE ORGANIZATION*

SUBCOMMITTEE	TITLE	CHAIRMAN	AFFILIATION	PHONE
—	N15 Chairman	Dennis Bishop	General Electric	(408) 925-6614
—	N15 Secretary	Robert Kramer	Northern Indiana Public Service	(219) 787-8531
INMM-1	Accountability and Control Systems	Howard Menke	Westinghouse	(412) 373-4511
INMM-3	Statistics	Frank Wimpey	Science Applications	(703) 821-4429
INMM-5	Measurement Controls	Yvonne Ferris	Rockwell International	(303) 497-4441
INMM-6	Inventory Techniques	Frank Roberts	Battelle-PNL	(509) 942-4767
INMM-7	Audit, Records and Reporting Techniques	Marv Schnaible	Exxon	(509)
INMM-8	Calibration	Lou Doher	Rockwell International	(303) 497-2575
INMM-9	Nondestructive Assay	Darryl Smith	LASL	(505) 667-6514
INMM-10	Physical Security	Tom Sellers	Sandia Labs	(505) 264-4472
INMM-11	Training and Certification	Fred Tingey	U. of Idaho	(208) 525-9637
INMM-12	Site Response Planning	Ed Young	Rockwell International	(303) 497-2518
INMM-13	Transportation (Proposed) **	Bob Wilde	Sandia Labs	(505) 264-7323
INMM-14	International Safeguards (Proposed) **	Bob Sorenson	Battelle-PNL	(509) 942-4437

** Advisory Group

Chairman, can use additional resources. Please contact him if you can help.

INMM-3 (Statistics)

The INMM-3 subcommittee has historically been among the most productive in N15. They have recently completed an extremely comprehensive revision of N15.5 (Statistical Terminology). This standard is now in the final balloting process. Standard N15.15 (Assessment of Normality) has also been reviewed and is being reaffirmed without change. Standards N15.16 (LOE) and N15.17 (S/R Differences) are currently in the review and revision stages. People interested in these areas should contact **Frank Wimpey** (SAI).

INMM-5 (Measurement Control)

This subcommittee was just recently initiated. It addresses recent emphasis in the safeguards area based on a multiplicity of disciplines. A more detailed description of scope and goals is provided elsewhere in this issue of the Journal. INMM-5's first product will be N15.41 (Nuclear Facility Measurement Control). Interested parties contact **Yvonne Ferris** (Rockwell).

INMM-6 (Inventory Techniques)

Standard N15.3 (Physical Inventories) is in the process of being reaffirmed without change. Additional help is needed in this area to define future standards. Interested parties should contact **Frank Roberts** (Battelle).

INMM-7 (Audit Record and Reporting Techniques)

Standard N15.2 (Records and Reports) has been withdrawn as out of date. It will be revised in the future. An extremely comprehensive new standard has recently been developed. It is N15.38 (Generic Guide to Auditing Safeguards Systems). This highly significant contribution to the field of safeguards is currently in the final balloting process. Standard N15.11 (Auditing NMC Statements) is also under review and will be revised during 1980. Marv Schnaible (EXXON) is the new subcommittee chairman.

INMM-8 (Calibration)

The INMM-8 subcommittee has also been a major contributor to N15 over the years. This subcommittee is now undertaking the review and updating of four standards issued during 1975. They include N15.18 (Mass Calibration), N15.19 (Volume Calibration), N15.20 (Radiometric Calibration), and N15.22 Calorimetric Assay). Interested parties should contact **Lou Doher** (Rockwell).

INMM-9 (Nondestructive Assay)

The INMM-9 subcommittee reflects the increased emphasis on safeguards measurements. It is the largest single subcommittee within N15, with six writing groups. INMM-9 has just recently published N15.23 (Rod Scanning). Upcoming products will include N15.35 (Physical Standards), N15.36 (Measurement Control), and N15.37 (Automation), all of which are now in the balloting process. Those interested in participating should contact **Darryl Smith** (LASL).

INMM-10 (Physical Protection)

This is a relatively new subcommittee which has just completed a comprehensive new standard, N15.40 (Definitions, Terms and Symbols), which is in the final ballot process. A previous standard N15.26 is being withdrawn as out of date. Work has recently been initiated on a new standard related to facility lighting. Interested parties should contact **Tom Sellers** (Sandia).

INMM-11 (Training and Certification)

This subcommittee has recently been expanded to include safeguards training. **Fred Tingey** (University of Idaho) is the new chairman. Near term plans are just being finalized.

INMM-12 (Site Response Planning)

This is a new N15 subcommittee. It represents a major new direction for N15. Its first standards will be N15.42 (Guide to Response Planning). This group is still in the formative stage. Detailed scope and goals are described elsewhere in this issue of the Journal. Interested parties should contact **Ed Young** (Rockwell).

INMM-13 (Transportation)

This advisory group was formed during mid-1979 to make recommendations concerning possible future N15 contributions in the area of transportation safeguards. The group is headed by **Bob Wilde** (Sandia) and will make final recommendations by year-end.

INMM-14 (International Safeguards)

This advisory group also represents the new trend in INMM and N15 activities. It was formed at mid year under the leadership of **Bob Sorensen** (Battelle-PNL) to make recommendations concerning possible future N15 contributions. Final recommendations are expected by early 1980. Results to date have focused on possible ways of improving INMM-IAEA cooperation and stimulating interaction with ESARDA.

Beyond the mere rehash of detailed program status, the salient point of this status report should be quite clear. The INMM N15 Standards Committee has undergone a dramatic change in scope and emphasis in order to respond to current safeguards demands. We of N15 are aggressively working to standardize safeguards procedures on a variety of technical fronts. As a safeguards professional, can you or your company afford to let this happen without your direct participation? My company thinks it's important to be in on the ground floor of such activities in order to have some input as to the final outcome. What better justification can there be for supporting N15 activities?

TABLE 2
STATUS REPORT—INMM
N15 STANDARDS ACTIVITIES

INMM-1 SUBCOMMITTEE (ACCOUNTABILITY AND CONTROL SYSTEMS)

N15.1-1970 CLASSIFICATION OF UNIRRADIATED URANIUM SCRAP
Withdrawn by ANSI May 1978. To be revised by January 1980 and reissued.

N15.4-1971 GUIDE TO PRACTICES, NUCLEAR MATERIAL CONTROL SYSTEMS FOR CONVERSION FACILITIES
Withdrawn by ANSI May 1978. To be revised by June 1980 and reissued.

*N15.8-1974 NUCLEAR MATERIAL CONTROL SYSTEMS FOR NUCLEAR POWER REACTORS
Issued. To be revised by January 1980 and reissued.

N15.9-1975 NUCLEAR MATERIALS CONTROL SYSTEMS FOR FUEL FABRICATION PLANTS
Issued. To be revised by January 1980 and reissued.

*N15.10-1972 CLASSIFICATION OF UNIRRADIATED PLUTONIUM SCRAP
Issued. To be revised by January 1980 and reissued.

*N15.13-1974 NUCLEAR MATERIAL CONTROL SYSTEMS FOR FUEL PROCESSING FACILITIES (A GUIDE TO PRACTICE)
Issued. To be revised by June 1980 and reissued.

P/N15.12 NUCLEAR MATERIAL CONTROL SYSTEMS FOR ENRICHMENT PLANTS. GUIDE TO PRACTICE
Action deferred. Working group not active.

P/N15.14 NUCLEAR MATERIAL CONTROL SYSTEMS FOR COLD SCRAP PROCESSING PLANTS, A GUIDE TO PRACTICE
Action deferred. Working group not active.

P/N15.25 STANDARD FOR MEASURING MATERIAL IN PROCESS EQUIPMENT
Action deferred. Working group not active.

* Extension of review period requested.

INMM-3 SUBCOMMITTEE (STATISTICS)

*N15.5-1972 STATISTICAL TERMINOLOGY AND NOTATION
Issued. Revision complete. On N15 ballot September 1979.

*N15.15-1974 ASSESSMENT OF THE ASSUMPTION OF NORMALITY (EMPLOYING INDIVIDUAL OBSERVED VALUES)
Issued. To be re-affirmed without change. To N15 ballot by September 1979.

*N15.16-1974 LIMIT OF ERROR CONCEPTS AND PRINCIPLES OF CALCULATION IN NUCLEAR MATERIALS CONTROL
Issued. To be revised by July 1980.

N15.17-1975 CONCEPTS AND PRINCIPLES FOR THE STATISTICAL EVALUATION OF SHIPPER-RECEIVER DIFFERENCES IN THE TRANSFER OF SNM
Issued. To be revised. Schedule not yet set.

P/N15.29 PROCEDURES FOR CORRECTING MEASUREMENT DATA FOR BIAS
Action deferred. Working group not active.

P/N15.30 SAMPLE SIZE CONSIDERATIONS IN THE ESTIMATION OF VARIANCE
Action deferred. Working group not active.

P/N15.31 COMBINING SETS OF DATA
Action deferred. Working group not active.

P/N15.32 PROCEDURES FOR RESOLVING SHIPPER-RECEIVER DIFFERENCES
Action deferred. Working group not active.

* Extension of review period requested.

INMM-5 SUBCOMMITTEE (MEASUREMENT CONTROLS)

P/N15.41 GUIDE TO NUCLEAR FACILITY MEASUREMENT CONTROL.
Working group assigned. Charter approved.

INMM-6 SUBCOMMITTEE (INVENTORY TECHNIQUES)

*N15.3-1972 PHYSICAL INVENTORIES OF NUCLEAR FUEL
Issued. Reaffirmation initiated September 1979.

INMM-7 SUBCOMMITTEE (AUDIT, RECORDS AND REPORTING TECHNIQUES)

*N15.2-1971 RECORD AND REPORTING UNITS FOR NUCLEAR MATERIALS CONTROL
On N15 ballot for withdrawal. To be revised. Schedule not yet defined.

*N15.11-1973 AUDITING NUCLEAR MATERIAL STATEMENTS
Issued. To be revised by January 1980.

P/N15.24 STANDARD FOR THE RECORDKEEPING AND REPORTING OF LICENSEE INVENTORY DATA
Action deferred. Working group not active.

P/N15.38 A GENERIC GUIDE FOR AUDITING NUCLEAR MATERIALS SAFEGUARDS SYSTEMS
Final draft complete. N15 ballot initiated September 1979.

* Extension of review period requested.

INMM-8 SUBCOMMITTEE (CALIBRATION)

*N15.18-1975 MASS CALIBRATION TECHNIQUES FOR NUCLEAR MATERIALS CONTROL
Issued. Review initiated. To reaffirmation by January 1980.

N15.19-1975 VOLUME CALIBRATION TECHNIQUES FOR NUCLEAR MATERIALS CONTROL
Issued. Review initiated. To reaffirmation by January 1980.

N15.20-1975 RADIOMETRIC CALIBRATION TECHNIQUES
Issued. Review initiated. To reaffirmation by January 1980.

N15.22-1975 CALIBRATION TECHNIQUES FOR THE CALORIMETRIC ASSAY OF PLUTONIUM BEARING SOLIDS APPLIED TO NUCLEAR MATERIALS CONTROL
Issued. Review initiated. To reaffirmation by January 1980.

INMM-9 SUBCOMMITTEE (NONDESTRUCTIVE ASSAY)

N15.23-1979 NONDESTRUCTIVE ASSAY OF THE FISSILE CONTENT OF UNPOISONED LOW-ENRICHED URANIUM FUEL RODS
Issued.

P/N15.33 CATEGORIZATION OF SPECIAL NUCLEAR MATERIAL FOR NONDESTRUCTIVE ASSAY
N15 ballot expected by January 1980.

P/N15.34 STANDARDIZED CONTAINERS FOR NONDESTRUCTIVE ASSAY
N15 ballot expected by January, 1980.

P/N15.35 NONDESTRUCTIVE ASSAY PHYSICAL STANDARDS
N15 ballot expected by January 1980.

N/N15.36 NONDESTRUCTIVE ASSAY MEASUREMENT CONTROL AND ASSURANCE
N15 ballot initiated September 1979.

P/N15.37 AUTOMATED NONDESTRUCTIVE ASSAY DATA ACQUISITION AND ANALYSIS
N15 ballot initiated September 1979.

P/N15.39 NONDESTRUCTIVE ASSAY OF IN PROCESS LOW-ENRICHED URANIUM FUEL MATERIAL
N15 ballot expected by July 1980.

INMM-10 SUBCOMMITTEE (PHYSICAL SECURITY)

N15.26-1976 PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIALS WITHIN A FACILITY
To be withdrawn. N15 ballot initiated September 1979.

P/N15.40 DEFINITION OF TERMS AND SYMBOLS ASSOCIATED WITH THE PHYSICAL PROTECTION OF NUCLEAR MATERIALS AND FACILITIES
Peer review complete. To ANSI for balloting by September 1979.

INMM-11 SUBCOMMITTEE (TRAINING AND CERTIFICATION)

SCOPE DEFINED. ACTION DEFERRED PENDING INMM - CERTIFICATION COMMITTEE RECOMMENDATIONS ON APPROACH (PROBABLY — LATE 1980).

INMM-12 SUBCOMMITTEE (SITE RESPONSE PLANNING)

P/N15.42 GUIDE TO RESPONSE PLANNING
Working group assigned.

INMM-13 SUBCOMMITTEE (TRANSPORTATION)

ADVISORY GROUP FORMED TO EVALUATE SCOPE. TO BE DEFINED BY JANUARY 1980.

INMM-14 SUBCOMMITTEE (INTERNATIONAL SAFEGUARDS)

ADVISORY GROUP FORMED TO EVALUATE SCOPE. TO BE DEFINED BY JULY 1980.

LASL Spearheads Efforts In Safeguarding Nuclear Materials

Nuclear safeguards and nonproliferation concerns have led to increasing demand for more accurate and timely nuclear materials measurement and accountability. LASL's unique background in national defense programs and safeguard technology has enabled the Laboratory to provide innovative technical leadership in the development of a national capability to respond to nuclear emergencies and acts of nuclear terrorism.

As a lead laboratory in the Department of Energy's Safeguards Research and Development Program, LASL is spearheading the development of nondestructive assay and radiation surveillance instrumentation for rapid, accurate measurement, verification, and control of nuclear materials in the various physical and chemical forms in which they are found throughout the nuclear fuel cycle.

International Safeguards: New Era of Cooperation

By Dennis M. Bishop, Chairman
N15 Standards Committee
(Nuclear Materials Control)
San Jose, California

Pending Senate ratification of the U.S./IAEA Safeguards Agreement (see INMM Journal Vol. 7, No. 4, 1979, Pages 47-58), selected nuclear facilities throughout the United States will soon begin implementing International Atomic Energy Agency (IAEA) safeguards requirements. These requirements have been defined by the U.S. NRC under 10CFR75 regulations and conforming amendments as proposed in May 1978. Implementation costs vary significantly by facility type, but have been conservatively estimated to be in the hundred thousand to million dollar range per facility.

The implementation of international requirements has been of growing interest within the safeguards community for some time. Because of its technical and economic implications, the INMM has become strongly involved in key issues regarding the implementation of IAEA requirements. Numerous INMM Journal articles have highlighted salient features of these interactions. However, perhaps the most significant INMM contribution has been the highly successful December 1978 workshop which served to inform and focus interests in vital ares of IAEA safeguards

Each of these INMM activities has had the same general objective; namely, to identify possible avenues for stimulating increased cooperation in the area of international safeguards. In a sense, the INMM's contribution has been one of a sounding board to bring about dialogue aimed at identifying and fostering commonality of purpose. Toward this goal, the purpose of this report is to inform the INMM membership of recent activities aimed at developing such worldwide avenues of cooperation. Significant events basically center around four recent events:

1. Second INMM Workshop

INMM Chairman **Bob Keepin** has initiated activities aimed at assessing the scope and timing for a projected follow-on INMM "Workshop II" on international safeguards. Pending Senate ratification of the Agreement, this workshop would be held in early 1980. Prime emphasis would be on reviewing the final 10CFR75 requirements, as well as surveying available experience in effectively and consistently implementing IAEA requirements.

2. INMM Chairman's Initiative

In a recent communication with Dr. **Sigvard Eklund** (IAEA Director General), Bob Keepin highlighted the growing need for increased communication, education and cooperation relating to the internationalization of uniform safeguards' standards and procedures. Toward this goal, prime emphasis should be placed on establishing channels for developing consensus procedural and physical standards related to all areas of international safeguards. While acknowledging the importance of letting current national systems do their job, Keepin underscored the need for more effective international cooperation and coordination of diverse safeguards efforts in various nations. He further stressed two important points: (1) the need to explore the possiblity for increased international cooperation under IAEA leadership in important areas of safeguards standards, and (2) the potential synergistic role that professional organizations such as the INMM might play in supporting IAEA lead programs and activities.

3. Keepin/Gupta - Letters

A recent exchange of letters between Bob Keepin, INMM Chairman, and **Dipak Gupta,** Chairman of the European Safeguards Research and Development Association (ESARDA), has also stressed the need for international cooperation. Both chairmen foresee a new era of cooperation between the INMM and ESARDA and pledge to support areas of mutual professional interest and commitment. A first step in such a cooperative relationship was taken in April 1979 when INMM N15 Chairman **Dennis M. Bishop** and other INMM members participated in the recent ESARDA symposium. Initial talks centered around possible mutual interest in the procedural and physical standards area. Future discussions are planned and will focus on defining the mechanism for specific areas of technical cooperation.

4. N15 Advisory Group

As has been pointed out in previous issues of the Journal, the N15 Standards Committee has recently initiated an INMM-14 Advisory Group to suggest possible ways of stimulating increased cooperation in the area of

A Standard for Measurement Control: P/N15.41

By Yvonne M. Ferris, Chairman
INMM-5 Standards Subcommittee on Measurement Controls
Golden, Colorado

Recognizing that the concept of measurement control has been around since the pyramids, INMM-5 nevertheless has been formed to produce an ANSI standard on this timely and much heralded subject. Both N15 and ANSI personnel are convinced that such a standard can be of help both to a nuclear facility just getting started, and to a long established facility which may have many years of concentrated effort in measurement control. After agreement that a need for INMM-5 exists, the primary task became the selection of the committee members. They are:

Willard B. Brown — NRC.
Joseph Cameron — Consultant.
Donald D. Cobb — LASL.
Charles W. Emeigh — NRC.
Yvonne M. Ferris — Rockwell.
William E. Gilbert, Jr. — DOE.
Rodney Hand — Allied.
Rush O. Inlow — DOE.
Victor W. Lowe, Jr. — Union Carbide.
Robert C. McBroom — General Atomic.
Carson L. Nealy — Rockwell.
Munson M. Thorpe — LASL.
Charles E. Pietri — DOE.

The committee held its first meeting on July 19 in Albuquerque where we were able to outline the scope and purpose of the standard; list the ingredients of the introduction, scope and purpose; select seven general topics for inclusion in the standard, and allocate job responsibilities to each of the members for gathering information on each of the seven topics.

Yvonne M. Ferris of Rockwell International's Rocky Flats Plant led the meeting of the INMM-5 subcommitee on measurement control. Yvonne recently was recently elected to a two-year term on the INMM Executive Committee.

The first product from INMM-5 will be generically oriented, applicable to all types of measurements from weighing to NDA. Almost without saying, such an approach demands close interaction and cooperation with INMM-1, INMM-3, INMM-8 and INMM-9 which INMM-5 pledges to do.

Even though a standard for a "grey beard" subject such as measurement control is difficult to write, and even though some have questioned the worth of such an effort in light of NRC regulations and DOE orders on the same subject, the members of INMM-5 are convinced that the yield from this undertaking will be a practical, usable document suitable for both licensed and license exempt facilities.

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international safeguards. Under Chairman **Bob Sorenson** (Battelle), an ad hoc advisory group meeting was held in conjunction with the Albuquerque annual meeting. Both USA and European INMM members participated. Results of this meeting will contribute to the future definition of specific recommendations during early 1980. The main result was one of defining areas of mutual concern and interest. Final results may not be limited to procedural and reference standards. Other areas such as technical working groups, position papers, etc. are being considered. A formal meeting was planned for this fall to discuss specific areas of possible contributions and innovative approaches to more effective IAEA-INMM-ESARDA cooperation.

The thrust of all this activity is straight forward. The INMM membership at all levels is working to ultimately bring about the effective, comprehensive, and consistent implementation of international safeguards requirements. This entire issue clearly offers new challenges based on many diverse technical and political factors and concerns. INMM members who share this concern and would like to get more involved in this important and expanding activity should contact any officer or member of the INMM Executive Committee.

New N15 Standard To Be Established On Site Response Planning

By E. R. Young, Chairman
INMM-14 Standards Subcommittee on Site Response Planning
Golden, Colorado

A new N15.42 standard is soon to be established through the efforts of the INMM-12 subcommittee.

As some members of the Institute have personally experienced, the nuclear establishment has been the object of a number of anti-nuclear demonstrations in recent years. As director of safeguards and security for Rockwell International at Rocky Flats, it has been my task to assure that "anti" demonstrations at our facility are handled in a safe and secure manner in order to minimize any violence or property damage. Also, it has been increasingly obvious that planning associated with emergency responses to other unusual situations at nuclear facilities is very important and has high visibility in the public sector.

In the spring of this year, **Dennis Bishop** and I discussed the object of developing a "Site Response Planning Standard" which would attempt to include all of the many factors which must be considered in successfully handling demonstrations, plus the steps and procedures necessary to establish sound and comprehensive nuclear facility emergency plans. The new standard would, of course, be in concert with and support all governmental issued rules and regulations.

Therefore, I am announcing in this issue of the Journal that such a subcommittee is in the formulative stages and believe that data emanating from such a standard will be of significant benefit to all members of the Institute.

The standard will discuss such items as: law enforcement support, legal rights and ramifications, trespass posting requirements, guard training requirements, public relations, response force interfaces and composition, communication systems, emergency operations center organization, emergency test and approval methods, and many other points associated with response planning where nuclear facilities are concerned.

The standard will be written in a manner to aid management in assuring that unusual situations, regardless of their cause, have been given sufficient thought, planning and review to minimize or eliminate adverse impacts.

I am hoping to include representatives of the subcommittee from throughout the industry as well as governmental organizations in order to assure a well organized and balanced standard. I believe a subcommittee should be made up of no more than 10 members, and I would appreciate receiving the names of Intsitute members who would like to serve on such a subcommittee.

Edward R. Young (left) of Rockwell International's Rocky Flats Plant (RFP) visited with George Weisz, director of the U.S. DOE Office of Safeguards and Security. Mr. Young is director of safeguards and security at RFP.

