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EDITORIAL

Seeks Input On National Safeguards Systems

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

Most of the technical papers which appear in this Journal describe safeguards techniques or subsystems. These are the basic building blocks from which domestic and international safeguards are constructed. It is gratifying to see the large amount of effort that is being devoted to the development of safeguards techniques and the substantial progress that is being made in safeguards technology and assessment methodology. On the other hand, it is most important to consider the general and specific objectives of national and international safeguards.

Two papers in this issue present different perspectives as to the objectives of IAEA safeguards and on how the objectives may be achieved: the paper by **D.A.V. Fischer,** an Assistant Director of the IAEA, and the paper by **Jim de Montmollin** and **Gene Weinstock,** of Sandia and Brookhaven, respectively. If these should stimulate discussion, so much the better. Unless we reach some agreement on why we are designing safeguards components, we will not be able to agree on the priorities for research and demonstrations.

Some complimentary perspectives were presented at the annual meeting in Albuquerque, last July, and were reprinted in the Proceedings issue last fall. Since these papers may become lost among the many other papers in that large volume, it may be useful to call attention to them and to how they relate to the papers in this issue.

The first paper in the Proceedings Issue is by **Dr. Sigvard Eklund,** Director General of the IAEA, who notes that international safeguards is a very young discipline, charged with a very important task, which is in the process of refining its understanding of this task and developing appropriate procedures. **Prof. Lawrence Scheinmann,** of Cornell, discusses the relationship between proliferation-risks and safeguards. Both papers emphasize that many politico-economic policies, in addition to safeguards, will affect a nation's incentives to proliferate or to refrain from proliferation. It is important to understand what the NPT and the IAEA should contribute, in conjunction with the other institutional arrangements, existing and proposed.

Another paper which should be compared to the de Montmollin-Weinstock paper, is "IAEA Safeguards from a United States Perspective", by **Frank Houck** of ACDA. These two papers are not in conflict, as it might at first appear. They represent two different approaches to defining safeguards objectives and attempting to determine how they are to be accomplished. The de Montmollin-Weinstock paper was stimulated, in part, by the fact that some critics consider that the NPT and its associated safeguards are neither sufficiently comprehensive nor sufficiently affective, as Dr. Eklund comments. It is important to remember that the IAEA was designed to contribute to the security of its members. Agency resources will always be limited. The R&D community can help the Agency by developing more efficient techniques and more efficiently designed procedures. But the scope for applications will be extended or restricted, depending on what the majority of the member nations perceive to be desirable for them.

A related issue which should be discussed in the Journal is that of systems integration. Too much of our work is focused narrowly on NDA, or containment-surveillance, or on statistical analysis, with little consideration being given as to how these pieces should be put together and actually used by the IAEA, in order to make the most effective use of the resources available today and of those that reasonably may be available in the future.

In this case, we have emphasized international safeguards. Similar thoughtful examination of the objectives, design and operation of national safeguards systems is also needed. Letters to the editor are invited. Please respond.

Higinbotham

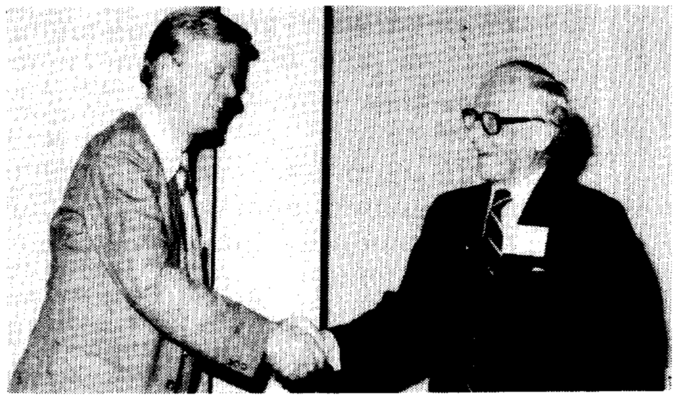
Safe — and Safeguarded Nuclear Power a Necessity

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

Nearly five years in preparation, the long-awaited U.S. National Academy of Sciences report by the National Research Council Committee on Nuclear and Alternative Energy Systems ("the CONAES report") was finally released in January. The DOE-sponsored exhaustive study by four major CONAES panels, 22 support groups — totalling some 300 individuals and costing over $4 million — has resulted in a number of conclusions ranging from heavy emphasis on conservation to the unequivocal consensus conclusion that the only choice the United States has to meet large-scale electricity demands for the intermediate term (next 30 years) is to burn coal and build nuclear power plants. In the decades ahead, dwindling oil reserves are expected to come under increasing priority commitment to transportation and petrochemicals (including petroleum-based liquid fertilizers for producing another vital energy form — food).