E. R. Young, Director
Safeguards and Security
Rockwell International
P.O. Box 464
Golden, Colorado 80401

*Dennis M. Bishop is chairman of the ANSI INMM N15 Standards Committee. He is associated with General Electric Company, San Jose, California 95124.

1979 Institute Awards Presented To William A. Higinbotham, Mark H. Killinger

By Dr. R. F. Lumb, Chairman
INMM Awards Committee
McLean, Virginia

The Institute will once again present its Distinguished Service Award to a deserving candidate at its 21st Annual Meeting in Palm Beach, Florida, June 30, July 1-2, 1980.

Selection for this award will be from nominated candidates and will be based upon the individual's dedication and contribution to the field of safeguards and nuclear material management. Candidates do not have to be members of the INMM.

The Awards Committee is seeking nominations for this prestigious award. Nominees should be submitted for consideration to the Awards Committee, together with the supporting basis, no later than March 1, 1980. Address nominations to:

R. F. Lumb
Chairman, Awards Committee
NUSAC, Incorporated
7926 Jones Branch Drive
McLean, Va 22102

In recognition of this award, the selected candidate will be honored at the Annual Meeting in Palm Beach and will be presented with a Distinguished Service Award plaque.

The prestigious annual INMM Distinguished Service Award was presented to Dr. William A. Higinbotham (right) of Brookhaven National Laboratory, technical editor of the INMM Journal, by Dr. Samuel C. T. McDowell, chairman of the INMM Awards Committee Dr. McDowell has been elected to a two-year term on the INMM Executive Committee. Higinbotham was honored for many years of distinguished service to the nuclear safeguards profession. See elsewhere in this issue for a related news story reprinted from the Brookhaven Bulletin.

A $500 award, plaque, and travel expenses to the 1979 annual meeting were awarded to Mark H. Killinger (left) of the University of Washington, Seattle, for winning the second annual INMM Student Paper Competition. Killinger, who worked for Battelle in Seattle as a graduate student and who is now with the U.S. NRC-NMSS, received his award and check from Dr. Samuel C. T. McDowell (DOE), INMM awards chairman this past year.

The Student Award

The Institute of Nuclear Materials Management is pleased to announce its third annual student competitive award, consisting of a $500 stipend for the best paper submitted by a college or university student, for presentation at its next Annual Meeting, to be held in Palm Beach, Florida, June 30, July 1-2, 1980. In addition, all reasonable travel expenses and subsistence for attendance at the meeting will be paid by the Institute of Nuclear Materials Management.

The winning paper will be presented by the author at the 21st Annual INMM Meeting in Palm Beach, Florida, and published in the 1980 INMM Proceedings. Notification of the winning paper will be made during April 1980.

Candidate papers should be submitted to later than March 1, 1980 to the INMM Awards Committee at the following address:

R. F. Lumb
Chairman, Awards Committee
NUSAC, Incorporated
7926 Jones Branch Drive
McLean, Va 22102

The INMM Student Awards Committee encourages and looks forward to the submission of a significant number of high-quality papers from which a selection can be made for the 1980 Award. The Student Award is international in character and entries are encouraged from all nations. INMM members, in the U.S. and particularly abroad, are encouraged to bring this award to the attention of their colleges and universities.

The 1979 winner of the Student Award was **Mark H. Killinger** from the University of Washington, whose paper titled "Optimal Use of Safeguards Expenditure for Verification Measurements" was presented by him at the INMM 20th Annual Meeting in Albuquerque, New Mexico, July 1979.

Editor's Note: In the space that follows are a reprint from *The Brookhaven Bulletin* on its report of the 1979 INMM Distinguished Award presentation and the summaries of the runners-up in the second annual INMM Annual Student Paper Competition — Thomas A. Gerdis.

INMM Honors Higinbotham

William A. (Willy) Higinbotham, senior scientist with BNL's Technical Support Organization, has received the first Distinguished Service Award of the Institute of Nuclear Materials Management (INMM), the foremost nuclear safeguards professional organization.

He was recognized for his dedication and many contributions to the field of nuclear safeguards and for his service to INMM. The award was presented July 17 during the INMM's 20th annual meeting, held in Albuquerque and attended by some 500 nuclear safeguards and nuclear materials management experts from North America, Europe, and Japan.

After receiving the INMM Distinguished Service Award, Willy Higinbotham was requested to sing "Atomic Power," a number which he first began performing at Los Alamos during the early 1940's. Higinbotham was honored July 17 during the INMM awards night activities at the 20th annual INMM meeting.

Although the award came as a surprise to Higinbotham, it was not news to his co-workers. They had known since March about the honor and managed to keep it a secret from him until the award was presented during a buffet dinner at the INMM meeting.

Keeping the secret required some closed mouths at BNL and some pretty fast footwork on the part of INMM, explained **Jack Cusack,** head of the Technical Support Organization. INMM was eager to surprise Higinbotham with the award, but there were complications — Higinbotham himself was a member of the Awards Committee which was to select the winner. After privately deciding on Higinbotham, the other members of the Awards Committee threw him off the track by introducing (and appearing to support) a "decoy" nomination of another professional in the field. Higinbotham whole-heartedly supported the "decoy" and, until the award ceremony, never realized that he was in fact the winner.

Higinbotham has been concerned with nuclear safeguards and proliferation since World War II, when he worked on the Manhattan District Project at Los Alamos. He was a member of a BNL **ad hoc** committee which, in 1967, proposed establishing a group here to provide technical advice and assistance to the AEC on safeguards for nuclear materials. The result was the formation of the Technical Support Organization (TSO) in 1968.

He served as associate head of the TSO from 1968 to 1972, and as head of the group from 1973 until 1975. His importance to the group has been recognized by a series of one-year post-retirement appointments which have allowed him to continue as an active TSO member. (In requesting Higinbotham's second post-retirement appointment, then-DAS chairman **Joseph Hendrie** noted that he was a "priceless fund of knowledge" for the new people in the group, and was "by way of being a unique national resource in the safeguards field.")

Higinbotham came to BNL in 1948 to work in the Instrumentation Division. He was associate head of the division until 1951, and division head from 1951 to 1968, when he transferred to the TSO in order to work full time on safeguards. His contributions to nuclear instrumentation were many — he received about 20 patents on electronic circuits, most notably the **"bootstrap" sawtooth generator** widely used in oscilloscopes, and the **Higinbotham Scaler,** which made it possible to reliably electronically count the random pulses from radiation detectors at high rates.

Active in the INMM since 1969, Higinbotham has been technical editor of the organization's journal, **Nuclear Materials Management,** since 1975. He has also served as chairman of the Federation of American Scientists, and is a fellow of the American Physical Society, the AAAS, the American Nuclear Society and the Institute of Electrical and Electronics Engineers. In 1972 he received the first annual award for contributions to nuclear instrumentation from the IEEE's Nuclear Science Group.

He is a man of many talents, however, and has also achieved quite a reputation in another, more musical kind of "instrumentation" — playing the accordian. While at Los Alamos, he played for the Saturday night square dances, and after coming to BNL, was one of the "Fearsome Foursome" that played for square dancing for many years.

Calorimetry End-Point Prediction

By Michael A. Fox
Rockwell International
Rocky Flats Plant
Energy Systems Group
Golden, Colorado

Summary

Calorimetry has for many years proven itself to be a valuable technique for evaluating the mass of some known radioactive material within a heat source. The heat generated by the radioactive material causes a gradual rise of temperature within the sensor cell contained by the calorimeter. This temperature asymptotically approaches a value that is proportional to the mass of the radioactive material.

The disadvantage of using calorimetry is the sometimes very large amount of time required to reach the equilibrium temperature value; and hence, it has become advantageous to develop a technique known as end-point prediction. End-point prediction is the process of extrapolating the complete temperature versus time function caused by heat radiated from the heat source when a given a minimal quantity of data.

Work that has presently been accomplished using end-point prediction has generated accurate results with increased throughput. In order to further increase throughput it is necessary to increase the accuracy of our assessment of the temperature versus time function as well as to reduce noise levels for low-level heat sources.

In this paper, several mathematical techniques for increasing accuracy and hence throughput have been developed and introduced and noise reduction techniques are considered as well. Complete testing of the equations is still in progress and the preliminary results look favorable.

Multipurpose Reprocessing Within Safeguarded International Centers

By John V. Massey
Ph.D. Student
School of Nuclear Engineering
Georgia Institute of Technology
Atlanta, Georgia

Summary

The co-location of reactors and fuel cycle operations has been suggested as a means of controlling and safeguarding special nuclear materials (SNM). This study addressed the flowsheet and plant design of a reprocessing facility located within such a center containing reactors using SNM (Pu or high enriched U) and refabrication and waste treatment facilities. Onsite fuel recycling facilities also serviced offsite reactors fueled with material not considered as SNM. Fourteen separate cases utilizing various reactor and fuel mixes were examined. Reactors considered were light water, liquid metal fast breeder, high temperature gas cooled, and heavy water reactors. Fuels were low enriched uranium, plutonium-uranium, thorium-denatured uranium, and plutonium-thorium. Solvent extraction flowsheets (based on the PUREX and/or THOREX processes) equipment and cell sizes, inprocess inventories, radiation releases, research and development requirements, and capital and operating cost were developed for a multipurpose reprocessing plant in each case. In the design special consideration was given to proliferation resistant measures, flexible methods of criticality control (to allow processing fuels of greatly different fissile content), and equipment and process design to accomodate the different instantaneous throughput rates due to varying fuel compositions.

Fox

Massey

OFFICE OF THE CHAIRMAN
G. Robert Keepin
Nuclear Safeguards Program Director
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87545
Phone: 505 667-4018

INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT

July 20, 1979

The Honorable Claiborne Pell
Chairman, Subcommittee on Arms Control,
Oceans, International Operations and Environment
Committee on Foreign Relations
United States Senate
Room 4304, Dirksen Office Building
Washington, DC 20510

Dear Senator Pell:

I am pleased to provide herewith the requested statement on behalf of the Institute of Nuclear Materials Management with regard to the US-IAEA Safeguards Agreement currently pending advice and consent to ratification by the United States Senate. In view of the Institute's vital interest in effective international safeguards, as well as the current high level of Congressional concern with the safety and safeguarding of nuclear power reactors and the nuclear materials that fuel them, the Executive Committee of the INMM has recently given this important and urgent matter its full consideration. Accordingly I am pleased to be able to submit this timely summary of the Institute's professional posture and position in support of the pending US-IAEA Safeguards Agreement.

As you may already be aware, the INMM is the leading professional organization concerned specifically with the management, safeguards, security, and control of nuclear materials. The Institute's unique role and high standards of professionalism in the field of nuclear safeguards and materials management is recognized throughout the United States as well as abroad, and its rapidly growing membership, currently over 600, includes prominent leaders from both the government and private industry sectors of the international nuclear community, including INMM Chapters in Europe and

Japan. The INMM also fulfills a key role in the education, training, and professional certification of materials accountability and safeguards personnel -- both domestic and international. The objectives and role of the INMM in nuclear affairs have been well summarized in a statement by Congressman Melvin Price of Illinois (Congressional Record, Vol. 120, No. 180, H-12747.)

While the Institute membership encompasses a wide diversity of viewpoints, background, experience, and professional affiliations, certain basic convictions are, I believe, shared by the INMM membership, namely that (1) nuclear power is becoming an increasingly important energy source for expanding world energy needs and establishing US energy independence; (2) the acceptability and long-term viability of nuclear power will require, inter alia, an effective and practical system of safeguarding nuclear materials against theft, diversion, and misuse on both the national and the international level; and (3) to be effective and practical, safeguards must be workable and implementable on some equitable and generally acceptable basis in various nations around the world.

Many in our own nuclear industry have, of course, been generally aware of the US offer, first made by President Johnson in 1967, to subject our own nondefense nuclear operations to the same IAEA Safeguards standards that we commend to other signatory nations to the Nonproliferation Treaty. However, as the time draws near for formal commitment to and implementation of the US offer, there has been growing concern in the US nuclear community with regard to the impact (economic, operational, etc.) that IAEA safeguards inspection might have on nuclear facility operations. In response to a very clear and widespread need for education and better understanding in this vital area, the INMM organized and conducted a "Workshop on the Impact of IAEA Safegards" in December 1978 in Washington, DC.

The Washington Workshop, attended by over 160 representatives of industry, government, the IAEA, Euratom, and several foreign countries, provided a timely forum for direct interaction, on an objective, professional basis, between all parties concerned with "real world" practical implementation of nuclear safeguards. In his opening remarks to the Workshop, Ambassador Gerard Smith, US Representative to the IAEA, emphasized the key importance of the US offer in relation to overall nonproliferation goals by stating bluntly that "if the US does not fulfill its part of the NPT bargain, then it could have a very detrimental effect on US efforts to implement safeguards and achieve nonproliferation goals around the world." The Workshop addressed a number of practical problems and concerns about the rule-making process, formulation of facility attachments and the "nitty gritty" of actual implementation of IAEA Safeguards inspection, protection of proprietary information, frequency and cost of inspection, intrusiveness into plant operations etc.

The overall consensus and thrust of the Washington Workshop seemed to be that such questions and concerns, although quite real, did not raise insurmountable problems, and that these could be resolved in due course -- as indeed they have been in other advanced countries (e.g., Canada, the Federal Republic of Germany, and Japan) that are now under NPT safeguards. Thus despite the many uncertainties about implementation and the difficulties to be overcome, a generally positive and constructive attitude of "getting on with the job" seemed to prevail throughout the Washington Workshop.

We in the INMM believe this kind of direct communication and interaction between the parties actually involved in implementing effective NPT safeguards (including the specific experience of other countries in applying NPT safeguards) has proved to be, and will continue to be, extremely valuable in eliminating apprehensions and misunderstandings about the new inspection and reporting requirements, and in allaying concerns about the practical impact of IAEA safeguards in affected US nuclear facilities. (It may be noted here that, in view of the generally recognized usefulness of the first Workshop, a second INMM workshop on the Impact of IAEA Safeguards in the US is tentatively planned for late 1979 or early 1980.)

Many of the same issues and questions concerning implementation of international safeguards that were taken up at the Washington Workshop were pursued further at the 20th Annual Meeting of the INMM just concluded (July 16-18, 1979) in Albuquerque, NM. This year's Annual Meeting, which carried the timely theme "International Safeguards," was attended by over 600 participants representing all of the Western-world nuclear supplier nations and Japan, as well as safeguards and materials management experts from all sectors of the nuclear community. In his keynote address to the INMM, Dr. Sigvard Eklund, Director General of the IAEA, asserted "an effective international safeguards regime is an absolute condition for the future viability of international trade in nuclear materials, plant and equipment. Any major setback in the nonproliferation regime would be a setback for nuclear energy everywhere, at least in the Western industralized world." Similar strong advocacy for strengthened International/NPT Safeguards, as well as recognition of the useful role that experienced safeguards professsionals can play therein, has been expressed by leaders in many sectors of the US nuclear community, including NRC Chairman Joseph Hendrie, US Senator John Glenn, DOE Deputy Secretary John O'Leary, and leading safeguards spokesmen in Europe and Japan. (Documentation of the above is available from INMM files upon request.)

Pursuant to our continuing vital concern with the issues and practical implementation of International/NPT Safeguards, the INMM Executive Committee at its most recent (mid-July) meeting has unanimously endorsed this general statement of support for early ratification and implementation of the US-IAEA Safeguards Agreement. We in the Institute firmly believe that as smooth and rapid a transition as possible to the implementation of International (IAEA) Safeguards in the spirit of the Nonproliferation Treaty is in the best interests of safe -- and safeguarded -- nuclear energy, in an increasingly energy-hungry world.

Finally, looking at "the other side of the coin," failure to ratify the US-IAEA Agreement could, in our view, lead to very grave consequences indeed, not only for the NPT (e.g., at the forthcoming NPT Review Conference in May 1980, et. seq.), but also as regards the vital overall objective of limiting the spread of nuclear weapons around the world.

Thank you for the opportunity to communicate these views and comments on behalf of the Institute of Nuclear Materials Management. I hope that you and/or members of your Committee staff will not hesitate to contact us in the future if the professional capabilities of the INMM can be of assistance in any way.

Very cordially yours,

G. Robert Keepin
Chairman, INMM

GRK:mg

xc: Honorable John H. Glenn, United States Senate
Mr. David Keaney, United States Senate Staff
Mr. Thomas Pickering, DOS
Mr. Louis Nosenzo, DOS
Mr. Joseph Hendrie, NRC
Mr. Charles Van Doren, ACDA
Mr. H. G. Handyside, DOE/INTP
Mr. George Weisz, DOE/OSS
INMM Executive Committee

United States Senate

COMMITTEE ON FOREIGN RELATIONS
WASHINGTON, D.C. 20510

September 6, 1979

Mr. G. Robert Keepin
Nuclear Safeguards Program Director
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87545

Dear Mr. Keepin:

Thank you indeed for your letter of July 20 on the views of the Institute of Nuclear Materials Management on the pending US-IAEA Safeguards Agreement, and urging its prompt ratification and implementation. I apologize for the misplacement of your letter, which has delayed my reply to you. I assure you that views of the Institute are most welcome and significant, and will be considered carefully by the Committee together with other analyses, views and information provided to us by a broad array of interested parties.

It is reassuring to know that from the Institute's standpoint, based on extensive discussions with industry and others involved in nuclear energy matters, that the problems of carrying out the proposed Agreement are manageable and do not pose an obstacle to ratification. This view is borne out by a study done for the Committee by the Congressional Research Service on industry comments to the Nuclear Regulatory Commission on its draft regulations for implementing the agreement.

The Committee is, of course, aware that there are differences of opinion over the reliability of safeguards. Some critics contend that safeguards cannot offer absolute assurance that no diversion of dangerous nuclear materials can ever occur. As we understand safeguards, as a practical matter they can improve the prospects for detecting diversion and possibly make diversion more difficult. In my view, this is by no means an unworthy goal.

I also appreciate your comments on the relationship between the US-IAEA safeguards agreement and the US position at the forthcoming NPT Review Conference, and, for that matter, the outcome of the International Nuclear Fuel Cycle Evaluation next February. The Committee is keenly aware of the connection between US readiness to accept safeguards on itself and the credibility of our nuclear non-proliferation policy. This is a major factor in the Committee's consideration of the Agreement.

I am sympathetic to calls for fast action on the agreement. However, as you can of course understand, the Committee has a responsibility to hear all relevant views, critical as well as favorable. Nevertheless, I assure you we will seek to do this in as timely a manner as possible.

Thank you again for your valuable contribution to the Committee's consideration of the US-IAEA Safeguards Agreement.

Ever sincerely,

Claiborne Pell
Chairman, Subcommittee on Arms
Control, Oceans, International
Operations and Environment

Titles and Abstracts Of Recent Safeguards R&D Publications and Reports from Japan

Editor's Note: This is the ninth in a series of listings of titles and abstracts of recent safeguards R&D publications and reports from agencies and R&D laboratories. It has been compiled by **Yoshio Kawashima** and colleagues in the Japan Chapter of the Institute of Nuclear Materials Management. We hope to have another listing in the Winter Issue. If your agency or R&D laboratory is interested in being included in this series, please contact the editors, **William A. Higinbotham** (516-345-2908) at Brookhaven National Laboratory, or **Thomas A. Gerdis** (502-895-3953) at the INMM Publications Office, P. O. Box 6247, Louisville, Kentucky 40207.

Experience in Japan in Complying with IAEA Data Reporting Requirements. S. Miyasaka, S. Koreki, H. Nishimura, K. Ikawa, M. Hirata, & S. Takeda. IAEA Safeguards Workshop Seminar Sept., 1978.

Abstract

In Japan, both nuclear facilities and their material balance areas to be controlled exceed two hundreds, respectively, and nuclear materials to be accounted for and inspected under NPT cover plutonium, high- and low-enriched uranium, natural uranium, depleted uranium, thorium and mixed plutonium-uranium, with total quantities of more than 5,000 Ekg. Therefore, for handling and processing of all safeguards information, a computer-based system has been originally considered.

For the accounting for and control of nuclear materials in Japan, an information system has been developed on the basis of all relevant articles of the IAEA document INFCIRC/153. The system was amended in conformity with the agreement between the government of Japan and the IAEA and with the domestic requirements. This system, named NPT-JAPAN, is a computer-based system for the handling and processing of all safeguards related information, such as design information (DI), inventory change report (ICR), physical inventory listing (PIL), material balance report (MBR), concise notes, and inspection report (IR), in order to maintain the national accountancy of nuclear materials, to prepare the reports to be sent to the IAEA, and to obtain various kinds of information required by national inspectors. The NMCC is now operating the system for implimentation of the safeguards under NPT.

A Quantitative Evaluation of the Effectiveness of Safeguards with Emphasis on Containment and Surveillance. Y. Akimoto, T. Ishii, and S. Yamagami, Mitsubishi Metal Corporation, Tokyo, Japan, and T. Shibata, Power Reactor & Nuclear Fuel Development Corporation, Tokyo, Japan. 1st Annual Symposium on Safeguards & Nuclear Material Management, ESARDA, May 1979.

Abstract

A concept of an improved safeguards system is proposed in which containment and surveillance and continuing material accountancy are effectively coordinated along with conventional material accountancy. In order to evaluate the effectiveness of the improved safeguards system an evaluation methodology has been developed. Diversion mode is treated dynamically as a function of time and converted to a detection probability as a function of detection time. The detection probability is, then, weighted and integrated with time to obtain a single value: an index of safeguards effectiveness. The evalution methodology is shown to be applicable to a combined system of material accountancy and containment and surveillance, and to be able to quantify safeguards effectiveness successfully.

Safeguarding of Gas Centrifuge Pilot Plant in Japan. T. Minato, Power Reactor & Nuclear Fuel Development Corporation, Tokyo, Japan. Oct. 1978 International Symposium on Safeguards Technology.

Abstract

The first part of the Japanese gas centrifuge pilot plant for uranium enrichment at Ningyo-toge will be in operation in August 1979. The plant has been designed to allow the effective application of safeguards, although a "non-access area" will be established to protect "commercially sensitive technology." The plant may be divided into two MBAs; process MBA and storage MBA, and may have 12 KMPs. "Running physical inventory taking" of the process area at the end of each accounting period is suggested to enable continuous operation of the plant. This will not affect the accuracy of total plant inventory, because the inventory of the "running" area will be quite small. Improvement of measuring accuracy and decrease of MUF are essential to make safeguards more effective. For this purpose a simulation analysis of nuclear material flow in the plant has been conducted, and from that analysis the required accuracies and the measuring intervals at each measurement point are to be established. An on-line masspectrometer and an enrichment analyser for UF_6

cylinders have been developed. Measurements of uranium deposit on metal surfaces are carried out to estimate hidden inventory more accurately.

A Process Control and Safeguards System Plutonium Inventory Control for MOX Fuel Facility. T. Mishima, M. Aoki, T. Muto & T. Amanuma, Power Reactor & Nuclear Fuel Development Corporation. **Nuclear Technology,** Vol. 43, 1979.

Abstract
The plutonium inventory control (PINC) system is a real-time material accountability control system that is expected to be applied to a new large-scale plutonium fuel production facility for both fast breeder reactor and heavy water reactor fuels at the Power Reactor and Nuclear Development Corporation. The PINC is basically a system for material control but is expected to develop into a whole facility control system, including criticality control, process control, quality control, facility protection, and so forth. Under PINC, every process and storage area is divided into a unit area, which is the smallest unit for both accountability and process control. Item and material wieght automatically are accounted for at every unit area, and data are simultaneously treated by a computer network system. Sensors necessary for the system are being developed.

A Study on Improvement of Material Accountability Verification Procedures. K. Ikawa, M. Hirata, H. Nishimura, Japan Atomic Energy Reasearch Institute, and H. Kurihara, S. Aoe, Science and Technology Agency, and S. Takeda, Tokai University. Oct. 1978 International Symposium on Nuclear Material Safeguards.

Abstract
This paper describes a method of considering the characteristic of the national nuclear fuel cycle quantitatively. This characteristic is presented here by the Diversion Factor (F_D), which relates to the quantity of attractiveness of nuclear material in the reference fuel cycle to a diverter. This expression was applied to several nuclear fuel cycle models. As a result, it has been found that this may come to be used as a quantitative approach for representing the characteristic of the national nuclear fuel cycle, according to how much it may be improved hereafter.

Material Accountability Control in the MOX Fuel Facilities of PNC. K. Karuki, M. Aoki, O. Mizuno and T. Mishima, Power Reactor & Nuclear Fuel Development Corporation. **Journal of Atomic Energy Society of Japan,** Vol. 21, No. 3, 1979.

Abstract
Prior to the NPT system, IAEA inspection based on bilateral agreements had been applied to the PNC's MOX Facilities. In the normal inspection of IAEA, book inventories, the number of fuel pins and assemblies, presence of PuO_2 powders and seals were verified together with non-destructive measurement for them. The NPT has led to the establishment of MBA and KMP, classification of nuclear materials on batch basis and introduction of statistical methods especially for MUF analysis. In this article, importance of fast accounting methods such as DYMAC or RETIMAC is stressed.

Semi-Dynamic Material Control and Safeguards Evaluation Methods (1), (2) & (3). K. Ikawa, H. Ihara, Japan Atomic Energy Research Institute, H. Sakuragi, Nihon Computer Bureau, and M. Iwanaga, Power Reactor & Nuclear Fuel Development Corp. March 1979 Annual Meeting of Atomic Energy Society of Japan.

Abstract
In this series of presentations, the conventional material control system based on MUF statistics and real-time systems represented by DYMAC were compared, their merits and demerits were made clear, and thereby, the intermediate concept of Semi-Dynamic material control was presented; in addition, considerations on safeguardability, the results of material flow simulation for the Barnwell plant, and the diversion analysis by using dynamic MUF (MUFd) were presented.

World Trends Around Safeguards. Y. Kawashima, K. Tsutsumi, Nuclear Material Control Center. Vol. 25, No. 6, **Nuclear Engineering** (of Japan).

Abstract
This article describes the background of so-called improved safeguards, the present IAEA safeguards system, the thoughts of key countries for the improved safeguards and future perspective for it.

The authors draw conclusions as follows: (1) Cost/effectiveness offers an important scale for determining safeguardability. (2) Is it possible for the improved safeguards to go ahead by neglecting the concept of significant amount which is enough to manufacture one nuclear explosive device? (3) It is important to consider how containment/surveillance can connect nuclear material control and physical protection. (4) European countries seem to place an emphasis on containment/surveillance, rather than on material control, while the U. S. places emphasis on the latter.

Experience with IAEA Safeguards at a Japanese LEU Fuel Fabrication Facility. T. Osabe, Japan Nuclear Fuel Company, Ltd. December 7, 1978, INMM Workshop on the Impact of IAEA Safeguards. (J. INMM, Vol. VIII, No. 1, P. 51, Spring 1979).

Abstract
The basic concept for implementation of NPT safeguards in a facility is that the IAEA shall utilize national safeguards as much as possible to verify that there has been no diversion of nuclear material from peaceful use. The Agency, however, has the right to perform independent measurements and observations of nuclear materials in the facility.

Certain administrative arrangements are completed prior to the application of safeguards to the facility in accordance with the agreements.

It is recognized that there are improvements to be made as a result of our experience in application of the present MUF verification program which has been developed by the IAEA, because the operator and inspector have different objectives in verification and evaluation of MUF.

Performance of TASTEX Gamma Spectrometer System at the Tokai Reprocessing Plant for Measuring Plutonium Concentrations in Solutions. R. Gunnink, A. L. Prindle, Lawrence Livermore Laboratory, and Y. Asakura, Power Reactor & Nuclear Fuel Development Corporation. July 1979 INMM Conference.

Abstract

The accountability and safeguarding of plutonium as a special nuclear material continues to be an important issue. Although the traditional chemical methods for analyzing plutonium are indespensable, non-destructive instrumental methods are assuming an increasing role in providing material balance and control of plutonium inventories. Not only must the total elemental amount be determined, but the amounts of the individual isotopes of mass 238 to 242 as well as 241Am are frequently of interest.

Since most of these isotopes, emit gamma rays with observable abundances, we have developed a spectrometer system which when properly calibrated, can provide rapid and non-destructive analyses for the isotopes of plutonium and 241Am. Our techniques use the 40-210 keV region of a gamma-ray spectrum since this region contains the most intense, and in a few cases, the only useable gamma signals for spectroscopic analysis. However, portions of the region are also very complex. For these reasons, a very high resolution germanium detector (a 1-2cc detector with approximately 510 ev FWHM resolution at 122 keV) is used. A minicomputer is required to deconvolute and interpret the relevant features of the resulting spectra.

Application of the Basic Concepts of Dynamic Materials Accountancy to the Tokai Spent Fuel Reprocessing Facility, A Feasibility Study. J. E. Lovett, International Atomic Energy Agency, Vienna, Austria, M. Hirata, Japan Atomic Energy Research Institute, Tokyo, Japan, R. H. Augustson, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, U. S. A. 1st Annual Symposium on Safeguards & Nuclear Material Management, ESARDA, May 1979.

Abstract

A preliminary investigation of the feasibility of "back-fitting" a dynamic materials accountancy system into the Tokai (Power Reactor and Nuclear Fuel Development Corporation, Japan) spent fuel reprocessing facility suggests that such a system would be feasible and would be capable of meeting currently discussed control objectives in terms of quantitative sensitivity and timeliness. Specifically, the proposed system uses existing (or to be installed under other programmes) plant instrumentation and laboratory capabilities to generate weekly measured material balances with a maximum delay (for completion of measurements and data processing) of three days. Evaluation would employ a battery of multiple period statistical tests to provide high detection probabilities while at the same time maintaining a very low false alarm probability. Detailed studies are still in progress; this paper presents the proposed system and the current status of the detailed investigations.

MISE-II Computerized Nuclear Material Accountancy System at JOYO. T. Senda, Y. Yamashita, H. Yamamoto, Power Reactor and Nuclear Fuel Development Corporation, Japan. 1st Annual Symposium on Safeguards & Nuclear Material Management, ESARDA, May 1979.

Abstract

In JOYO, the nuclear fuel management is made by using the MISER-II code. This paper describes the conception of this nuclear material accountancy code, 6 files and their function and the evaluation method for burn-up change in the core.

"Burnotheque": A Valuable Standard For Accurate Burn-up Determination by Non-Destructive Examination. H. Adachi, Nippon Atomic Industry Group Co. LTD., Kawaski, Japan, J. Basselier, Belgonucleaire, Brussels, Belgium, L. Leenders, Centre d'Etude de l'Energie Nucleaire, Brussels, Belgium. 1st Annual Symposium on Safeguards & Nuclear Material Management, ESARDA, May 1979.

Abstract

As in many fields, the comparative method seems to be the most reliable one for the non-destructive burn-up determination. The proposed method consists in comparing fission product activities of the examined fuel rod with those of standard burn-up samples. It is evaluated on the basis of samples collected from three SENA assemblies respectively unloaded after 1, 2 and 3 cycles, including destructive analysis and follow-up calculations.

Advantages and limitations of the method are discussed with respect to fuel management and safeguarding as well as possible application to fuel assemblies.

NRC Appoints Ralph J. Jones

Ralph J. Jones, a former treasurer of INMM who served on the Institute's Executive Committee, has been appointed chief, transportation and product standards branch, Division of Engineering Standards, Office of Standards Development, U. S. Nuclear Regulatory Commission, Washington, D.C.

He succeeds **Robert F. Barker** who had accepted an assignment with the International Atomic Energy Agency, Vienna, Austria. Jones' appointment was announced by **Robert B. Minogue,** director of the Office of Standards Development.

Mr. Jones has been with the NRC and its predecessor, the Atomic Energy Commission, since 1957 except for a three-year period with a commercial fuel supplier. During this entire period, he has specialized in control and safeguarding of nuclear materials.

The long-time INMM member comes to this position from the Safeguards Standards Branch with which he has been associated since 1972. He has been chief of that branch since 1975. Prior to joining the AEC, Mr. Jones served in the U.S. Navy and was employed as a chemist and quality control specialist in the pharmaceutical industry.

Mr. Jones received a B.S. degree in Industrial Chemistry from Kansas State University, Manhattan, in 1944 and an M.B.A. from Rutgers University in 1957.

Political Problems May Surround End of INFCE in February 1980

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Editor's Note: The following article appeared in the June 9, 1979, issue of **Arms Control Today,** a publication of The Arms Control Association, Washington, D.C. The first paragraphs provide background leading up to Mr. Clausen's article. The following is reprinted with permission.

The International Nuclear Fuel Cycle Evaluation (INFCE) has been an important part of the Carter Administration's strategy to slow the spread of nuclear weapons by checking movement towards an international plutonium economy. Over nearly two years and though eight working groups, this fifty-nation conference has examined the structure of the world nuclear trade and sought alternatives to advanced fuel cycle technologies which could spread the capability to easily construct nuclear weapons.

As a non-proliferation specialist in the U. S. Department of Energy, Office of Energy Research, Peter Clausen has been a participant in INFCE Working Group 3. In this article he discusses the impluses leading to convening INFCE and the issues which have surfaced in conference meetings. He concludes that the inability of INFCE to deal with two themes underlying the conference – demands of developing countries for nuclear energy aid and growing public doubt about nuclear power in many countries – may cause the end of INFCE in February 1980 to be surrounded by political problems. The views he expresses here are his own entirely, not those of the Department of Energy or the U. S. government.

When the Carter Administration first proposed the Internationl Nuclear Fuel Cycle Evaluation (INFCE) in the spring of 1977, it is doubtful that either the U. S. or the some fifty other nations and organizations that were eventually to participate had a very clear idea of what they were getting into. It was to be an unprecedented diplomatic-scientific event — an exhaustive, two-year inquiry into many, if not all, the issues surrounding nuclear energy and its relationship to nuclear weapons proliferation. Moreover, in the contentious circumstances in which it was proposed, INFCE offered ample scope for the projection of all manner of national hopes, apprehensions, and discontents.

Consciousness-Raising

For the U.S., INFCE represented an opportunity to engage the rest of the world in the kind of "consciousness-raising" that had led it, beginning late in the Ford Administration and then more decisively under President Carter, to draw back from the breeder reactor-based plutonium economy that had until recently been taken for granted as the next step in nuclear power development. The new American nuclear policy focused squarely on the accessibility through the nuclear power fuel cycle of plutonium and highly enriched uranium, the basic raw materials of nuclear weapons, posing a critical proliferation risk. Accordingly, the US had announced an indefinite deferral of plans for commercial reprocessing of spent fuel from U. S. power reactors and the subsequent recovery and recycling of plutonium. In addition, the United States breeder program was to be put on a more measured pace and reoriented from its emphasis on early demonstration of the Liquid Metal Fast Breeder Reactor (LMFBR) to a more broadly based assessment of technologies and fuel cycles, with relative proliferation risks a major consideration. Internationally, the U. S. urged the other industrial nations to pause for a similar reassessment of their nuclear energy strategies and to refrain from exporting sensitive reprocessing and enrichment technologies.

Confrontation with Allies

This "revisionist" analysis of nuclear power, and the early attempts to implement it, brought the U.S. into immediate and sharp confrontation with its major alliance partners and those developing countries, such as Brazil and Argentina, which were seeking greater independence in the nuclear fuel cycle. To Japan and the large European nations, committed to the breeder economy as a route to reduced dependence on imported oil and uranium, the policy was perceived as a threat to energy security and, in some cases, to the health of export-oriented nuclear industries. To the aspiring nuclear energy states of the third world, it was seen as a threat to technological development and a regressive step in the ongoing dialogue between industrial and developing countries.

It was, then, in an embattled atmosphere that the U.S. proposed INFCE. America's foreign critics were, for the most part, suspicious of the initiative, and apprehensive that it might prejudice their domestic nuclear plans, or provide a forum for pressure to accept U.S. preferences in this field. Despite this initial difference, however, INFCE got under way in October 1977 with some ground rules that allayed the worst fears of the more reluctant participants. The latter gained assurance that INFCE would not interfere with their national energy programs and that it would not be a negotiating forum but rather a technical study, with no mandate to take decisions or otherwise obligate the participants.

In keeping with this nondirective conception, the work of INFCE was divided into eight relatively autonomous working groups (see chart), each open to the participation of any interested country. Overall guidance and coordination were entrused to a smaller Technical Coordinating Committee (TCC), but these functions have been performed in a modest way. In practice, the working groups, each of which is preparing a final report, will dictate the substantive outcome of the study.

INFCE's final Plenary Session is scheduled for February 1980, and the study is therefore three-fourths complete. The working groups have largely drafted their reports, and it is not too soon to venture an assessment of what the whole exercise has accomplished and, more tentatively, what it means for the future of nuclear energy and the international nonproliferation regime.

Nuclear Hasn't Stood Still

Two general observations can be made at the outset. First, the nuclear world has, inevitably, not stood still during the course of INFCE. The period since the study began has been the occasion neither of the pause in commitments to sensitive technologies that the U.S. had sought, nor of the forebearance in new actions in the name of nonproliferation that nuclear consumer states had hoped for. During INFCE, the United Kingdom has moved ahead with its plans for the Windscale reprocessing facility, and the Japanese have signed major new contracts with British and French reprocessors and announced plans for a national enrichment capability. In the U.S. on the other hand, the Congress has passed the Nuclear Nonproliferation Act of 1978, which imposes significant new conditions for U.S. nuclear cooperation with other nations.

Whether or not such actions have, as often charged by their opponents, prejudiced the outcome of INFCE, they have underlined the importance attached to these questions by the protagonists in the nuclear debate, and dramatized the differences between them. Other events, however, such as the Three Mile Island nuclear accident and the reactions to it, and the allegations of a weapons-oriented enrichment project in Pakistan, have served as reminders of the considerable common ground among the protagonists and of the farther dimensions of the nuclear debate, beyond INFCE's deliberations.

Not Detached Study

The second observation to make at the start is that, again inevitably, INFCE has not been a detached, technical study, its terms of reference notwithstanding. The vocabulary may be largely technical, but the messages and stakes are highly political, and as such INFCE presents a fascinating case study in the interaction of science and politics. A review of the major issues of INFCE illustrates this time and again.

A good example is the effort, in Working Group 1, to assess the availability of uranium over the next several decades against the projected demand for it. The stakes in any "official" view of the supply and demand outlook are high, as the U.S. has discovered to its frustration in attempting to introduce a greater element of realism into the discussions. An optimistic outlook on uranium reserves and future production, along with a modest view of nuclear growth over the rest of the century, would of course work in favor of the U.S. argument. The heart of this argument is that near-term commitments to plutonium separation and recycle and to breeder commercialization to achieve fuel economies are premature, and that the transition to a plutonium-based nuclear economy need not take place, if at all, until more time has been devoted to establishing institutional and technological arrangements that can make this economy safer from a security standpoint.

Temporary Predicament

Not surprisingly, however, states already committed politically and financially to rapid nuclear growth and an early shift to plutonium — or determined to leave this option open for the future — are not eager to endorse supply and demand projections that cast doubt on these plans. The majority preference in INFCE has been to regard the current predicament of nuclear power as a temporary phenomenon that will soon give way before the imperatives of energy supply, and to be reluctant to accept anything beyond the most conservative proven reserve figures as indicative of the potential for future uranium production. In the end, INFCE is likely to come out carefully ambiguous on the long-term sufficiency of uranium resources, and to project a range of future nuclear power capacity stretching from the mildly optismistic to the wildly implausible.

Of course, it is not just the global supply of uranium that concerns countries with nuclear power programs. A more immediate, and, in light of the recent history of energy markets, understandable concern has been gaining reliable access to uranium and to enrichment services, the supply of which is controlled by a very few countries. In Working Group 3, the U.S., Canada, and Australia have been very much on the defensive in dealing with consumer state complaints about excessive, and unilaterally determined, nonproliferation conditions on the supply of uranium or enrichment services, and the use or threat of supply cutoffs to encourage acceptance of these conditions on the part of customers.

"Proliferation Resistance"

Another of INFCE's political thickets has been the question of the so-called "proliferation resistance" of alternative technologies and fuel cycle strategies. The concept — the relative susceptibility of a given nuclear system to diversion of material for weapons purposes — is basic to the U.S. argument against the plutonium economy. The organization of the working groups around separate stages of the fuel cycle has to some extent frustrated the comparison of proliferation risks across entire fuel cycle strategies, and this has made it somewhat more difficult for the US to make its case effectively. But it was never likely in any case that INFCE would come out with a straightforward endorsement of the superior proliferation resistance of the "once-through" cycle (in which spent fuel is stored indefinitely, as such, rather than reprocessed for recovery of the plutonium and residual uranium it contains). But the U.S. can take some encouragement that this issue, despite much initial hostility, has emerged as a legitimate topic of discussion. Indeed, the proliferation resistance argument has on occasion been turned against the U.S. approach, as when the long-term storage of spent fuel is characterized as the creation of ever more accessible (as the radiation barrier declines) "plutonium mines."

Questions Persist

One can identify numerous other technical-political questions that have inspired lively debate in INFCE without settling key issues in a way that could indicate a clear direction for future nuclear planning. What is the potential for improving the fuel efficiency of the existing generation of light water reactors (LWRs), thus extending their lifetime against the time when depletion of uranium resources calls for a shift to plutonium fuels? Nonproliferation issues aside, what are the relative environmental advantages and disadvantages of alternate strategies for the post-reactor (or "back-end") phase of the fuel cycle? Does reprocessing make the ultimate disposal of nuclear wastes easier, or can spent fuel be disposed of with no technical or environmental penalty? At what uranium price does the shift from LWRs to breeders become economically compelling? National positions on these and similar issues can be deduced in fairly linear fashion from their holders' place in the general debate on the plutonium economy.

Two-Year Rehersal?

Has INFCE then produced nothing but a two-year rehersal of preconceived views, an extended opportunity for each faction in the nuclear debate to protect and justify its own position? This would be an excessively pessimistic verdict. To a surprising degree, there have in fact been elements of a genuine dialogue, some mutual learning, and even a modest degree of consensus building. Moreover, the net result will probably not be as inimical to American purposes as most observers would have predicted at the outset. An overview of INFCE's likely results presents a mixed but not entirely discouraging picture in terms of original American objectives.

First, INFCE will not produce the technological break-through — the much desired but illusory "fix" — that could make nuclear energy risk-free from the standpoint of nuclear weapons proliferation. Although certain technical innovations can perhaps incrementally increase the difficulty or cost of diverting weapons material from the nuclear fuel cycle, the sensitive processes and materials will in the final analysis remain sensitive. And, countrary to U.S. hopes, the LMFBR, fueled with plutonium obtained through something much like conventional present-day reprocessing facilities, remains the strategy of choice for moving to a more renewable nuclear energy economy.

If the technological dimension is only marginally susceptible to manipulation in the interests of proliferation resistance, then the burden of making the next generation of nuclear power safer will largely fall to institutional, political, and diplomatic arrangements. Questions of timing, precedent, and framework, rather than of hardware, will be the critical ones.

Organization of INFCE

Working Group	Subject / Cochair Countries
1	**Fuel and Heavy Water Availability** Canada Egypt India
2	**Enrichment Availability** France Iran West Germany
3	**Supply Assurances** Australia Philippines Switzerland
4	**Reprocessing, Plutonium Handling, Recycle** Japan United Kingdom
5	**Fast Breeders** Belgium Italy USSR
6	**Spent Fuel Management** Argentina Spain
7	**Waste Management and Disposal** Finland Netherlands Sweden
8	**Advanced Fuel Cycle and Reactor Concepts** Republic of Korea Romania United States

No New Regime

INFCE will not produce a panacea here, either. The makings of a new international nuclear energy regime are simply not at hand, and certainly not on U.S. terms. Nevertheless, some elements of a broadly consensual approach may be emerging through the INFCE process, and here there are grounds for optimism for those who share the U.S. alarm about the prospect of a worldwide rush to plutonium.

For one thing, the vocabulary of INFCE discussions — the terms in which debates are framed — suggest that some of the hoped for consciousness-raising has, in fact, occurred. Even where substantive positions remain unyielding, noticeably more legitimacy now attaches to expressions of concern about sensitive fuel cycle processes than was the case two or three years ago. (Pakistan has probably helped here, but the phenomenon is broader than a reaction to this one case.) Indeed, it is not exaggerating to say that those who press the case for early commitments to reprocessing and breeders now ofen appear on the defensive and find it necessary to justify their case in a way that makes it clear that they no longer claim the automatic support of the conventional wisdom.