The CONAES report — which has been condensed and summarized in a new book "Energy in Transition" just published by W. H. Freeman, Inc., San Francisco — also concludes that nuclear generated electricity may be the nation's only choice for the 20-year period beginning in 1990, i.e., a sharp curtailment of coal burning plants around 1990 may be necessitated by the future strong demand for coal as a valuable source of synthetic liquid and gas fuels, and by the threat that carbon dioxide accumulation from coal combustion may pose in altering climatic conditions through the heat-trapping "greenhouse effect." While fully supportive of the ongoing development of fusion and solar power, the study did not foresee significant contributions from these sources over the next 30 years — the designated time frame of the study.

INMM Chairman Bob Keepin introduces Prof. and Mrs. Ryohei Kiyose (right) of the University of Tokyo and Dr. Harold Bueker of KFA Julich, West Germany, to Dean and Mrs. David Benedetti (left) of the University of New Mexico. (Madge Keepin is between the Benedetti's).



Happy reunion of old friends at Albuquerque. Dr. Sigvard Eklund, Director General of the International Atomic Energy Agency, and INMM Chairman Bob Keepin established a lifelong friendship when Keepin worked for Eklund as a member of the IAEA Headquarters staff in Vienna from 1963-1965.

Among the five or so major points made by the CONAES report:

- reducing the growth of energy demand should be the highest priority of the United States' national energy policy,
- beginning in the 1980s, liquid fuels will be the most critical near-term energy-supply problem for the United States, (This one hits home for us all!)
- coal and nuclear power will offer the only large-scale, intermediate-term options for generating electrical power,
- the breeder-reactor option must be kept open in case energy demand cannot be reduced without radically changing lifestyles,
- the risk of nuclear-weapons proliferation is real and is probably the most serious potentially catastrophic problem associated with nuclear power.

Regarding the nuclear proliferation problem, the report states:

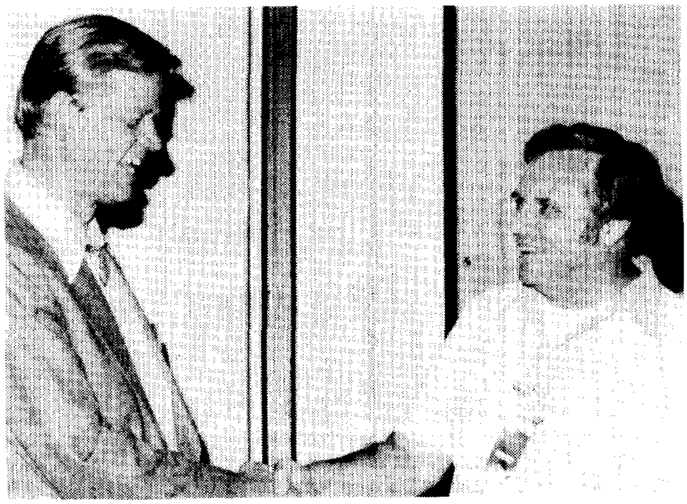
"At best, the danger can be delayed while better control institutions are put in place. . . . There is a wide difference of opinion about which represents the greater threat to peace: the dangers of proliferation associated with the replacement of fossil resources by nuclear energy or the exacerbation of international competition for fossil fuels that could occur in the absence of an adequate worldwide nuclear-power program."

And as all of us in safeguards and materials management know so well, "an adequate worldwide nuclear power program," in order to be a viable and internationally acceptable energy option, must be backed by an effective, workable system for safeguarding nuclear materials and facilities on both the national and international levels.

By direct analogy with the reactor safety recommendations made by the Presidential Commission on the accident at Three Mile Island (the Kemeny Report), many safeguards experts have expressed the basic conviction that there cannot be acceptable safety, or acceptable safeguards, without adequately trained, motivated and qualified (e.g. certified or licensed) operators, managers and inspectors. This has, for many of us, led to a renewed sense of urgency and necessity for establishing an objective means for formal certification of the professional qualifications of safeguarders and material managers. The newly-established INMM certification program is one response to this rather widely perceived need.

As the major thrust of the Institute's certification program during the past year or more, two specially commissioned committees (Certification Test Formulators and Test Evaluators) have developed a test library of over 700 examination questions covering the broad field of safeguards and materials management. This test library has undergone a rigorous and intensive process of validation; including testing of three selected groups of practicing professionals plus a control group in order to screen, evaluate, modify (as necessary), and ultimately validate the questions in order to ensure an effective and objective examination regimen.

Bob and Madge Keepin greet Dr. Charles Beets of MOL, Belgium at the Chairman's Reception in Albuquerque. Dr. Beets was an Invited Session Chairman at the Albuquerque meeting.



Two good friends share a warm handshake — Bob Keepin and Roy Cardwell, the present and immediate past chairmen of the INMM relax after the Awards Banquet at Albuquerque.