This heightened concern about proliferation risk, combined with increasingly acknowledged economic realities, has produced something of a new conventional wisdom that is reflected frequently in INFCE discussions and reports, Its main tenets can be briefly summarized as follows: Sensitive fuel cycle facilities and fast breeder reactors should follow a fairly strict economy of scale logic. Such facilities should be large, limited in number, and closely safeguarded. For most countries, reliance on international markets in nuclear fuels and services is preferable, from both an economic and security standpoint, to efforts to achieve nuclear autarky. (More reliable performance by supplier states is critical here.) Plutonium is a highly sensitive material whose storage and transport should be subject to an international regime going beyond mere safeguards. With respect to plutonium uses, recycle in LWRs appears to be of at best marginal advantage from an economic and resource-saving point of view. (This drastically narrows, for the foreseeable future, the market for plutonium.)

Fledgling Norms

Again, these fledgling norms command a wide if not universal following among the major INFCE participants. Their cumulative effect is to define a rather narrowly circumscribed, and strictly controlled, international plutonium economy.

To sum up, it seems likely that INFCE's main accomplishment will have been to better sensitize nations to the broader implications of technological, economic, and political choices in nuclear energy development, and to have set in motion a number of processes of consultation and institution-building that will undoubtedly outlive the study and could have an important shaping influence on the future nuclear energy regime. These latter could include an international plutonium storage system, perhaps some version of the U.S. "fuel bank" idea to improve supply security, and quite possibly an international dimension to some future fuel cycle facilities.

There remain large question marks, however. Two of these in particular deserve mention because they hold the potential to diminish the long-term impact, and indeed the very relevance, of the INFCE exercise. Neither the perspectives of the developing countries nor the question of public acceptance of nuclear power have occupied a great deal of INFCE's time. Yet it seems clear that these issues could have more to do with the coming shape of the proliferation and energy supply problems than all the INFCE discussions and reports combined.

Sidestepped North-South Debate

INFCE has for the most part been a dialogue among the Western industrial states, polarized (to the extent that it has been) along supplier-consumer lines. Despite frequent lip service to the "special needs of the developing countries," only a relatively few pages of the final INFCE product will be devoted to these needs, and the limits of the consensus building process described earlier are soon reached when one considers the positions of such countries as Argentina, India, and Pakistan.

An INFCE consensus that could include all the "problem countries" is undoubtedly beyond reach, but it is likely that the exercise will be seen by developing countries generally to have discreetly side-stepped the North-South dimension of the nuclear debate and in particular the issues of technology transfer, technological development, and nondiscrimination. To the extent that this perception prevails, it will be doubly unfortunate: first, because nuclear proliferation, as a problem in international and regional security, is today posed primarily in terms of the third world; and second, because the legitimacy of the existing international nonproliferation regime is put in jeopardy by this perception.

The supplier states in general and the U.S. in particular have yet to deal effectively with the charge that their position on sensitive technology exports violates the bargain struck in Article IV of the Nonproliferation Treaty (NPT), which promises "the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy." This charge can be expected to figure prominently at the NPT Ten-Year Review Conference scheduled to follow the final INFCE Plenary by a matter of months. Formulating a response to it is a major piece of unfinished INFCE business for the industrial states. Having recognized and begun to deal with the danger that competition for LDC nuclear markets could weaken the non-proliferation regime by stimulating the spread of sensitive technology, they now must articulate a more convincing role for the LDCs in that regime or risk an erosion of support for it.

Nuclear fuel might be diverted to make nuclear weapons either from the "front-end" of the nuclear fuel cycle, from plants used to enrich uranium fuel; or from the "back-end" of the fuel cycle, from facilities which reprocess spent fuel from reactors for reuse. U.S. policy, a moving force behind the INFCE idea, has been to convince countries moving to build enrichment or reprocessing plants, or breeder reactors which would use reprocessed plutonium fuel, to delay their construction plans. INFCE working groups have discussed methods of satisfying the needs of non-nuclear weapons countries for nuclear fuel and processing services which would not be prone to use in nuclear weapons programs.

Public Acceptance Dilemma

If third world disaffection tests international nuclear consensus from one side, public opinion in the industrial democracies threatens it from the other. In a very real sense, the "public acceptance" issue, though alluded to in INFCE's terms of reference, has been an unwanted and somewhat embarrassing guest at the proceedings. The whole study has taken place against a background of growing doubts as to whether nuclear energy can sustain the public confidence necessary for its continued development.

No INFCE faction can really take heart from this situation, though most have at one time or another succumbed to the temptation to use the issue in a partisan way. For example, the U.S. and its INFCE allies can perhaps be forgiven for pointing out that their export policies are by no means the major source of problems facing nuclear programs in Europe and Japan, or that the steadily declining forecasts of nuclear power growth strengthen the case for deferring the breeder transition. On the other hand, critics of the U.S., especially in Germany and Japan, can, with some justice, complain that the US policy on reprocessing could, even if inadvertantly, threaten to unravel the delicate compromises with public opinion that have allowed their nuclear facilities to be constructed and licensed.

Nevertheless, INFCE participants must increasingly confront the realization that their internal disagreements bear only a slight resemblance to the way the nuclear issue is framed politically in many of their societies. The issues dividing the U.S. and its critics sometimes seem esoteric nuances in the context of a public debate in which nuclear power tends to be viewed as all of a piece. In the end, the problem of justifying and selling nuclear power to their own publics seems to be the real common ground of the major participants in INFCE, and it could eventually make their sometimes heated differences seem a bit beside the point.

NRC Publishes Proposed Rule Changes In Anticipation Of US/IAEA Safeguards Agreement

The Nuclear Regulatory Commission is republishing for public comment proposed new regulations which would implement the United States/International Atomic Energy Agency (IAEA) Safeguards Agreement when it becomes effective.

In 1967, the United States volunteered to have IAEA safeguards applied to all major U.S. nuclear activities with the exception of those having direct national security significance. This offer was made to encourage the widest possible adherence to the Treaty on the Non-Proliferation of Nuclear Weapons, by demonstrating to other nations that they would not be placed at a commercial disadvantage by application of safeguards under the treaty. The offer also was a manifestation of U.S. support of the international safeguards system and demonstrated the U.S. belief that IAEA safeguards would not interfere with peaceful nuclear activities.

Following formal negotiations between the U.S. and the IAEA, the IAEA Board of Governors approved the proposed US/IAEA Safeguards Agreement on September 17, 1976. The agreement has been submitted to the U.S. Senate for its advice and consent to ratification as a treaty.

The implementing regulations are contained in a proposed new Part 75 of NRC regulations, "Safeguards on Nuclear Material — Implementation of US/IAEA Agreement" and amendments to Parts 40, 50, 70, 150 and 170. They include provisions to permit IAEA inspection of certain licensed installations; a requirement for licensees to prepare and submit information about their installations; provisions for the NRC to transfer such information to the IAEA subject to special precautions in case of proprietary or other sensitive information; a requirement for submitting reports required by the Agency; and requirements for material accounting and control.

The proposed regulations were first published for public comment in May of 1978. The following November the Commission announced the availability of some supplemental documents and extended the public comment period for another 30 days.

Consideration of the comments has resulted in substantial changes to the original proposal. The Commission has decided to republish the proposed rule, with changes, for the purpose of affording further opportunity for licensee participation in formulating the policies and procedures that will apply to their activities.

Written comments or suggestions on the proposed rules should be sent by (45 days after FR publication), to the Secretary of the Commission, Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. The text of the proposed implementing regulations was published in the Federal Register on July 17, 1979.

Physical Protection Systems Training

By P. B. Herrington and O. G. Bates
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INTRODUCTION

In 1973, Sandia Laboratories began a research and development program on the physical protection of nuclear facilities and materials for the Department of Energy, Office of Safeguards and Security (DOE/OSS). The principal goal of this research program is to provide designers and operators of nuclear facilities with the technology and techniques necessary for the design and evaluation of physical protection systems. As a part of the activity to transfer this technology and associated design and evaluation techniques, Sandia has developed and conducted six domestic training workshops and one international training course. A second international course is planned for November 1979.

The first five domestic workshops were conducted at Sandia Laboratories, Albuquerque, New Mexico, between December 1977 and April 1978. A total of 114 individuals, primarily personnel from DOE area offices and associated contractors, participated in these workshops. The sixth domestic workshop was conducted at the DOE area office in Richland, Washington, and included 23 participants from six organizations.

The 1st International Training Course in Physical Protection of Nuclear Facilities and Materials was conducted in Albuquerque during November 1978. This training course was sponsored by DOE, in consultation with the Nuclear Regulatory Commission, and was given under the general auspices of the International Atomic Energy Agency. It was intended for an audience of representatives from developing countries who are responsible for preparing physical protection systems. The countries represented included Argentina, Brazil, Chile, Czechoslovakia, India, Indonesia, Iran, Iraq, Israel, Korea, Malaysia, Mexico, Pakistan, the Philippines, Poland, Portugal, Romania, Spain, Thailand, Turkey, Venezuela, and Yugoslavia.

COURSE CONTENT

The instructional material presented during each workshop was structured to address the particular needs of the attendees; however, the use of a systematic approach for the design and evaluation of physical protection systems was a common thread throughout the content of each training activity.

Figure 1 illustrates the relationships among the six principal functional components in the systematic approach: systems concepts, facility characterization, threat analysis, design and evaluation techniques, component evaluation and development, and protective force considerations.

In Figure 1, the component of system concepts is depicted as the context in which the other five functions in the design and evaluation process occur. Briefly summarized, the systematic approach views each feature of the physical protection system as potentially contributing some functional performance. The combination of these functions constitutes the overall performance of the system. The functions of these physical protection components can conveniently be grouped into four categories: detection, delay, communication, and response.

Prior to beginning the conceptual design or evaluation of a facility, it is necessary to characterize the facility in order to know what must be protected and what potential protection features already exist. Similarly, the threat must be identified in terms of the range of attributes of potential adversaries. Facility characterization data and adversary attributes comprise the basic input to systematic methods of design and evaluation which can be used to determine the vulnerabilities of the facility and to formulate an effective conceptual design. A knowledge of component performance and protective force procedures and performance is necessary to the evaluation and implementation of the design.

System Concepts

The concepts which are emphasized for fixed-site protection systems can be summarized as follows:

1. The primary objective of a physical protection system (PPS) at a nuclear facility is to prevent the theft of strategic quantities of special nuclear materials and acts of sabotage which might endanger the public by the release of radiological substances.

2. The PPS is one of several systems required for the safe, secure operation of a total facility. As such, the PPS should be designed to interface effectively with the other systems of the facility, e.g., material control and accountability, safety , and process operations.

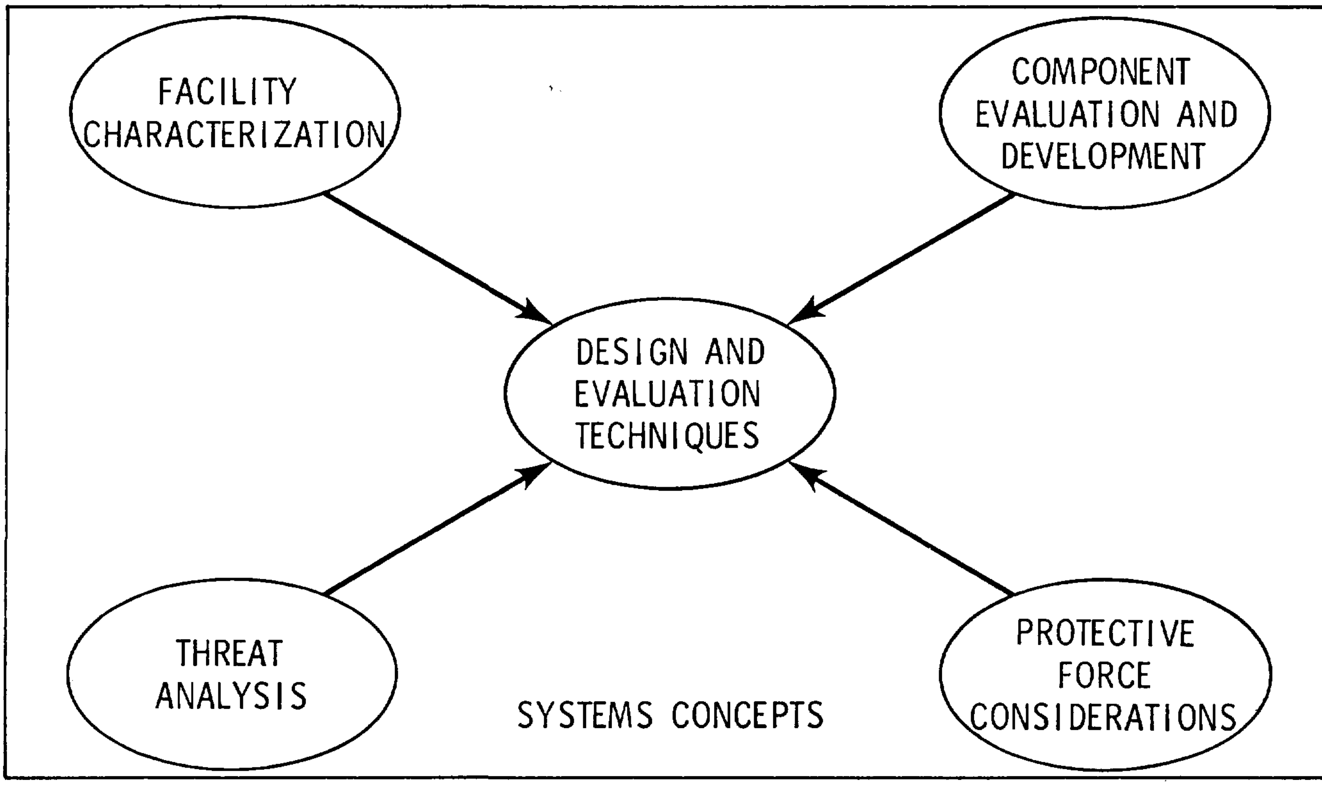

Figure 1. Systematic Approach to Design of PPS.

3. An effective physical protection system must provide the functions of detection, delay, communication, and response. The delay, communication, and response functions contribute to system performance **only if they are preceded by detection.**

4. The system features which carry out the required functions must be integrated effectively. For example, detection must occur while there is sufficient delay (or time remaining) for the alarm to be communicated to the protective force and for that force to respond.

5. PPS performance must be maintained at adequate levels under all environmental conditions, e.g., weather and time of day, and for all operational configurations of the facility.

6. The physical protection system should not be totally compromised should the adversary capabilities exceed those identified in the threat analysis.

7. In order to achieve its objective, the PPS should provide protection-in-depth, i.e. an adversary must defeat a series of PPS features in order to succeed.

Facility Characterization

The data concerning facility configuration and procedures required to begin the design or evaluation process were detailed. A key consideration is the identification of potential adversary targets. In the case of a nuclear reactor facility, the technique of vital location analysis[1] was introduced as a method of identifying potential sabotage targets within the facility.

Threat Analysis

A methodology which has been used to assess the capabilities of adversaries posing subnational threats to nuclear facilities was presented. The threat analysis material was derived from research performed by the Rand Corporation for Sandia Laboratories.[2]

Component Evaluation and Development

An introduction to the selection, procurement, installation, testing, maintenance, and integration of components of a physical protection system was presented. The components which were discussed included intrusion detection systems, entry-control systems, and barriers.

Intrusion Detection Systems—The hardware which comprises intrusion detection systems includes sensors, processors, alarm assessment systems, and alarm reporting systems. Factors which influence the performance and techniques used in the integration of this hardware were discussed, and an overview of the **Intrusion Dection Systems Handbook**[3] was presented.

Entry-Control Systems—Hardware evaluation results for personnel identity verification, metal detection, explosives detection, and nuclear materials detection were discussed. Included was development work on various entry-control hardware and integrated entry-control systems. The material presented on entry-control systems is contained in the **Entry-Control Systems Handbook.**[4]

Barriers—The barrier development and evaluation program at Sandia Laboratories was discussed. Barrier penetration test results were presented in order to orient the attendees to the rapid penetration times possible for several conventional barriers and to explain some concepts for improving barrier delay times. The **Barrier Technology Handbook**[5] served as the basis for this session.

Protective Force Considerations

The protective force is possibly the most important element of a physical protection system; however, it is also the element whose effectiveness is most difficult to quantify. Factors such as the functions performed by a protective force, training, and procedures which should be considered when designing or assessing this force were discussed.

Design and Evaluation Techniques

The role of effectiveness evaluation techniques is to translate estimates of the performance of components in carrying out their specific functions into estimates of the performance of the combination of these components, i.e. the physical protection system, in protecting facility targets from potential adversaries with a range of attributes. The application of these techniques is a key step in the design process since it clarifies the functional relationship between individual design features and overall system performance. An important aim of the course was to demonstrate how these evaluation techniques can be applied. To this end, attendees were shown how an effectiveness evaluation is performed.

Two analytical tools were used for the effectiveness evaluations. The primary tool was a set of 13 generic physical protection logic trees.[6] These logic trees depict the relationship among a set of basic events which represent all the ways an adversary can penetrate and/or exit from a site using tactics of force, stealth, or deceit. These logic trees were used for qualitative evaluation of hypothetical physical protection system configurations as well as for conceptual design exercises devised to assist the attendee to associate proposed features with the specific functional role performed by the feature.

As an adjunct to the logic trees, a relatively simple quantitative evaluation technique, the Estimate of Adversary Sequence Interruption (EASI) model,[7] was introduced. The EASI model calculates the probability of interrupting an adversary traveling along a physical path which is described by (1) probability of detection, (2) adversary delay time, (3) probability of communication, and (4) protective force response time. The systematic application of EASI to a facility produces quantitative results which can be used as an estimate of physical protection system performance. These results can also be used to perform sensitivity analyses of alternative facility upgrades or conceptual designs. The combination of the generic adversary logic trees and EASI provides a systematic effectiveness evaluation tool.

COURSE FEATURES

A key instructional feature of the workshops is that approximately 50 percent of the training time has been devoted to hands-on exercises in small-group work sessions. Other major instructional and organizational components used in the courses included lectures/discussions, tours, course materials, participant critique, and staff coordination.

Small-Group Work Sessions

Participants in the course exercises were divided into groups of five with an instructor for each group. These participants were then provided with hands-on experience in analyzing the strengths and weaknesses of a physical protection system, developing conceptual plans, and formulating alternative upgrade options for a hypothetical facility which contained a carefully chosen collection of features from real facilities. The instructor introduced the problem to be solved and the material available for its solution. The group was prompted to use the resources to which they had been introduced in the lecture sessions to solve the problem with minimal assistance from the instructors.

Lecture/Discussions

Approximately 40 percent of the course was devoted to lecture presentations followed by discussions. A set of instructional objectives geared to the needs of the participants served to target the material presented in each session.

Hardware Demonstrations

Lectures were supplemented by equipment displays and demonstrations by Sandia technical specialists. These demonstrations familiarized the attendees with physical protection equipment and provided them with an opportunity for informally sharing hardware testing techniques and summarizing test results.

Course Materials

Each participant received his own copy of the **Intrusion Detection Systems Handbook,** the **Entry-Control Systems Handbook,** the **Barrier Technology Handbook** in addition to the two notebooks which contained the course instructional material.

The first course notebook[8] consisted of class notes for each lecture session and included (1) session sheets which had well-defined instructional objectives, a summary of material presented, and a list of additional resource material available for futher study, (2) written test on the lecture subject, and (3) copies of the visual materials used during the lectures.

The second notebook[9] consisted of material developed for the small-group work sessions. This material included session sheets for each small-group session, a statement of the problems to be worked, instructional guidelines, practice exercises, and think-about-items for later discussion.

During the course, participants had exclusive use of a calculator programmed to perform the EASI path analysis and a full set of the generic logic trees for adversary penetration of the physical protection system zones.

Staff Coordination

Both the domestic workshops and the international training course were structured using the team concept: a lead instructor developed the instructional objectives and other technical materials and coordinated the instructional staff, a course director provided management support and technical direction to the team, a training specialist provided instructional design and administrative support, and subgroup instructors assisted in the development of subgroup materials and served as instructors.

Participant Critiques

At the end of the course, participants completed a critique on (1) how well the course objectives met individual needs, (2) strengths and weaknesses of the course, and (3) areas for addition or deletion. Daily meetings were conducted by the course staff immediately following the course sessions to (1) review the progress of small-group sessions, (2) share student feedback, and (3) adjust the course materials and presentations to address attendee problems in understanding the material and participating in the work sessions.

Foreign Guest Speakers

For the International Training Course, domestic representatives for NRC and DOE spoke on the U. S. system of physical protection, and guest speakers from Canada, France, Iran, and the UK presented their national approaches to physical protection. An IAEA representative presented the Agency's view on State systems of physical protection.

Resource Room

Also for the International Training Course, a large conference room was maintained in order to permit the participants to (1) review additional documents and other technical reference material, (2) view equipment demonstrations and displays, and (3) meet informally to discuss questions, ideas or problems.

RESULTS

Immediate feedback from the participants indicated that the objectives of the training course had been accomplished. The introduction to technology and techniques for systematic design and evaluation provided them with a starting point for designing and evaluating physical protection systems for a performance viewpoint. Subsequent feedback from attendees has indicated that the course content has been useful.

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Concrete Spaller

RICHLAND, Washington— A device for decontaminating concrete surfaces in nuclear facilities is the subject of a United States patent assigned recently to the Department of Energy

The device—called a concrete spaller—was invented by **Charles H. Allen,** at the DOE's Pacific Northwest Laboratory, which is operated by Battelle Memorial Institute. Dr. **J. Michael Halter** and **Robert G. Sullivan** have incorporated the spaller into a system for use in nuclear facilities. All three researchers are members of Battelle's Engineering Physics Department.

In facilities that have become too contaminated for continued use, the spaller can be used to break off a minimum of a quarter-inch of the outer surface of a contaminated wall. The process doesn't destroy the integrity of the structure, so normal activities can resume as soon as contaminated rubble is removed.

The spalling technique also offers a less expensive decommissioning method compared to conventional techniques which require dismantling the entire structure; crating the contaminated concrete rubble, and disposing of it in burial grounds. The spaller saves money by reducing the amount of rubble requiring special handling and burial. After it has been used to remove the contaminated outer layer of concrete, the rest of the facility can be demolished using standard demolition techniques.

The spaller, powered by a hydraulic pump or an air compressor, consists of a hydraulic cylinder connected to an expanding bit. The bit is inserted in pre-drilled holes and activated to break off pieces of concrete about eight inches in diameter.

Passive Neutron Assay Of Irradiated Nuclear Fuels

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ABSTRACT

Passive neutron assay of irradiated nuclear fuel has been investigated by calculations and experiments as a simple, complementary technique to the gamma assay. From the calculations we have found that the neutron emission arises mainly from the curium isotopes, the neutrons exhibit very good penetrability of the assemblies, and the neutron multiplication is not affected by the burnup. From the experiments on BWR and PWR assemblies, we have found that the neutron emission rate is proportional to burnup raised to 3.4 power. Our investigations indicate that the passive neutron assay is a simple and useful technique to determine the consistency of burnups between assemblies.

I. INTRODUCTION

Nondestructive assay (NDA) methods for the determination of the burnup and cooling times of irradiated nuclear fuels are needed to safeguard against diversion of fissile materials to weapon use. Because irradiated fuels represent a possible source of plutonium, it is essential that the International Atomic Energy Agency (IAEA) have a measurement capability for effective international safeguards. For easy implementation the preferred NDA method should use simple, portable equipment that can be carried from site to site for rapid and reasonably accurate assays.

Gamma-spectroscopy has been investigated as a measurement method for determining nondestructively the burnup and cooling time of irradiated fuels.[1-4] The measurement is usually performed in a hot cell or in a cooling pond. The method is based on measurement of the concentrations of radioactive burnup monitors (^{95}Zr, ^{137}Cs, or ^{144}Ce-^{144}Pr) or, in recent years, the activity ratios (^{134}Cs/^{137}Cs or ^{154}Eu/^{137}Cs). The problems related with gamma-spectroscopic measurements have recently been reviewed.[1-3] The major problems are the fission products (or their precursors) may migrate at high fuel temperature (^{106}Ru-^{106}Rh, ^{134}Cs, and ^{137}Cs); the intensities of gamma rays from the fission products in the interiors of assemblies are substantially attenuated by the relatively dense fuel rods (density 10 g/cm^3); these activity ratios are sensitive to the epithermal-to-thermal flux ratio in addition to the fuel burnup. Burnup measurements cannot be performed by gamma assay on fuels shortly after discharge because the gamma activity is dominated by relatively short-lived isotopes (e.g., ^{140}La), reflective of recent reactor power level. Gamma-spectroscopic measurement also requires high-resolution germanium detector and multichannel analyzer (MCA), both of which necessitate well-trained personnel to obtain meaningful results. Though it is foreseeable that MCA with automatic features can be developed, thus minimizing the need for comprehensive training of the operator, a basic problem of the gamma assay method remains — it is only sensitive to the outer layers of rods of a fuel assembly. An alternative NDA method more sensitive to interior rods of an assembly is highly desirable for spent fuel inspection.

In addition to the various gamma rays, irradiated fuels also emit neutrons. Neutrons are less subject to self-absorption in the fuel assembly than are gamma rays. Passive neutron assay has been identified as a potentially useful inspection assay method of spent fuel both by the recent review[2,3] and in the IAEA Advisory Group Meeting.[4]

At the Los Alamos Scientific Laboratory (LASL) we have performed calculations and experiments to investigate the merits of passive neutron assay. From the calculations we have found that the neutron emission arises mainly from the curium isotopes,[5] and that the neutrons exhibit very good penetrability of the assemblies.[6] From the experiments on boiling water reactor (BWR) and pressurized water reactor (PWR) assemblies,[7] we have found that the neutron emission rate is proportional to burnup raised to 3.4 power. This report will summarize our findings with passive neutron assay.

Because the neutron emission arises mainly from the curium isotopes, the passive neutron assay does not verify the fissile content of the assembly but can verify the burnup.

II. ORIGINS OF THE PASSIVE NEUTRONS

In a spent fuel assembly, neutron emission arises from spontaneous fissioning of the even isotopes of

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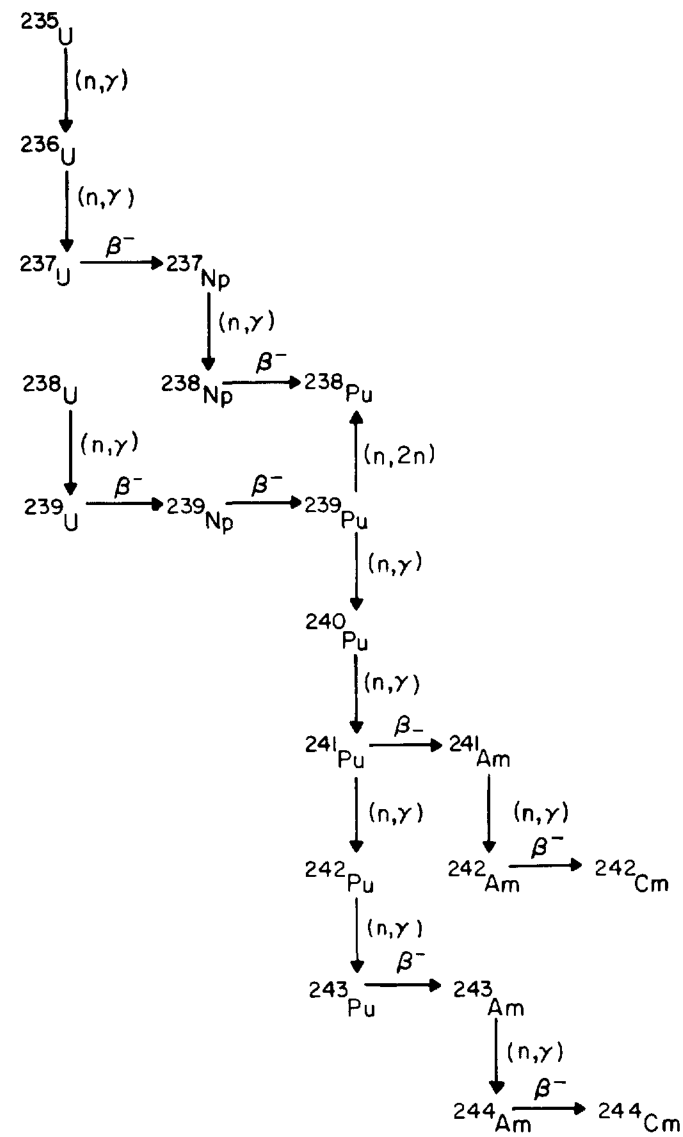
plutonium and curium and from the (alpha, n) reaction in oxide arising from the alpha emission of the various isotopes of plutonium, americium and curium. Figure 1 shows the major pathways of production of the transuranium isotopes in fuels irradiated in light water reactors (LWR). While it is possible to calculate the buildup of the transuranium isotopes, the uncertainty of such a calculation would be large because the neutron capture cross sections of some of these isotopes are not well established.

The following calculations are based on the results of a postirradiation examination study on Trino Vercellese reactor fuel.[8] In this study, which was done in Italy in 1976, the burnups of each of the fuel samples were determined by mass spectrometric measurements of ^{148}Nd. The uranium, plutonium and americium isotopic concentrations were determined by mass spectrometry with typical precision of better than 0.5%. The curium isotopic contents were determined by means of alpha-spectrometry measurement. The standard deviations fo the measurements of the curium concentrations are better than 5%. All the isotopic compositions were referred to reactor shutdown, except for ^{241}Am, which was expressed at the time of measurement.

To calculate the passive neutron emission rate arising from the spontaneous fission and (alpha, n) reaction in oxide, we used the nuclear data information shown in Table I.[9] Using the isotopic composition of the fuel samples as determined by destructive analysis, we calculated the neutron emission rate at discharge and at subsequent cooling time for burnups ranging between 13,000 and 26,000 MWD/MTU. Figure 2 shows the calculated neutron emission rate for a 12,859 MWD/MTU burnup fuel sample; Fig. 3 shows the neutron yield for a 26,884 MWD/MTU burnup fuel. The percentage contributions from the various fissionable isotopes to passive neutron emission rates are shown in Table II. Curium isotopes are the main contributors of the passive neutrons for burnups that exceed 15,000 MWD/MTU, accounting for at least 70% of the neutrons up to a cooling time of seven years. For cooling times of less than two years, the two curium isotopes dominate the neutron emission (greater than 70%) with ^{242}Cm the major contributor at short cooling times. Only for low burnup (less than 15,000 MWD/MTU) and for long cooling time (greater than two years) are the contributions from the Pu isotopes significant to the neutron emission rate. In the ^{242}Cm and ^{244}Cm decay, spontaneous fission is the major source of the passive neutron emission (see Table I).

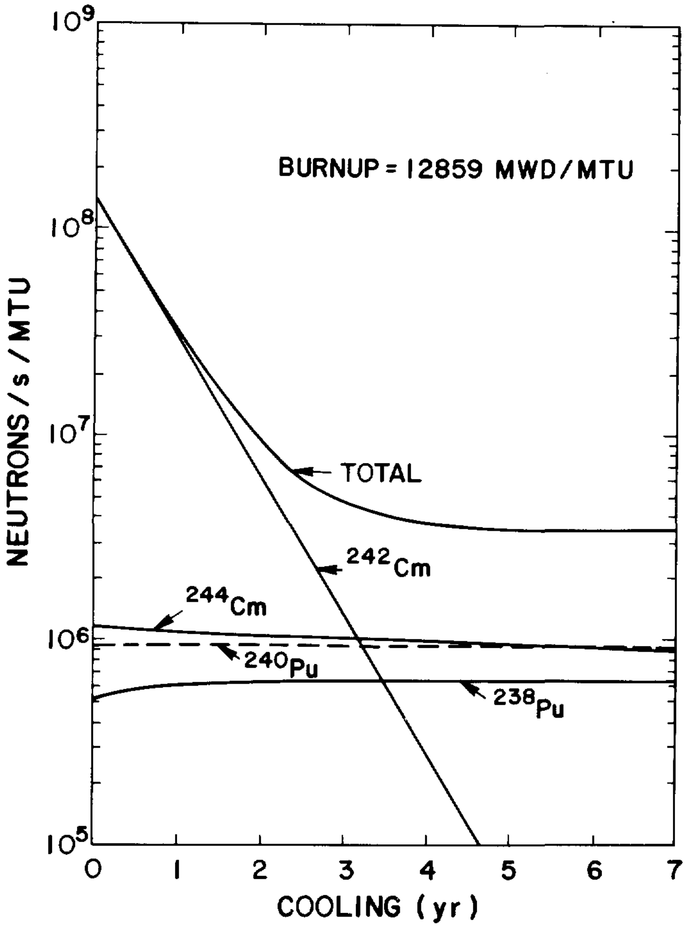


1. Major pathways of production of transuranium isotopes.

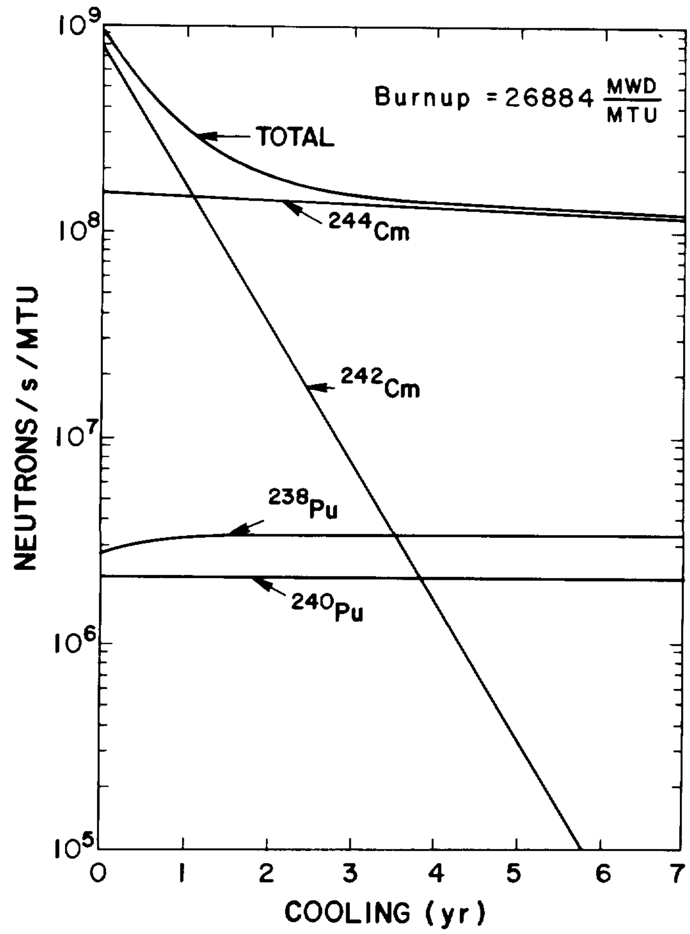
TABLE I

SPONTANEOUS FISSION AND ALPHA INDUCED NEUTRON YIELD

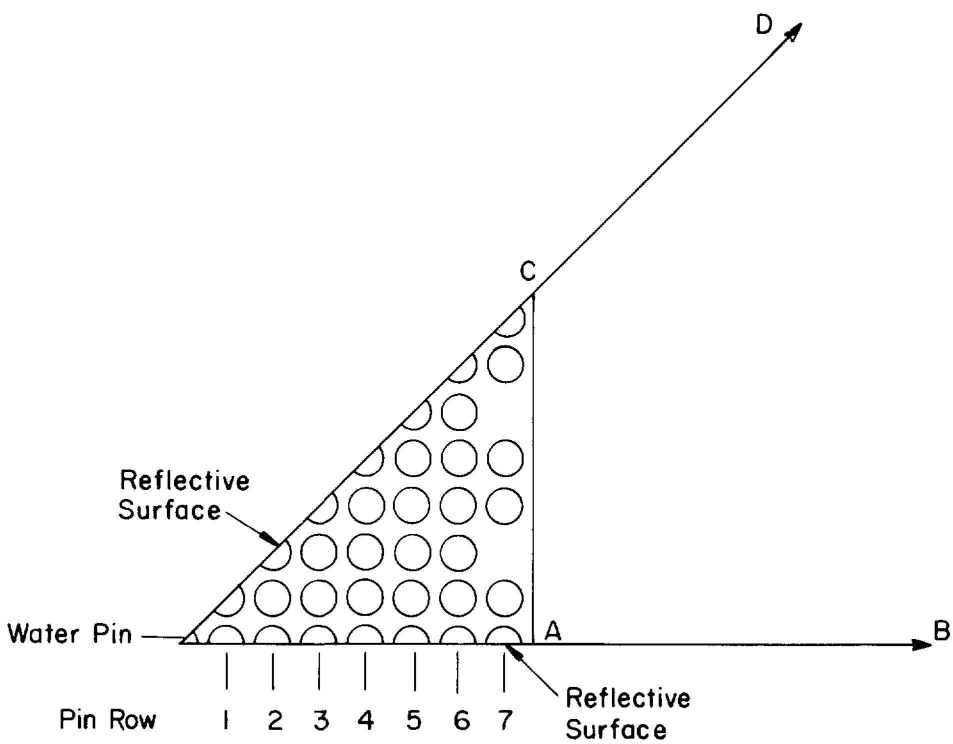
Source	Total Half-life (years)	Yield neutron / g s — Spontaneous fission	(,n) in oxide	Total
^{235}U	7.10×10^{8}	5.12×10^{-4}	1.11×10^{-3}	1.62×10^{-3}
^{238}U	4.51×10^{9}	1.14×10^{-2}	1.33×10^{-4}	1.15×10^{-2}
^{238}Pu	8.78×10^{1}	2.51×10^{3}	1.84×10^{4}	2.09×10^{4}
^{239}Pu	2.44×10^{4}	2.16×10^{-2}	5.38×10^{1}	5.38×10^{1}
^{240}Pu	6.55×10^{3}	9.14×10^{2}	2.01×10^{2}	1.11×10^{3}
^{241}Pu	1.47×10^{1}	1.10×10^{-2}	1.96	1.97
^{242}Pu	3.87×10^{5}	1.68×10^{3}	2.87	1.68×10^{3}
^{241}Am	4.33×10^{2}	5.79×10^{-1}	3.64×10^{3}	3.64×10^{3}
^{242}Cm	4.46×10^{-1}	2.13×10^{7}	4.75×10^{6}	2.60×10^{7}
^{244}Cm	1.81×10^{1}	1.10×10^{7}	1.03×10^{5}	1.12×10^{7}



2. Neutrons per second from ^{238}Pu, ^{240}Pu, ^{242}Cm and ^{244}Cm isotopes at a burnup of 12859 MWD/MTU. The total includes contributions from the other uranium, plutonium, and americium isotopes of the Trino reactor fuel.



3. Neutrons per second from ^{238}Pu, ^{240}Pu, ^{242}Cm and ^{244}Cm isotopes at a burnup of 26884 MWD/MTU. The total includes contributions from the other uranium, plutonium, and americium isotopes of the Trino reactor fuel.



4. Cross section of one-eighth of a Trino assembly; AB and CD are neutron reflective surfaces. Together they simulate the complete spent fuel assembly.

TABLE II

PERCENTAGE CONTRIBUTION TO PASSIVE NEUTRON EMISSION RATE FROM THE FISSIONABLE ISOTOPES

Cooling Time (years)	^{235}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{242}Cm	^{244}Cm	^{241}Am*
BU=12859 MWD/MTU										
0	2.3-55**	8.0-3	3.8-1	1.8-1	6.8-1	5.7-4	5.6-2	97.6	8.3-1	2.2-1
1	9.9-5	3.5-2	1.9	7.7-1	2.9	2.4-3	2.4-1	89.5	3.5	1.2
2	3.3-4	1.2-1	6.6	2.6	9.9	7.6-3	8.2-1	64.0	11.3	4.6
3	6.7-4	2.3-1	13.4	5.2	19.8	1.5-2	1.6	27.2	21.8	10.6
5	9.0-4	3.1-1	17.9	7.0	26.5	1.8-2	2.2	1.6	27.0	17.4
7	9.0-4	3.2-1	18.0	7.0	26.7	1.6-2	2.2	7.3-2	25.1	20.5
BU=15170 MWD/MTU										
0	1.4-5	53.-3	3.5-1	1.2-1	5.4-1	4.9-4	5.9-2	94.0	4.7	1.5-1
1	5.3-5	2.0-2	1.6	4.7-1	2.1	1.8-3	2.3-1	77.1	17.7	7.3-1
2	1.4-4	5.3-2	4.2	1.2	5.4	4.4-3	5.9-1	42.2	44.0	2.3
3	2.1-4	8.1-2	6.5	1.8	8.3	6.4-3	9.0-1	13.6	64.7	4.0
5	2.5-4	9.7-2	7.8	2.2	10.0	7.0-3	1.1	7.3-1	71.9	6.1
7	2.6-4	1.0-1	8.2	2.3	10.5	6.7-3	1.1	3.4-2	70.0	7.7
BU=20602 MWD/MTU										
0	4.4-6	2.1-3	3.2-1	5.8-2	3.2-1	3.3-4	5.6-2	88.8	10.3	1.2-1
1	1.5-5	7.0-3	1.3	2.0-1	1.1	1.1-3	1.9-1	63.3	33.5	5.0-1
2	3.0-5	1.4-2	2.7	4.0-1	2.2	2.1-3	3.8-1	27.3	65.8	1.2
3	4.0-5	1.9-2	3.5	5.3-1	2.9	2.6-3	5.0-1	7.6	83.1	1.8
5	4.6-5	2.1-2	4.0	6.0-1	3.3	2.7-3	5.8-1	3.9-1	88.5	2.6
7	4.9-5	2.3-2	4.3	6.5-1	3.5	2.6-3	6.2-1	1.9-2	87.6	3.2
BU=26884 MWD/MTU										
0	1.8-6	1.2-3	2.9-1	3.2-2	2.2-1	2.4-4	6.1-2	83.1	16.2	9.7-2
1	5.3-6	3.4-3	1.0	9.4-2	6.6-1	6.8-4	1.8-1	51.9	45.8	3.4-1
2	9.2-6	6.0-3	1.8	1.6-1	1.1	1.1-3	3.1-1	19.1	76.8	7.0-1
3	1.1-5	7.3-3	2.2	2.0-1	1.4	1.3-3	3.8-1	4.9	89.9	9.7-1
5	1.3-5	8.2-3	2.5	2.2-1	1.6	1.3-3	4.3-1	2.5-1	93.7	1.3
7	1.3-5	8.8-3	2.7	2.4-1	1.7	1.3-3	4.6-1	1.2-2	93.2	1.7

*^{241}Am
content is expressed at three years after irradiation at the time of measurement

***2.3-5 is defined to be 2.3×10^{-5}.

If all the assemblies being verified have cooling times longer than two years, then cooling time corrections can be neglected because most of the ^{242}Cm activity ($T_{1/2}$ = 163 days) would have decayed away, and the other neutron emitting isotopes have half-lives longer than 14 years. For cooling time less than six months (burnup less than 27,000 MWD/MTU), the dominant neutron emission source decays with the 163 day half life. Between these two limits, the neutron emission rate depends on the burnup and cooling time.

These calculations indicate that passive neutron emission from irradiated fuels depends on the accumulation of the ^{242}Cm and ^{244}Cm isotopes, which in turn depends on the burnup.

III. PROPERTIES OF PASSIVE NEUTRON ASSAY

For inspection purposes, the spent fuels normally will be assayed as whole assemblies submerged in water. To explore the properties of passive neutron assay such as response versus distance, assay penetrability, and the multiplication effect, we performed the following calculations.

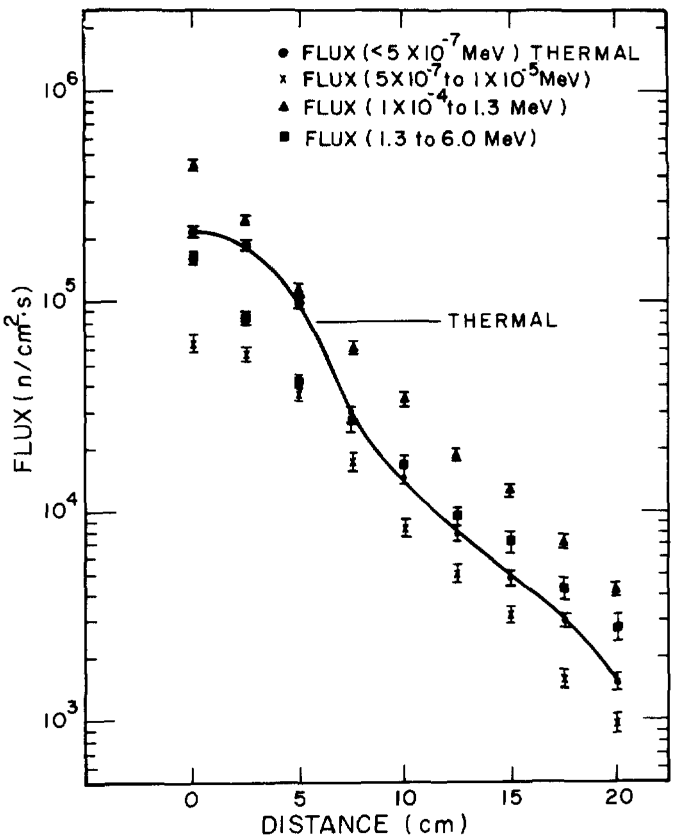
A Monte Carlo transport code, MCNP,[10] was used for the calculations. A Trino reactor spent fuel assembly was mocked up as shown in Fig. 4. For ease in computation, the assembly was assumed to be infinite in length, and the fuel pin cladding was mixed with the fuel. These assumptions were not expected to affect results significantly. The neutron sources for different burnups within the fuel rods were taken from the results of the previous calculations in Sec. II and based on postirradiation destructive examinations. The neutron sources in the assembly were generated assuming a cooling time of one year. A water temperature of 54°C was assumed.