Thanks to the professional dedication and sustained hard work of all who contributed to this major Institute effort, by February 1980 we were ready for formal implementation of the INMM certification program. Thus, in accordance with Article IV, Section 6g of the INMM Bylaws, on February 5, 1980 the new INMM Certification Board was established to administer, execute and certify the examination and qualification procedures that have been developed and set forth under the Institute's Professional Certification Program. The 10 member INMM Certification Board is constituted as follows.

F. H. Tingey, Univ. of Idaho, Chairman

Y. M. Ferris, RIRF	**F. A. O'Hara, BCL (IAEA)**
J. L. Jaech, Exxon	**J. A. Prell, NRC**
R. J. Jones, NRC	**C. M. Vaughan, GE**
R. F. Lumb, NUSAC	**D. W. Wilson, GE**
D. L. Mangan, Sandia Labs.	

Each of the above individuals has been fully accredited as a Certified Safeguards Specialist having met all formal requirements thereof, including successful completion of the new INMM Certification Examination. The normal term of appointment to the Certification Board has been established as three years.

A complete description of the basic prerequisites, qualification procedures and requirements of the INMM Certification process is included in a separate report by Certification Board Chairman **Fred Tingey** (see page 6 this issue). I would only add here that the Entry-Level Examination under the new INMM Certification Program will be offered at the Institute's 1980 Annual Meeting in Palm Beach, Florida.

It is clearly of the utmost importance to develop and maintain close coordnnation between the Institute's expanding education and training activities (cf report by Education Committee Chairman **Harley Toy**, pp 12-14 this issue) and the newly-established INMM professional certification program. And indeed every effort will be made to ensure maximum possible coordination between all aspects of the Institute's education, training and certification functions.

Turning to other important INNM organizational, and long-range-planning matters, you will recall my

A couple of former "PK's" (preacher's kids) break out in song and revelry. Bob Keepin, INMM chairman and Willy Higinbotham, the first INMM Distinguished Service Award winner, obviously enjoyed themselves at the Awards Banquet in Albuquerque last July 17.

announcement in the Winter issue of the Journal of the formation of an Ad Hoc Candidate Search and Evaluation Committee to initiate the search for an Executive Director of the Institute. As indicated previously, no precipitous action is contemplated in this vital matter, and the position-definition/recruitment process may extend over many months or perhaps even a year or more. It does seem, however, both significant and noteworthy that even at this early stage some extremely well-qualified individuals have indicated their interest in being considered for the position of INMM Executive Director.

With regard to the Long Range Plan for the Institute that was referred to in the Winter issue, I am pleased to announce that at the Spring meeting of the INMM Executive Committee in Wilmington, N.C., **Sam McDowell** was confirmed as Chairman of an Ad Hoc Committee of seven (including **Vince DeVito, Jim Haycock, Ed Johnson, Ralph Lumb, Jim Powers, and Joe Steigler**) to develop a draft Long range Plan by the end of the current fiscal year (ending September 30, 1980.) Ideas and inputs from the INMM membership are actively sought for this important undertaking.

In closing I'd like to take note of two recent international meetings of interest and importance to Institute members. First, 11 INMM members participated in the highly successful 2nd Annual ESARDA Symposium on Safeguards and Nuclear Materials Management held in Edinburgh, Scotland, March 26-28, and a comprehensive review of the Edinburgh meeting will appear in summer issue (Volume IX, No. 2). Also included in this issue (cf page 30) is a summary report on the INMM co-sponsored 3rd International Conference on Nondestructive Evaluation in the Nuclear Industry held February 10-13 in Salt Lake City, Utah.

As can be readily inferred from **John Jaech's** and **Joe Stiegler's** excellent Annual Meeting program and arrangements (cf pages 8-9 of this issue), the forthcoming 1980 Annual INMM meeting in Palm Beach, Florida — under the theme "Safeguards Today and Tomorrow," — promises to be one of the Institute's best and biggest ever. Make your plans now to join your many friends and colleagues in safeguards from around the United States and many countries of the world who are planning to attend the Palm Beach meeting.

From DOE-Chicago Operations

Shelly Kops Retires from Safeguards

An INMM stalwart — Chicagoan **Shelly Kops** — has retired from Nuclear Materials Management and Safeguards after 27 years of federal service with the U.S. Atomic Energy Commission and the U.S. Department of Energy.

Kops, a founding member of INMM, served as Institute Treasurer and on the Executive Committee. He has been in N15 standards with his activity on INMM-7 subcommittee (Audits, Records and Reporting Techniques).

He taught (with **Cal Solem** of NRC) the first INMM course Accounting and Auditing Techniques May 19-22 at Battelle Columbus Laboratories. He is a member of the Safeguards Committee of the American Society for Testing and Materials. He has served as an instructor at the safeguards training school of Argonne National Laboratory.