A. Neutron Response Versus Distance

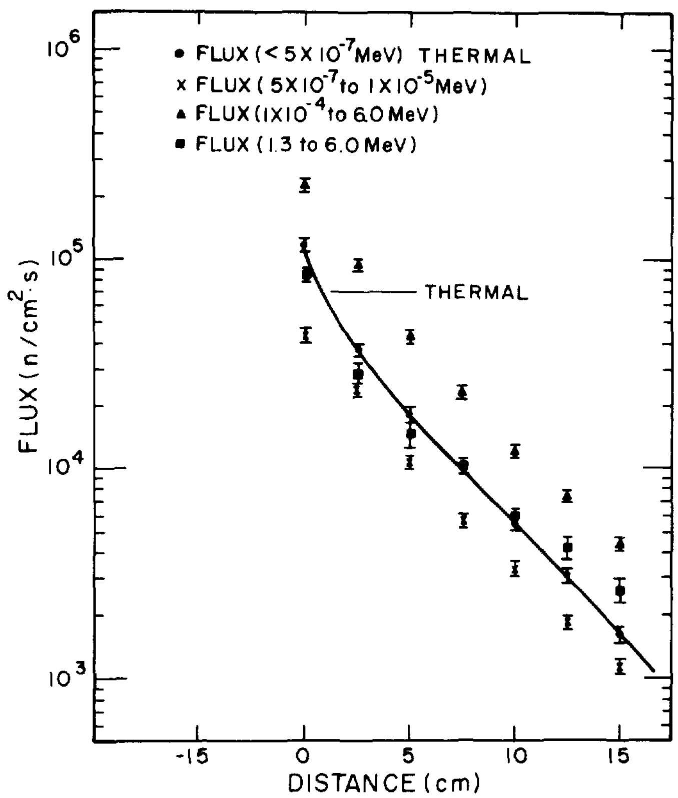
The purpose of this calculation is to optimize the location of the neutron detector and to determine the sensitivity of passive neutron assay to variation in detector-to-source distances.

Figures 5 and 6 represent spatial flux distributions (at the assembly midplane) in water outside one assembly. The burnup value chosen for the plot is 20,602 MWD/MTU. In Fig. 5, distance is measured along line AB (midplane normal as referred to in Fig. 4). In Fig. 6, distance is along line CD (midplane diagonal).

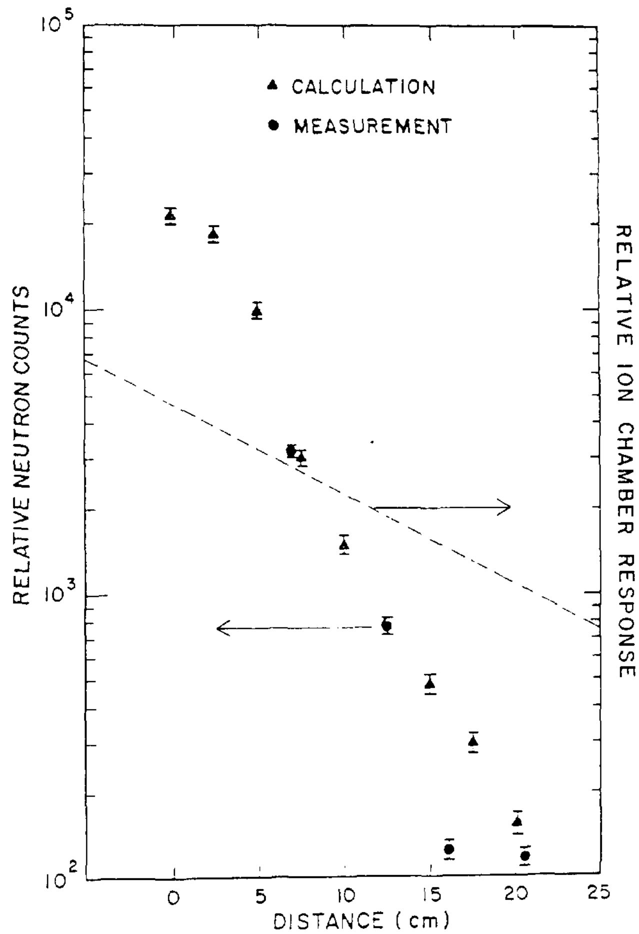
In general, the midplane normal flux is higher than the midplane diagonal flux at the same distance from the assembly surface. Notice that for the thermal neutrons (energy less than 5×10^{-7} MeV) the flux exhibits a smaller slope through the region 0-3 cm than in the region further from the assembly (see Fig. 5) due to the slowing down of fast neutrons. A thermal neutron detector so positioned with respect to the assembly can minimize the effect of distance variations as well as maximize the neutron response.



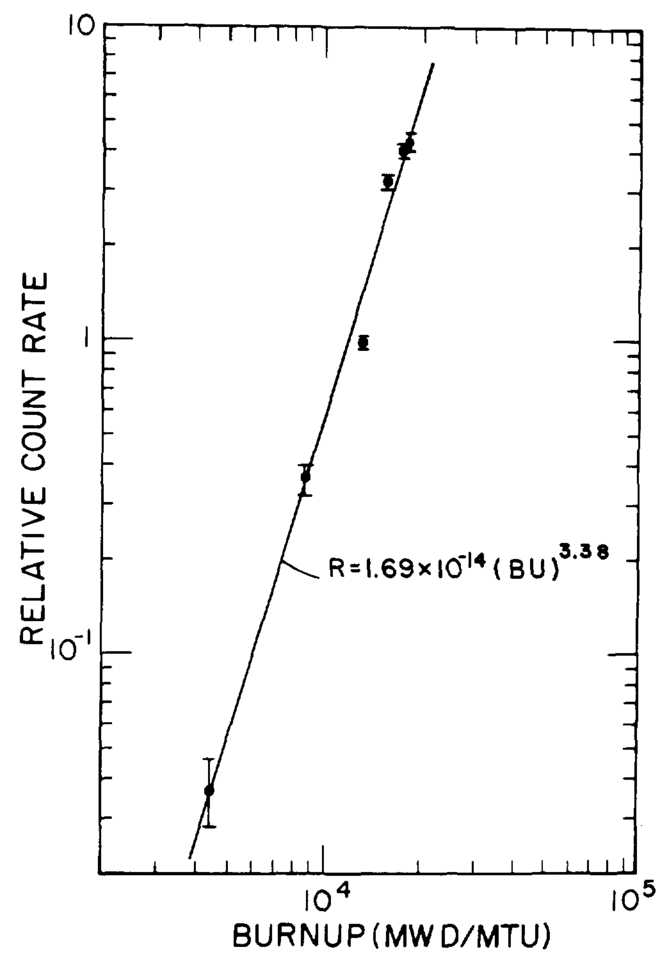
5. Flux along mid-plane normal from the assembly.



6. Flux along mid-plane diagonal from the assembly.



7. Comparison of the measured and calculated relative thermal neutron response as a function of increasing detector-to-assembly distance.



8. Relative fission chamber response versus burnup for six spent fuel assemblies from a BWR.

B. Assay Penetrability

The purpose of this calculation is to investigate the spatial distribution of the importance of fuel pins in contributing to the detector signal. Or, in other words, how well does a neutron from inside the assembly escape from the assembly? An intermediate burnup level (20,602 MWD/MTU) assembly was chosen.

In the first calculation, source neutrons were started uniformly in the volume of the first fuel pin row; in the second calculation rows 1 through 3 (see Fig. 4 for the definition of row); in the third calculation, rows 1 through 5; and in the fourth calculation, rows 1 through 7 (all fuel pins). Note that the first fuel pin row is actually the second row of pins, the first being a central water pin. These calculations allowed the determination of the relative flux contribution of various combinations of fuel pin rows. The results of the calculation are summarized in Table III. In this table the flux contribution per pin from all the fuel pins is normalized to one. If the flux contribution per pin is greater than one, that means these rows of fuel pins will make an above average contribution to the signals of passive neutron assay. The standard deviation (S.D.) in Table III is a measure of the uniformity of flux contribution from the various rows of fuel pins, the smaller the standard deviation, the more uniform the contributions.

The results indicate a relatively uniform flux contribution within the calculational precision of about 8%. Thus, passive neutron assay "sees" all the fuel pins about equally well. The reason that the neutron signals originating in the inner fuel pin rows can penetrate the assembly is because the source neutrons from the inner rows slow down in the water and induce fissioning in the outer fuel rows. The neutrons from the induced fissions can then penetrate the assembly. In this respect the passive neutron assay is significantly different from the gamma assay which detects signals from the outer layers of the assembly.

C. Multiplication Effect

Next, the neutron multiplication effect was examined. While the Cm isotopes (the origin of most of the passive neutrons) within the fuel rods may be prop-

TABLE III

RELATIVE FLUX CONTRIBUTION TO PASSIVE NEUTRON ASSAY FROM DIFFERENT FUEL PIN ROWS

THERMAL FLUX ALONG MID-PLANE NORMAL

Position*	5	7.5	10	12.5	15	17.5	20
Pin Row							
1	.95	1.20	.95	1.07	.86	.79	.83
2,3	1.00	.92	1.16	1.05	1.17	1.01	1.04
4,5	.72	1.08	.84	.87	.79	.75	1.01
6,7	1.23	.95	1.06	1.08	1.11	1.22	.99
S.D.	.21	.13	.14	.099	.19	.22	.094

FAST FLUX (1×10^{-4} to 1.3 MeV) ALONG MID-PLANE NORMAL

Position*	5	7.5	10	12.5	15	17.5	20
Pin Row							
1	1.05	1.20	.96	1.16	.88	.97	.87
2,3	1.14	.92	1.03	1.00	.86	.92	1.00
4,5	.86	.98	1.09	1.02	.99	1.18	.95
6,7	1.00	.94	.91	.97	1.09	.89	1.05
S.D.	.12	.13	.079	.084	.11	.13	.068

THERMAL FLUX ALONG MID-PLANE DIAGONAL

Position*	0	2.5	5	7.5	10	12.5	15
Pin Row							
1	.92	.86	.84	.85	.88	.94	.98
2,3	.85	.88	1.00	.95	.80	.80	.84
4,5	.69	1.03	.90	1.09	1.06	1.14	.97
6,7	1.33	1.04	1.09	.96	1.06	.99	1.09
S.D.	.29	.097	.11	.098	.13	.14	.10

FAST FLUX (1×10^{-4} to 1.3 MeV) ALONG MID-PLANE DIAGONAL

Position*	0	2.5	5	7.5	10	12.5	15
Pin Row							
1	.81	.84	.90	.96	.99	.91	.96
2,3	.80	.69	.88	.79	.89	.79	.75
4,5	.96	1.53	.95	.94	1.10	1.02	1.04
6,7	1.15	.72	1.10	1.14	.97	1.10	1.08
S.D.	.16	.39	.099	.14	.087	.14	.15

***Distance from the surface or corner of the assembly in cm.**

TABLE IV

MULTIPLICATION FACTOR FOR VARIOUS BURNUPS

Burnup (MWD/MTU)	Multiplication
12 859	1.57
15 170	1.54
19 208	1.52
20 602	1.54
23 557	1.49
25 258	1.50
26 884	1.51
S.D. (%)	1.8

ortional to burnup as indicated in the post-irradiation examination,[8] the passive neutron assay response may be different due to neutron multiplication dependence on burnup.

In this calculation, the neutron sources for different burnups within the fuel rods were taken from previous calculations. The results are shown in Table IV. From the table, the system multiplication factor is rather constant (standard deviation 1.8%) with burnups ranging from 13,000 to 27,000 MWD/MTU. This illustrates the multiplication factor is not significantly affected by isotopic differences over the range of burnup considered. The multiplication factor is mainly a function of the fuel density within the rods, and the spatial distribution of the fuel rods in the assembly. If the purpose of the assay is to determine the consistency between burnup and neutron emission rate, the multiplication effect can be ignored.

IV. MEASUREMENT OF PASSIVE NEUTRONS FROM IRRADIATED FUEL

We have performed two separate passive neutron measurements of irradiated fuels: a BWR facility and a PWR facility. The BWR has a power rating of 63 MWe and has been in operation since 1962. The PWR has a power rating of 1100 MWe and has been in operation since 1973.

A. Response versus Distance

At the BWR facility, we have measured the neutron response as the detector-to-assembly distance was increased. The detector, a fission chamber containing 58 mg ^{235}U deposit, was submerged in a tube at approximately the mid-plane of an assembly. The electronics used consisted of an amplifier, a discriminator with the discrimination level set above the alpha signals, and a scaler. The spent fuel assembly, BRP-6, has a declared burnup of 17,814 MWD/MTU and a cooling time of 842 days. The detector position was fixed with the spent fuel assembly being moved.

The results, together with the calculated values for thermal neutrons, are shown in Fig. 7. The calculated neutron count at a distance of 12 cm was normalized to the measured value. The calculated precisions ranged from 6 to 9%. It is observed that for thermal neutrons, the measured "diffusion length" of 4.3 cm agrees well with the calculation. In general, the passive thermal neutron counting rate decreases by an order of magnitude when the detector-assembly-distance is increased by 10 cm. In Fig. 7 the relative response (the dashed line) from an air ion chamber measured on the same assembly was also shown. In comparison, the ionization chamber signal reduces by a factor of ten when the distance is increased by 30 cm. These results illustrate that the passive neutron signal has a shorter range in water than the ionization chamber assay. The results also show that fission chambers are insensitive to gamma radiations.

B. Neutron Emission Rate Versus Burnup

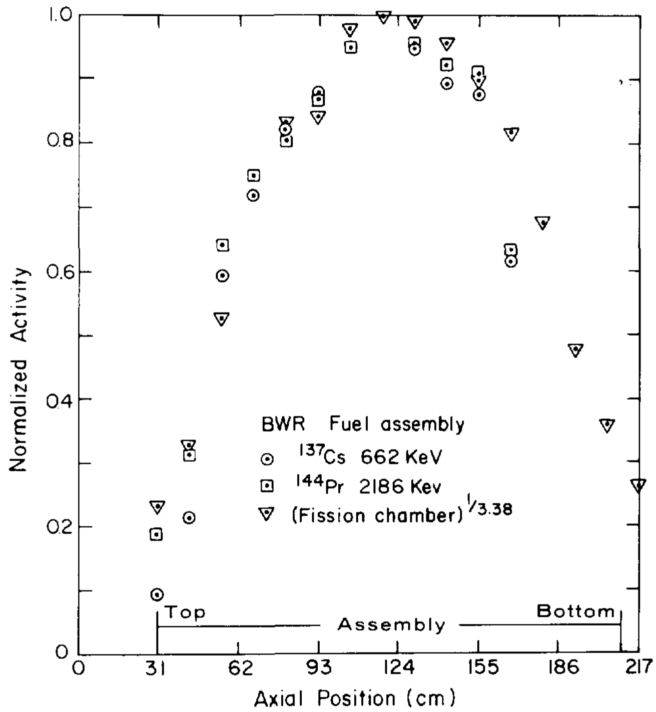
At the BWR facility, we have measured the neutron emission rate from six spent fuel assemblies with burnups ranging from 4356 to 18,804 MWD/MTU. The measurements were performed with a 58 mg ^{235}U fission chamber located in a tube place 27 cm from the midplane of the assembly. The neutron counting rates for various burnups are listed in Table V and also shown in Fig. 8. We found that the passive neutron counting rate is proportional to burnup raised to 3.38 power. No cooling time correction has been made because all but one of the assemblies had long and similar cooling times.

We have also performed axial scans of PWR spent fuels with fission chamber. Since we found that the neutron emission rate is proportional to $(\text{burnup})^{3.38}$, the $(\text{neutron emission rate})^{1/3.38}$ should then be proportional to burnup. The axial neutron scan can then be compared with the axial gamma scan using the Ge detector. Figure 9 shows such a comparison. We found that the neutron and gamma scan agrees well, support-

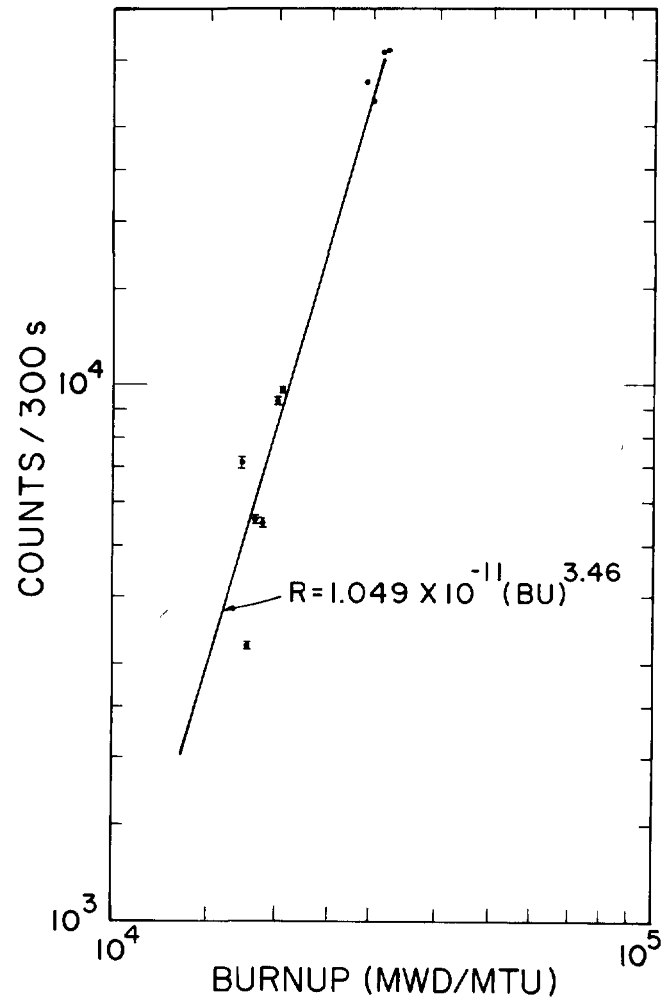
TABLE V

PASSIVE NEUTRON ASSAY OF BOILING WATER REACTOR SPENT ASSEMBLIES

Assembly	Burnup (MWD/MTU)	Cooling Time (Days)	Counting Rate (cps)
BWR 1	4356	842	.038 ± .010
BWR 2	8883	1452	.373 ± .031
BWR 3	13332	843	.981 ± .037
BWR 4	15264	843	3.296 ± .069
BWR 5	17122	844	4.064 ± .076
BWR 6	17814	842	4.125 ± .102



9. Axial profile of fission chamber response raised to 1/3.38 power compared with ^{137}Cs and ^{144}Pr activity profile.



10. Relative fission chamber response versus burnup for nine spent fuel assemblies from a PWR.

ing further that the neutron emission rate is proportional to burnup raised to 3.38 power.

Because the neutron count rate at the BWR exercise was relatively low (maximum counting rate 4 cps), for the PWR exercise we used a fission chamber with higher ^{235}U loading (135 mg) and the chamber was placed closer to the assemblies than the previous exercise (12 cm from mid-plane). The neutron counts for a 300 s assay on 9 assemblies is shown in Table VI and Fig. 10. The error bars of the PWR measurement are smaller than the data points. We found that the fission chamber counting rates are all proportional to burnup raised to the 3.46 power. A cooling time correction has not been made. To make the cooling correction, it is necessary to know the curium isotopic ratio for burnups ranging from 17,000 to 32,000 MWD/MTU. Although we have some indications of this isotopic ratio up to a burnup of 27,000 MWD/MTU for Trino reactor fuel, we do not know the curium buildup beyond this burnup.

IV. CONCLUSIONS

The agreement of the counting rate dependency on burnup between the two excersises is rather surprising since a boiling water reactor and a pressurized water reactor may have rather different actinide buildup. This agreement may be incidental; however, the results indicate that the passive neutron assay is a useful technique to determine consistency of burnups between assemblies.

TABLE VI

PWR SPENT ASSEMBLIES MEASURED BY PASSIVE NEUTRON ASSAY

Assembly	Burnup (MWD/MTU)	Cooling Time (Days)	Counts/300 s
PWR 1	17404	528	7195
PWR 2	17776	832	3246
PWR 3	18279	528	5569
PWR 4	18723	837	5501
PWR 5	20066	527	9361
PWR 6	20252	527	9754
PWR 7	29129	140	36255
PWR 8	31851	279	41292
PWR 9	32185	279	41436

Several salient features of passive neutron assay emerge from our study.

1. Passive neutron assay uses simple room temperature detector (fission chamber) requiring no liquid nitrogen as in Ge detectors. The simplicity of the assay electronics (amplifier, discriminator, and scaler) enhances the reliability of apparatus. The measurement and data processing are straightforward.

2. Passive neutrons are more penetrating than gamma rays. The inner rods of an assembly can be detected in neutron assay.

3. A possible diversion scenario is the substitution of the spent fuel assembly with, for example, ^{60}Co rods, which can be easily produced in a reactor. Such a diversion can be easily detected by passive neutron assay since the activated rod has no neutron signal.

4. The neutron counting rate is reasonable and can be easily increased by reducing the assembly-detector distance.

While our study indicates that passive neutron assay is a useful assay technique and can well compliment the gamma assay of spent fuels, further investigations will clarify the nature of passive neutron assay: (1) the effect of cooling time on the neutron signals, and (2) investigate detectors other than fission chamber that can be used in passive neutron assay. Fission chambers contain fissile material. This may cause difficulty in shipping because of legal problems.

ACKNOWLEDGMENTS

We would like to express our thanks to **R. Voll, H. Brazydlo, L. Monshor** of Consumers Power Co., and **D. O'Boyle, G. Perdikis, D. Walden,** and **M. Peterson** of Commonwealth Edison for their help in the experimental portion of this study. The design and installation of apparatus by **S. Beach** of LASL Group Q-1 is also appreciated.

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F. Charles Gilbert Named Director of DOE's Office of Nuclear Materials Production

Dr. F. Charles Gilbert has been named director of the newly established Office of Nuclear Materials Production (ONMP) under DOE's Assistant Secretary for Defense Programs.

The ONMP has the responsibility for the production of certain special nuclear materials for national defense requirements, as well as for DOE research and development programs, other government agencies and industry. The production of these materials is accomplished in production reactors and related facilities at the DOE plants at Savannah River, South Carolina, and Richland, Washington.

ONMP also operates reactor fuel fabrication facilities at Savannah River and Richland, as well as Oak Ridge, Tennessee; Ashtabula, Ohio; and Fernald, Ohio. Spent fuel and target-processing plants are operated at Savannah River and another processing plant is held in standby at Richland. N-Reactor at Richland also produces steam as a by-product to the Washington Public Power Supply sufficient to produce 4.5 billion kilowatt hours of electricity per year.

This program formerly was part of the Office of Nuclear Energy Programs under DOE's Assistant Secretary for Energy Technology.

A MODEL FOR ABSORPTION-MODIFIED MULTIPLICATION EFFECTS IN THE ASSAY OF HEU PLATES IN A RANDOM DRIVER

by

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ABSTRACT

A model has been developed which describes the enhancement of the response over the sum of the responses of individual highly enriched uranium plates that is obtained when such plates are stacked in a random driver. The model can be used also to show the effect of substitution at different positions in the stack.

Introduction

As part of a safeguards study at Argonne National Laboratory (ANL), a National Nuclear random driver was used in the active mode to assay unirradiated highly enriched (93 percent) uranium (HEU) plates used at the ANL zero power reactor facility. Experiments were done with plates of various dimensions, but the most extensive investigation was made of 2" x 2" x 1/16" plates. These were stored in stacks with no spacing between the plates; a full stack of plates of the latter dimensions contains 75 plates.

During the assay of these plate stacks, we found results typically attributed to source neutron multiplication in the sample. For example, the count for a full stack was much greater than the sum computed from the measurements of a single plate at the 75 appropriate heights above the rotating table in the driver.

Substitution experiments were also performed with 75-plate stacks in which a dummy plate, or an adjacent pair of dummies, was substituted for an HEU plate or, respectively, an adjacent pair of HEU plates, at three positions in the stack. The dummy plates were of plexiglass, aluminum, or depleted uranium (DU). Regardless of the material, the pattern of the results was, within statistical variation, the same. There was a definite position effect. Of the test positions used, the loss of count was greatest for substitution near the middle of the stack, less for substitution a quarter of the way down from the top of the stack, and least for substitution a quarter of the way up from the bottom of the stack. All these count losses were greater than for removal of the same number of HEU plates from the top of the stack. This means that assays, the number of HEU plates determined by using the gross counts for a substituted stack in an equation for gross counts as a function of successively greater numbers of only HEU plates, will tend to be lower than the true number of HEU plates in the stack. The amount by which the assay is low will, of course, reflect the varying degree of count loss according to the location of the dummies in the substituted stack. This pattern in illustrated by typical results for two plate substitutions shown in Table I.

Table I. Assay for two-plate substitutions at three stack positions.

Material	Position (a)	Assay	LE (b)
Al	B	72.66	0.67
	C	71.52	0.65
	T	71.81	0.65
DU	B	72.69	0.58
	C	71.39	0.55
	T	72.07	0.56
Plex	B	72.98	0.92 *
	C	72.09	0.54
	T	72.80	0.55

(a) B near 1/4 stack height
C near 1/2 stack height
T near 3/4 stack height

(b) One-sided 95 percent confidence level.

* Sample count variance exceeded Poisson variance at the 95 percent confidence level.

In spite of statistical variation, the position effect was so definitely delineated that we believed it would be a good test of a model which purported to explain the multiplication effect. We succeeded in developing a rather simple model which involves the gross features, at least, of the mechanisms we imagined to be acting, and which reproduced the curve of count vs number of plates as well as the position effect. The processes described in the model are specific to the stack of plates. While the values of the two parameters which appear in the model will be affected by the instrument used, the model itself should be applicable to the type of measurements described here, when made in any random driver.

We emphasize at the outset that the units which appear in the model, as it is described here, whether HEU or dummy, consist of five plates rather than a single plate. This was done because the model requires the solution of a number of simultaneous equations equal to the number of units in the stack and 75 simultaneous equations was excessive. In this way, with only 15 units, we only have to solve 15 equations, but can still reach our goal of understanding our results. We are convinced that, were the unit in the model a single plate, the same qualitative results would be obtained, and we would be able to reproduce the quantitative results of single plate substitution as well.

The Model

With the rotating table in the driver at a particular height and with units of equal thickness, we let the height variable be the position of a unit, designated i, and count up from i = 1 for the unit resting directly on the table. We let N_i be the net response from a single unit, due to the sources in the driver, when the unit is at position i. The differential response curve, N_i vs i, was determined by moving a unit of five HEU plates up through a stack of 70 DU plates, one unit at a time. It was done in this way in order to have the same effects of absorption, scattering, and moderation on N_i to be found in a full stack of HEU plates.

To construct the model, it is assumed that the total net response from the unit at position i is N_i plus that due to interrogating sources provided by the other units in the stack. It is assumed that, were there no absorption by intervening units, the additional response from the unit at position i due to the source presented by the unit at position j could be represented by a fraction, f, of the total response from the unit at position j. Thus, if C is the total net response, the additional response from the unit at position i due to the presence of adjacent units is

$$f(C_{i+1} + C_{i-1}).$$

If the "transmission" of a unit is g, whose value will be determined both by transmission and moderation of neutrons passing through it, the additional response from the unit at position i due to interrogating sources presented by units at positions (i + 2) and (i - 2) will be

$$f(gC_{i+2} + gC_{i-2})$$

or, by extension,

$$C_i = N_i + f(\ldots + g^2C_{i+3} + gC_{i+2} + C_{i+1} + C_{i-1} + gC_{i-2} + g^2C_{i-3} + \ldots). \qquad (1)$$

If there are n units in the stack, n equations of this form must be solved for the n values of C, which are then summed to give the total net response from the stack. For instance, at n = 4,

$$C_1 = N_1 + f(C_2 + gC_3 + g^2C_4)$$
$$C_2 = N_2 + f(C_1 + C_3 + gC_4)$$
$$C_3 = N_3 + f(gC_1 + C_2 + C_4)$$
$$C_4 = N_4 + f(g^2C_1 + gC_2 + C_3)$$

The equations have been solved by keeping them in this form and using a method of successive approximations.

Application

It is clear that the applicability of the model does not depend on any particular differential response curve, N_i vs i. It could be flat, i.e., N_i independent of i; or a set of tabulated values could be used. It is the case that, with our fixed interrogating sources in their usual locations, our differential response curve is parabolic. The one found for this work was

$$N_i = 279.89 + 23.941i - 1.10156i^2$$

for 100-sec counts. The initial constant has been adjusted slightly so that N_1 is the same as observed for the first unit at the time the full stack of HEU units was being built up and counted. The backgrounds were a little different on the two occasions, and not every unit of five plates will be absolutely identical. Values of N_i are plotted as the lower curve of Fig. 1. Were the table height greater, for instance, the peak would have come nearer to the center of the stack of 15 units.

If this particular differential response curve is summed over i, from i = 1 to n, the result is cubic in n. We found that the observed response was also well fit by a cubic in n. A cubic was fit, by least squares, to the observations of gross count vs the number of five-plate HEU units in the stack, and the results from that curve at n = 10 and at n = 15, less the background, were used to evaluate f and g; these were found to be 0.09356 and 0.69822, respectively. Then all other required values of C_i were calculated, summed, and the background added to construct the curve of gross count vs n shown in Fig. 2, where the actual observations are also plotted for comparison. While these values of f and g are not expected to be the best, in a least squares sense, the sum of squared residuals, 22668, was not excessively greater than that sum, 18793, for the least squares cubic fit. The model has one less parameter than the cubic. Nevertheless, it seems likely that, were the work of finding least squares values for f and g undertaken, the model would turn out to give as good a fit, and possibly better, than the cubic.

If a DU dummy unit is in place at position i, N_i and C_i will be zero, but the powers of g will not be altered. For other dummies, appropriately different values of g would be needed for quantitative calculations, but the qualitative effects would not be expected to be altered. That is, it is expected that the results shown in Table I, where the assays for aluminum and DU substitution are nearly the same and those for plexiglass substitution are higher, could be reproduced.

The calculated values of C_i, connected by smooth curves, are shown for three cases in the upper part of Fig. 1. Curve (a) is for a full stack of 15 five-plate HEU units. For curve (b) the top HEU unit has been removed. Curve (c) is for 15 five-plate units, 14 HEU units and a five-plate DU unit at position 8. The greatest loss of total integrated response for a single substitution will occur when the substitution is at the position with the greatest C_i in a full stack. For our set-up, this is near the center of the stack. It would be exactly at the center were the table height in the driver such that the maximum value of N_i was at the center of the stack, or were the differential response curve flat.

For comparison with the pattern shown in Table I, calculations were made of the responses to be expected from stacks of 14 HEU units and a DU unit at positions 4, or 8, or 12. The corresponding assays based on the curve of Fig. 2 would be 13.58, 13.21, and 13.43, respectively. These parallel the results shown in Table I.

Conclusions and Discussion

We conclude that the model gives an accurate description of the impact on the total integrated response of neutron and, presumably for this driver, gamma-ray multiplication and absorption within a stack of these well-defined plates. It supports the reality of the position effect and provides a means of assessing that effect on the detection of loss by substitution. With a symmetric or, as here, nearly symmetric differential response curve, that bias will be greatest at positions near the center of the stack, will become less than the statistical error as one approaches either end of the stack, but will always be present.

The question arises as to other applications. Here it should be emphasized that the model, as described here, is simple, containing only the gross features of the processes we supposed might be responsible for the effects it was required to explain. We have not worked out methods for evaluating f and g from first principles, nor have we thoroughly studied the determination of differential response curves. In one trial we found that the curve obtained by putting a single five-plate unit on the table and finding the response at varying table heights lay above the curve used here. Presumably even the differential response curve is affected by absorption in neighboring units, which might make some extensions of the model difficult to carry out with numerical accuracy. Nevertheless, the model seems to be sufficiently accurate in concept to be extendable to other cases of similar geometry. Such a possibility would be powders loaded into cylindrical containers to various fill heights. If they are considered to consist of finite layers for which the required parameters can be determined, the same calculational methods as used here could be applied. One more naturally thinks of powders, of course, as continuous. Then the basic model could still be applied, but more involved methods of solution would be required, since Eq. (1) would become an integral equation.

We have made a crude simulation of the results to be expected if varying amounts of active powder are mixed with a diluent having a lower value of g and loaded into containers to a constant fill height. We did this by appropriately adjusting g upward as the differential response curve was lowered, and by using a fixed 15-unit stack. The resultant curve of net counts vs "mass" had the expected shape, with the concavity toward the mass axis.[1]

Acknowledgement

It is a pleasure to acknowledge helpful comments by S. B. Brumbach.

Reference

[1] See, for instance, J. E. Foley and L. R. Cowder, *Assay of the Uranium Content of Rover Scrap with the Random Source Interrogation System*, Los Alamos Scientific Laboratory Report LA-5692-MS (August 1974), Fig. 5.

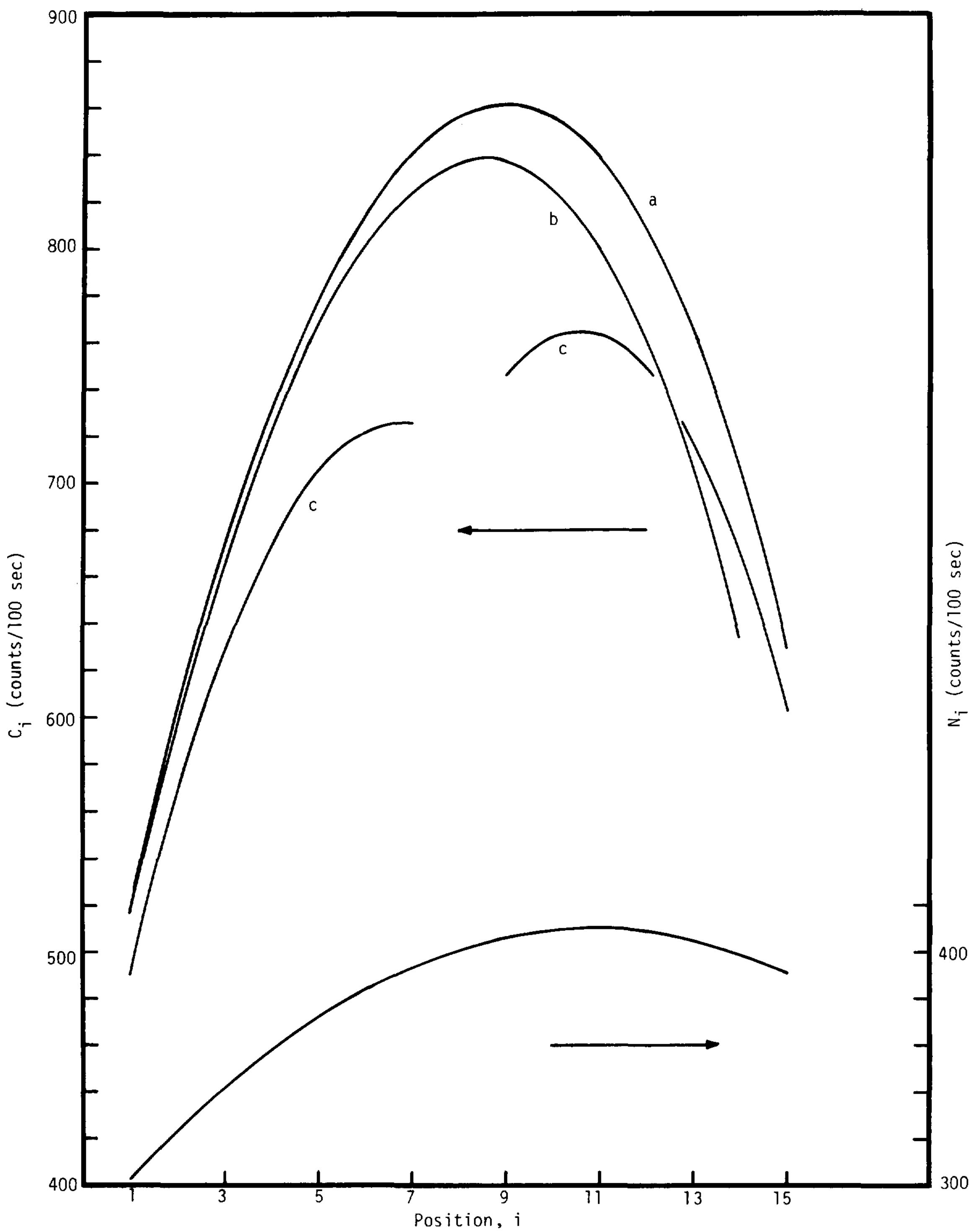

Fig. 1. Net counts as functions of position, i. The bottom curve, with its ordinate to the right, shows the response of a single five-plate unit to the sources installed in the driver. The top curves show examples of total response; the ordinate is to the left. Curve (a) is for a stack of 15 five-plate HEU units. Curve (b) is for a stack of 14 five-plate HEU units. Curve (c) is for 15 five-plate units of which the one at position 8 is a DU unit.

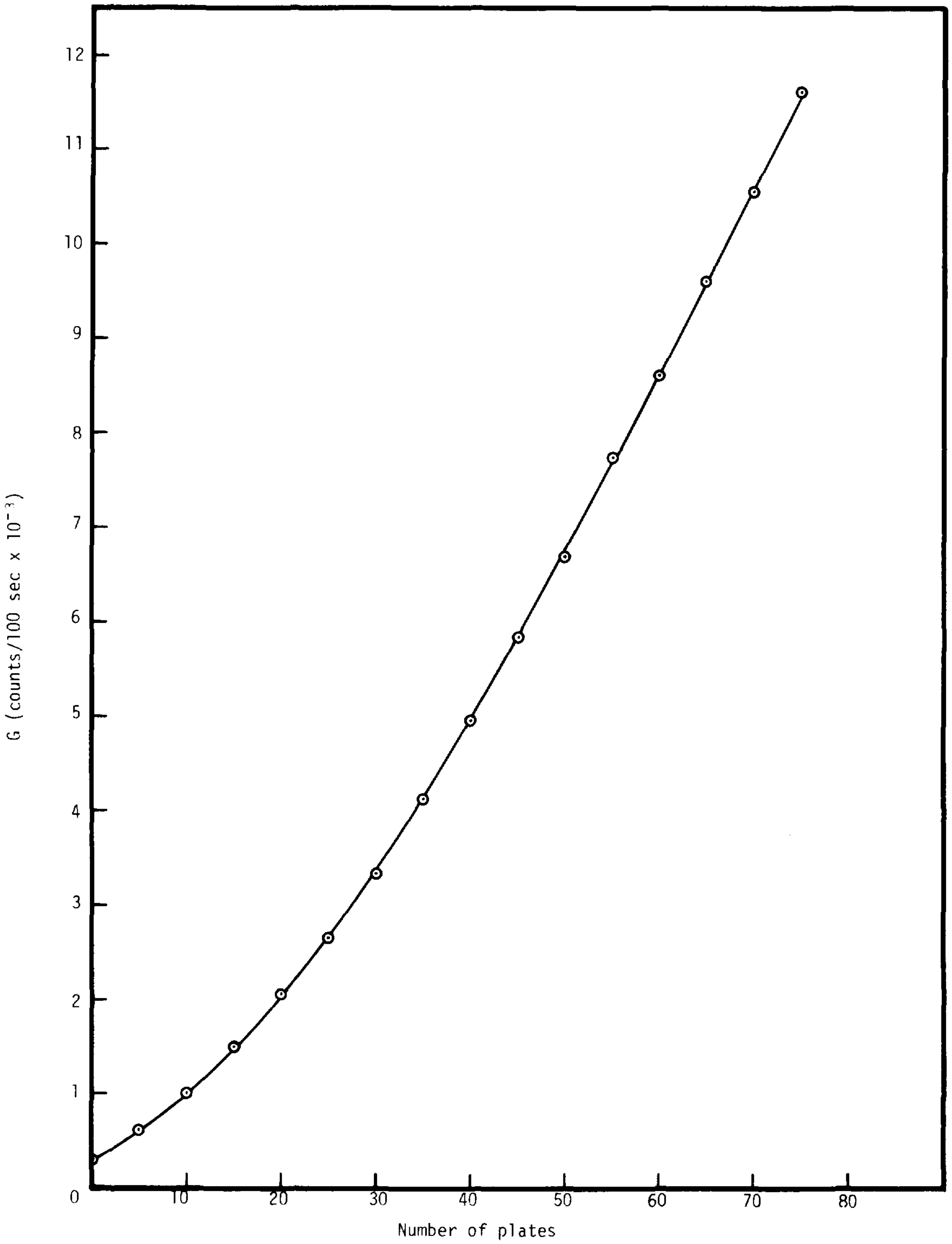

Fig. 2. Gross counts as a function of the number of HEU plates in the stack. The stack is built up by adding five plates at a time. The circled points are the observations, and the line is calculated from the model.

SPENT FUEL MEASUREMENTS USING HIGH RESOLUTION GAMMA SYSTEMS

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ABSTRACT

Equipment and procedures currently used by the IAEA to take and analyse the results of spent fuel measurements based on high resolution gamma spectrometry are described. Comments on the problems faced by the inspector are given together with mention of desirable improvements, typical results and comparisons of sets of data.

INTRODUCTION

Measurements of spent fuel are performed to determine some of the characteristics of the irradiated materials. Cooling time and burn-up or burn-up related quantities are the most relevant pieces of information that can be extracted from high resolution gamma spectra. The spectra, however, are obtained at some time after the material has been removed from the reactor and refer to localized spots in the item. They are affected by the measurement conditions as well as by the characteristics of the fuel.

The spectrum gives measured intensities, at various energies, whose values must be related to the ones present in the fuel which, in turn, depend on the reactor operating conditions. Both cooling time and burn-up related quantities can be obtained from the ratio of measured intensity at a reference time - the removal of the fuel from the reactor - once corrections for all the above mentioned effects have been performed.

In the case of burn-up related quantities, the measured result needs to be further corrected to give the value that would exist if no loss of the nuclear species considered had occurred during the residence of the fuel in the reactor.

All the desired information must be derived from a single spectrum which means that cooling time has to be determined first and only after that can the burn-up be assessed.

BASIS

Measurements have been made of spent fuel gamma spectra for some time and no attempt is made here to summarize or review the work on the subject (1), (2), (3). This paper describes a simple model that has been used by the IAEA in cases where the plutonium production can be neglected.

Cooling time determination - The determination depends on application of the law of radioactive decay to two nuclear species having sufficiently different half-lives. Representing by N_1, N_2 and N_1^o, N_2^o the number of atoms of species 1 and 2 respectively at the times of measurement and removal from the reactor, the cooling time T is given by:

$$T = \frac{1}{\lambda_1 - \lambda_2} \ln \left(\frac{N_1^o}{N_2^o} \quad \frac{N_1}{N_2} \right) \qquad (1)$$

or taking into account the value of the ratio N_1/N_2 (See Appendix I)

$$T = \frac{1}{\lambda_1 - \lambda_2} \ln \left(\frac{X_2(E_2)}{X_1(E_1)} \frac{\lambda_1}{\lambda_2} \frac{K_1(E_1)}{K_2(E_2)} \frac{F(E_1)}{F(E_2)} \frac{N_1^o}{N_2^o} \right) \qquad (2)$$

Where X is the intensity of the line at energy E from isotope N, λ is the decay constant, K is the branding ratio and F(E) the detection efficiency at energy E. The ratio N_1^o/N_2^o is a correction term determinable from the reactor operating history.

The isotopes currently used can be considered either as being both produced directly from fission or one of them being a decay product of an isotope which is a direct fission product. Typical of the first situation is the pair Zr-95 - Cs-137 and of the second, the pairs La-140 - Cs-137 and Pr-144 - Cs-137. In the second case, if the decay constant of the direct fission product is considerably smaller than the one of its descendant as for La-140 and Pr-144, then the equations shown can be used provided the decay constants and atom ratios at t = 0 refer to the direct fission products and the remaining parameters refer to the isotopes whose gammas are actually measured.

The time behaviour of the average neutron flux in the reactor can be described as a series of n cycles of constant flux ϕ_i and length t_i, and in this case N_1^o and N_2^o are respectively given by:

$$N_1^o = \frac{\Sigma_f \gamma_1}{\lambda_1} \sum_{i=1}^{n} \phi_i \left(1 - e^{-\lambda_1 t_i}\right) e^{-\lambda_1 \theta_i} \quad (3)$$

and

$$N_2^o = \frac{\Sigma_f \gamma_2}{\lambda_2} \sum_{i=1}^{n} \phi_i \left(1 - e^{-\lambda_2 t_i}\right) e^{-\lambda_2 \theta_i} \quad (4)$$

where γ_1 and γ_2 are fission yields and θ_i is the time difference between the ends of cycles n and i.

The operating history gives the reactor power output on a time basis while equations 3 and 4 require the neutron fluxes in the fuel during its residence in the reactor. The local neutron flux ϕ_i is related to the reactor operating power P_i during the cycle i by:

$$\phi_i = \psi R f_i^j P_i \quad (5)$$

where R represents the local to average axial flux ratio, f_i^j the power factor for the position j occupied by the fuel during the cycle i and ψ is the product of the average neutron flux in the fuel at 1 MW (assuming that P_i is also expressed in MW) and the number of fuel units loaded into the reactor.

The use of genetically related isotopes, such as Zr-95 - Nb-95 has been mentioned for cooling time determinations, but it has been our experience that this pair is of little value for that purpose because it quickly establishes itself in a transient equilibrium.

Burn-up determination - High resolution gamma measurements yield activities and activity ratios. Activities, best exemplified by Cs-137, can be used for consistency checks among fuel units of the same type if the measurements are done under fixed conditions, or for absolute determinations if the efficiency of the system is known or standards are available. The activity ratio is explified by Cs-134/Cs-137 and it is not subject to the same limitations as for absolute activities.

Activity Ratios - The atom ratio R_m^o of two isotopes 1 and 2 at the time of removal from the reactor can be calculated from the measured values by:

$$R_m^o = \frac{X_1(E_1)}{X_2(E_2)} \frac{\lambda_2}{\lambda_1} \frac{K_2(E_2)}{K_1(E_1)} \frac{F(E_2)}{F(E_1)} e^{(\lambda_1 - \lambda_2)T} \quad (6)$$

where the last term represents the cooling time correction factor. This expression needs to be corrected for the loss of the isotopes involved during the residence of the fuel in the reactor. The corrected atom ratio $(R_m^o)_c$ is given by:

$$(R_m^o)_c = \frac{R_m^o N_{1_p}^o}{N_1^o} \frac{N_2^o}{N_{2_p}^o} \quad (7)$$

where $N_{1_p}^o$ and $N_{2_p}^o$, represent the number of atoms respectively of the isotopes 1 (Cs-134) and 2 (Cs-137) that were produced and N_1^o and N_2^o have to be derived from the reactor operating history. The expressions for the Ns follow:

$$N_1^o = \frac{\Sigma_f \lambda_1}{1} \sum_{i=1}^{n} \phi_i \left(1 - e^{-\lambda_1 t_i}\right) + \sum_{i=1}^{n} \frac{\phi_i \lambda_1}{\sigma\phi_i - \lambda_1} e^{-\sigma \sum_{i=1}^{i-1} \phi_i t_i} \left(e^{-\sigma\phi_i t_i} - e^{-\lambda_1 t_i}\right) e^{-\lambda_1 \theta_i} \quad (8)$$

$$N_{1_p}^o = \Sigma_f \gamma_1 \left[\sum_{i=1}^{n} \phi_i t_i - \frac{1}{\sigma} \left(1 - \prod_{i=1}^{n} e^{-\sigma\phi_i t_i}\right) \right] \quad (9)$$

$$N_2^o = \frac{\Sigma_f \gamma_2}{\lambda_2} \sum_{i=1}^{n} \phi_i \left(1 - e^{-\lambda_2 t_i}\right) e^{-\lambda_2 \theta_i} \quad (10)$$

$$N_{2_p}^o = \Sigma_f \gamma_2 \sum_{i=1}^{n} \phi_i t_i \quad (11)$$

In the above expressions Σ_f and σ are respectively the macroscopic fission cross-section of the fuel and the activation cross-section of Cs-133 and have to be average to take into consideration changes with burn-up and the neutron spectrum. The first can sometimes be obtained from the literature and the second can be calculated using, for example, Westcott's method (4) if the characteristics of the neutron spectrum are known. The number of atoms indicated by expressions 8 through 11 was originated in a number of fissions N given by:

$$N = \Sigma_f \sum_{i=1}^{n} \phi_i t_i \qquad (12)$$

A theoretical ratio, $R_{th} = N^o_{1p}/N^o_{2p}$, based on the reactor operating history can be derived from the above expressions and compared with $(R^o_m)_c$.

It can be shown that the number of fissions, N, is related to $(R^o_m)_c$ by:

$$N = \frac{\gamma 1}{\gamma 2} \frac{\frac{\Sigma_f}{\sigma}\left(1 - \prod_{i=1}^{n} e^{-\sigma \phi_i t_i}\right)}{\frac{\gamma_1}{\gamma_2} - (R^o_m)_c} \qquad (13)$$

If one represents by Q the number of fissions per unit value that corresponds to a burn-up of 1 $MWdT^{-1}$, then the burn-up, B, of the measured fuel is B=N/RQ, where R is the local to average axial flux ratio.

Single Isotope Measurements - The single isotope measurement can be best used to perform consistency checks among identical units. In the case of a direct fission product with low capture cross-section, such as Cs-137, the measured intensity at the time of removal from the reactor, X^o_c, is proportional to the burn-up and is given by:

$$X^o_c = X e^{\lambda T} \frac{\lambda \sum_{i=1}^{n} \phi_i t_i}{\sum_{i=1}^{n} \phi_i (1 - e^{-\lambda t_i}) e^{-\lambda e_i}} \qquad (14)$$

EQUIPMENT AND PROCEDURES

Two types of measurements are required for each fuel unit, one resulting in a high resolution gamma spectrum and the other yielding the local to average flux ratio, R. The high resolution gamma spectrometry system consists of a multi-channel analyser (currently SILENA SYSTEM B 27 having 1000 channels) and an intrinsic germanium detector (currently PRINCETON GAMMA TEC with volumes up to 80 cc) mounted in a lead shield and "looking" through a collimator at a section of the fuel unit being measured. In practice a large span of cooling times and burn-up might need to be covered, so a space is provided between the end of the collimator and the detector shield for the insertion of absorbers to adjust the beam intensity. This arrangement is necessary to avoid saturation of the detection system without changing the measurement geometrical conditions.

The axial fission product activity distribution has been obtained with a small CdTe detector (currently TYCO with a volume of about 0.1 cc) which is movable together with its preamplifier inside a pipe running parallel to the longitudinal axis of the fuel.

COLLECTING AND PROCESSING THE DATA

At present no analysis of the data is performed during the measurement taking. The gamma spectra are stored on magnetic tape and the axial profile data from the CdTe detector are collected with a multi-channel analyser which produces a printed version of the results. Deriving the relevant information from the NDA data is a relatively complex operation even if, as in the present case, most of the processing is done automatically. The steps that are required involve: collecting the NDA data, obtaining the reactor characteristic values and operating history, and processing the results. The information about the reactor involves: a) reactor operating power on a time basis; b) for each measured fuel unit: the positions in the reactor in which it was used and the respective power factors, the date and time in and out of each position (this includes the declared cooling time), and the declared burn-up; c) the reactor characteristic values i.e.: the average fission and Cs-134 production cross sections and the average neutron flux in the fuel at some reference power. A core map would help, in many instances, to interpret the results.

Processing the results, which is done on a unit by unit basis, includes: a) obtaining manually the fission product activity profile and the local to average flux ratio; b) preparing a reactor operating history file; c) feeding the computer with all the previous information as well as with the measurement results (contained on the magnetic tape), the irradiation conditions of the specific fuel unit, and finally, the type, number and thickness of the external absorbers used. The programmes then sequentially: determine the areas of the peaks of interest, correct the areas for attenuation in the external absorbers, determine the function F(E), determine cooling times, determine the corrected Cs-137 activity and the Cs-134/Cs-137 atom ratio both theoretical and measured, and determine burn-up values.

RESULTS

The most important results that can be derived from the measurements are the cooling time and burn-up related parameters such as the Cs-ratio and the Cs-137 activity. The isotopes and gamma lines selected for this work are the ones commonly employed. For cooling time, the ratio of the intensities of Zr-95 at 722.20 and 756.72 keV to Cs-137 at 622keV are used, and when present the ratios of La-140 at 815.80 and Pr-144 at 696.48 to Cs-137 are also considered. The ratio of the Cs-134 intensities at 604.7 and the sum at 795.78 and 801.87 to Cs-137 are used to determine the Cs-ratio.

The function F(E) has been determined using Cs-134 or the Rh-106 gamma lines at 512, 622 and 1050 keV. In general, a linear function has been assumed with the normalization done to 622 keV. At present the function F(E) is determined for each spectrum. However, for most of the earlier data that function was derived from the weighted average activity ratios of the spectra collected with the better statistics and applied to all the spectra of identical fuel units. With these data a function of the type F(E) = a exp(bE) has also been determined and the results compared with the linear hypothesis. It was found that the difference between the ratio $F(E_1)/F(E_2)$ calculated using the linear and exponential approximations was less than 1% for all E_1, E_2 pairs of interest.

Data gathered by the IAEA during inspections at nuclear facilities are "safeguards confidential" and for this reason the full results of the measurements performed cannot be presented here. However, during the course of the Agency's activities some fuel units have been assayed more than once, for example as a consequence of repeated visits. Comparing measurements of the same fuel units, done sequentially or not, is illustrative of the kind of results that can be obtained. However, the repeated measurements are not, in general, pure repetitions because in most of the cases something has been changed; it can be the counting time, some measurement conditions, or even all the equipment used. It is, on the other hand, precisely this variation that better illustrates the actual implementation of the technique.

TABLE 1

PERCENT DIFFERENCES BETWEEN SUCCESSIVE MEASUREMENTS

Run No.	Counting time Ratio (t_R/t)	Cs-Ratio	Cs-137	Cooling Time	Comments
1	1.20	-3.05	1.47	-1.80	$t_R = 0.6\ t_N$ **
2	3.33	7.99	-7.98 *	2.86	$t_R = t_N$
3	7.20	2.73	0.17	-0.28	$t_R = 3.6t_N$
4	1.22	5.07	-0.35	1.36	$t_R = 1.1t_N$
5	10.00	-0.86	0.05	-0.55	$t_R = 5t_N$
6	17.27	3.17	1.46	0.38	$t_R = 5.7t_N$
7	1.60	4.73	-10.61 *	1.25	$t_R = 0.8t_N$
8	2.33	1.87	4.64	0.88	$t_R = 0.7t_N$
9	1.00	-1.86	-15.08 *	0.73	$t_R = 0.9t_N$
10	4.17	-5.00	-0.76	1.78	$t_R = t_N$
11	17.31	3.45	20.76 *	1.11	$t_R = 4.5t_N$
	$\bar{x}$	1.66	0.95	0.47	
	S_x	3.91	1.83	1.36	
	$S_{\bar{x}}$	1.18	0.69	0.41	

* Not included in the average

** t_N = 1000 s

t_R/t is the ratio of the longer (reference) counting time to the shorter time.

Table 1 gives the percent differnces in Cs-ratio, Cs-137 activity and cooling time for two successive runs of the same fuel unit taking as a reference the result obtained with the better statistics, i.e., the longer counting time. The normal counting time is 1000 sec. The table embodies two groups of runs, namely 1 through 7 and 8 through 11 done on two different occasions and shows that both sets of data yield virtually the same results. The overall percent differences between runs are 1.66 ± 1.18; 0.95 ± 0.69 and 0.47 ± 0.41 respectively for Cs-ratio, Cs-137 activity and cooling time. Some large differences occur for Cs-137 activity, but these are caused by adjustments of the equipment or of the fuel between the runs and therefore even if they give no direct indication about the reproducability of the measurements as such they emphasize the need for the constancy of the experimental conditions to obtain Cs-137 activity values usable in consistency checks. In these measurements the collimator used barely exceeded the diameter of the fuel units.

TABLE 2

MEAN PERCENT DIFFERENCES FOR THREE SERIES OF MEASUREMENTS

		Local to Average Activity Ratio R		Cs-Ratio From History		Cs-Ratio From Measurement	
Set No. *		1	3	1	3	1	3
No. of repeated measurements	n	18	12	18	12	18	12
Mean value	-	-2.90	2.23	-3.06	2.12	-1.40	0.97
Standard deviation of pop.	S_x	4.08	8.82	4.36	8.75	7.72	11.99
Standard deviation of mean	$s_{\bar{x}}$	0.92	2.54	1.03	2.53	1.82	3.46
No. of repeated measurements	n	30		30		30	
Mean value	$\bar{x}$	-0.84		-0.99		-0.45	
Standard deviation of pop.	S_x	6.77		7.05		9.53	
Standard deviation of mean	$S_{\bar{x}}$	1.24		1.29		1.74	

* *The percent differences listed for sets 1 and 3 are relative to set 2*

A summary of the results of remeasurements performed on three different occasions is presented in Table 2, which shows the local to average activity ratio, R, and the Cs-ratio both calculated and measured. In this case, one set of results, #2, was taken as reference and the percent differences with respect to the reference were calculated. The table shows the mean value of the difference as well as the standard deviation of the population and of the mean for both sets and for all the data combined. The results presented give a pessimistic view of the capabilities of the method in the sense that sometimes optimal data taking is sacrificed in favour of constant conditions. This approach is taken to avoid introducing either changes in the measurements that might not be recorded or delays which would prolong the work. For example, if the intensity of the radiation field is too high, the local to average flux ratio can be reduced by high dead time. This was the situation with the fuel units that give the largest contribution to the values of the standard deviation of the local to average activity ratio and of the Cs-ratio derived from the reactor history.

TABLE 3

STANDARD DEVIATION OF THE MEAN AND POPULATION OF n COOLING TIME MEASUREMENTS AS PERCENTAGE OF THE MEAN VALUE

	No. of Measurements	Standard Deviation of the mean $S_{\bar{x}}$	Standard Deviation of population S_x
	2	3.97	5.28
	3	0.49	0.85
	3	0.36	0.63
	5	0.33	0.74
	9	0.18	0.53
	10	0.31	0.98
	10	0.25	0.80
	12	0.18	0.62
	7	0.18	0.47
	11	0.27	0.90
	2	2.21	3.04
$\bar{x}$	-	-	1.35
S_x	-	-	1.49

The results are listed in order of increasing cooling times.

Regarding the cooling time, Table 3 shows the standard deviation of the mean and population, expressed in percent of the mean value, derived from measurement of fuel units with the same cooling time. The cooling times covered by the table range from about 8 months to 3 years for which the results show a mean standard deviation of 1.35%. Comparisons can be made between the Cs-ratios derived from the operating history and from measurements. Since the first one is based on a declaration, but not only on it, and the second is fundamentally a measured quantity such comparison yields one of the most relevant pieces of information for verification purposes. However, such comparison is not without difficulties, considering the number of parameters that can influence the results.

COMMENTS

Spent fuel measurements are complex and time consuming. Both of these aspects have improved considerably in the last few years through more automatic treatment of the results and the use of larger detectors. The latter aspect is perhaps now sometimes over-emphasized in that the measurement time itself may be only a fraction of the fuel handling time, making the possible gains in counting time irrelevant. The handling both in terms of time and the possible hazards to the fuel are factors against the measurement of isolated fuel assemblies. These factors, genuine as they are, can be used in a way adverse to the proper implementation of safeguards verifications, if nothing else only due to purely economic considerations. Therefore, each situation needs to be properly evaluated and, in general, attributes and variables type of measurements have to be applied. The work described in this paper falls mainly into the second type of measurement but the use of CdTe or other small detectors belongs to the first category.

At this stage the method described in this work does not properly fulfill one of its basic requirements, which is to give to the inspector during the verification the quantitative assurance that the rejection limits have not been reached. This is still a goal which calls for evaluation of the results in the field at least to the extent of giving that assurance.

The complexity of the method is another factor that still impairs its use in several ways. For example, not all inspectors are familiar enough with the method to use it in the best way. Therefore, a compromise generally has to be established between optimum conditions and simplicity to provide the most dependable results. In general, there are a number of necessary and implicit requirements for good data taking. To have full assurance that the equipment is operating and operated in the proper conditions might be a difficult task even for an experienced experimentalist outside his usual environment. Time is another consideration against complex methods in the sense that optimization of the equipment to the specific case might be lengthy, a price that the inspector might not be able to pay both in terms of his own commitments or the ones imposed upon the facility. Therefore, in general, the method is not applied according to its best capabilities.

It seems clear that cooling time measurements can be performed with this technique with a reasonable precision. The Cs-activities and Cs-ratios are more difficult to assess and are bound to have larger errors than the cooling times. Comparison between Cs-ratios based on reactor history and on measurements is of great importance for verification purposes and in this context it is essential to have good sets of reactor characteristic parameters.

The application of the method as described calls for information about the reactor operation. This might create some burden on the operator to provide the required information, but this aspect should not be over-emphasized since the operator needs such information for his own use, if not frequently at least at re-loading times.

The equipment, especially as used by the Agency, can be a source of many problems since it has to be transported around the world, assembled and disassembled in a short time, packed by non-professionals, and often operated under far from laboratory conditions.

APPENDIX I

OVERALL EFFICIENCY FUNCTION F(E)

In calculating the ratio of intensities of gamma rays one is faced with the fact that the detection efficiency and internal absorption within a radiation source are not constant for all energies, therefore making that ratio uninterpretable unless these effects are taken into account. This can be done by introducing a corrective function F(E) which can be determined as described below.

In a sample containing several nuclides, the number of atoms N_1 of the species i having a decay constant γ_i can be determined from the observed intensity X_{ji} of the line of energy E_j by the following expression:

$$N_i = \frac{X_{ji}}{\lambda_i K_{ji}} \frac{1}{\varepsilon_j S_j} \quad (1.1)$$

where K_{ji} is the absolute branching ratio, ε_j is the detector efficiency in the measurement geometry used and S_j is the self absorption factor.

Expression 1.1 holds for all energies and therefore one can select an isotope for which several energies are present in the spectrum (Cs-134 and Rh-106 are well suited for this purpose) and choose one of them, E_R, to normalize all the values. Since for the same isotope N_i is constant, one has:

$$\frac{\varepsilon(E_j)S(E_j)}{\varepsilon(E_R)S(E_R)} = \frac{X(E_j)}{X(E_R)}\frac{K(E_R)}{K(E_j)} \quad (1.2)$$

The right hand side of equation 1.2 can be calculated for each E_j in the spectrum and the function F(E) that best describes the results can be determined. One therefore has:

$$\frac{\varepsilon(E)S(E)}{\varepsilon(E_R)S(E_R)} = F(E) \quad (1.3)$$

in which detector efficiency and self-absorption effects are lumped together. Applying 1.1 to two isotopes, 1 and 2, observed respectively at energies E_1 and E_2 one has:

$$\frac{N_1}{N_2} = \frac{X_1(E_1)}{X_2(E_2)}\frac{\lambda_2 K_2(E_2)}{\lambda_1 K_1(E_1)}\frac{\varepsilon(E_2)S(E_2)}{\varepsilon(E_1)S(E_1)} \quad (1.4)$$

where:

$$\frac{\varepsilon(E_2)S(E_2)}{\varepsilon(E_1)S(E_1)} = \frac{F(E_2)}{F(E_1)} \quad (1.5)$$

In the above derivations it has been assumed that the intensities are corrected for attenuation in absorbers placed between the radiation source and the detector.

ACKNOWLEDGEMENTS

To all those that directly or indirectly have made this work possible, we address our deepest thanks. We must specifically mention our colleagues in the Far East Section; the fruitful discussions with M. deCarolis and T. Dragnev; the preparation of the first programmes by J. Wilson and the work of the US cost-free experts: J. Mandler, R. Helmer, W. Killian and R. Morneau, who prepared the programmes now in use.

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Study Says TV Was 'Unprepared, Or Unwilling' To Provide Special Analysis Needed On Three Mile Island Coverage

RADNOR, Pa. — Television covered the first stages of the Three Mile Island nuclear accident last March 28 with "admirable responsibility," but was "unprepared, or unwilling," to provide the specialized analysis needed to clarify the full story, a study done for TV Guide magazine said (August 4 issue).

The News Study Group of the Massachusetts Institute of Technology reviewed the 12 days of network coverage of Three Mile Island, from the first reports of the accident to the final reactor shutdown. It said:

"Television news moved with admirable responsibility initially, even to the point of being slow with the story.

"Television news reported carefully both industry and Government accounts from within the plant, though with a growing suspicion that the full story was not told.

"Television news eventually proved to be unprepared, or unwilling, to put together the specialized analysis and detailed explanation needed to clarify the whole story; at times, in fact, it avoided promising — but risky — reporting leads in favor of more conventional — and safer — coverage."

The study said TV did reflect the reality of the situation. "But television at its best should do more than hold a mirror to events. Television news begins to falter when it tries analysis," it said.

The MIT group said the accident also tested industry's ability to operate safe, efficient nuclear plants; the Government's ability to regulate them, and the ability of the press to handle complex stories with a clear, coherent voice.

"With the benefit of 20/20 hindsight, it's possible to see that industry, Government and press didn't quite measure up. The three institutions that should be helping the public — and the public's representatives — determine the future of nuclear power in the United States, needed help themselves," the study said. **Edwin Diamond,** journalist and critic, heads the MIT group and was assisted by **Leigh Passman.**

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Editor's Note: For years 1972-1977 (Volumes 1-6 of **Nuclear Materials Management**), No. 3 is the proceedings issue of that year. Beginning in 1978 (Volume VII), No. 3 becomes a regular issue of the Journal. The proceedings of the 1978 annual meeting is designated, Volume VII, Proceedings Issue. Future issues of the INMM Proceedings will be designated similarly, i.e., in 1979 it will be designated Volume VIII, Proceedings Issue. Copies of the tables of contents for INMM Proceedings issues are available on written request to the editors.

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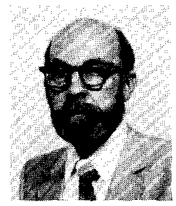

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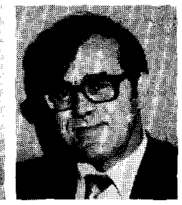

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