Kops who received B.S. and M.S. degrees at Roosevelt University of Chicago, was honored February 22 by some 225 colleagues and friends with a retirement luncheon coordinated by **Ray Lang,** Chairman of the INMM Site Selection Committee, along with **Carl Ahlberg, June Cunningham, Bill Donovan** and **Yvonne Washington**.

His gift was an AM-FM tape player. His wife, three children, daughter-in-law and other relatives and friends were present for the occasion held in the Sabre Room near ANL. **Roy Cardwell** and **Harley Toy** represented the INMM leadership at the luncheon.

Some of Shelly's favorite comments and quips appeared in the printed program for the luncheon. Selected quotes: "It's in the mail." "I'm working on it." "I'll call him back." "I'll have it to you next week." "I work better under pressure." "Lethargy triumphs over all." "Never do today what you can do tomorrow." "You misunderstood me." "Possession is 9/10 of the law." "Not enough corn beef?!!!" "You know — he's right!"

Kops

Lang

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Fred Tingey to Chair INMM Certification Board

By Dr. Fred H. Tingey
University of Idaho
Idaho Falls, Idaho

The ad hoc committee on certification chaired by **Frank O'Hara** has completed its assignment and the program is ready for implementation. The Institute owes much to Frank, **Fred Forscher,** former chairman of the Certification Committee and others in the Institute for putting together a test library and program which the Institute and its members can view with justifiable pride. As Dr. Forscher pointed out in his article in the last INMM Journal as a result of TMI and the Kemeny report, "it has now become abundantly clear that there is no acceptable safety, no acceptable safeguards, without properly motivated, trained, and qualified (certified or licensed) operators, managers, and inspectors".

I am particularly appreciative of the opportunity to serve as Chairman, of the new INMM Certification Board. Serving with me will be **Y. M. Ferris, J. L. Jaech, R. J. Jones, R. F. Lumb, D. L. Mangan, F. A. O'Hara, J. A. Prell, C. M. Vaughan,** and **D. W. Wilson.** Besides being outstanding leaders and members of the Institute, the members of the Board have the somewhat unique distinction at this time of having "passed" an examination consisting of **all** questions in the library.

The test library currently consists of some 700 test questions organized and categorized into five basic areas of application: (1) General (physics, chemistry, fuel cycle, etc.), (2) Nuclear Materials Accounting, (3) Measurements and Statistics, (4) Material Control, and (5) Physical Protection.

The test library has been validated through the process of administering the test to three selected groups of practicing professionals and a control group to evaluate, screen and modify the questions in order to ensure relevancy and objectivity.

The certification process anticipates two levels of competency and experience. At the first level the examination covers the five basic areas of safeguards, as listed above. The basic prerequisite for the first level is a bachelor's degree in an appropriate discipline or a minimum of five years' experience in the field, or an appropriate combination of these. Upon successful completion of the examination, the candidate is designated a Certified Safeguards Intern.

The second level of competency/experience presumes intern status or equivalent plus additional experience and specialization. Upon peer recommendation, the candidate for Certified Safeguards Specialist will take a written examination covering the five basic areas defined for the Intern examination, but with emphasis on his designated area(s) of specialty. In addition, an oral review before members of the INMM Certification Board is required. Upon successful completion of the examination and/or recommendation by the Certification Board, the candidate will be accredited by INMM as a Certified Safeguards Specialist.

Re-certification will be accomplished on a five-year basis by submitting to the Certification Board evidence indicating continuing education and professional development in the Safeguards field.

It is intended that certification will be conducted jointly with all INMM sponsored training seminars as well as the annual meeting of the Institute. Particularly the entry level examination will be offered at the Institute's 1980 Annual Meeting, June 30 — July 2, in Palm Beach, Florida.

The responsibility for adequate training to precede the certification examinations has not escaped the attention of the Institute nor the Certification Board. In this regard the INMM sponsored courses in Accounting and Audit Techniques in May, 1980 and the two statistics courses — Fundamentals and Advanced — in September, 1980 are relevant. Also the Certification Board is actively engaged in the identification, collection, and production of video tape lectures, demonstrations and courses, which focus on various aspects of the Safeguards problem. These, when identified, collected and catalogued, will be made available on loan to the interested candidate for his/her own review and training. In this regard the membership of the Institute could be of great service to the Board if they would identify to a Board member the existence of such candidate tapes in their own companies or organizations.

The certification program will remain viable only if it is credible. This means that the ultimate goal is to have the various domestic and international agencies concerned with Safeguards accept the INMM certification as a desirable and necessary requirement in the licensing or approval process.

Tingey

Palm Beach Meeting Program Focus On Invited Papers Sessions

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

If you've not already made your plans to attend the annual INMM meeting in Palm Beach on June 30-July 2, the Program Committee hopes that this report will prompt you to do so immediately! In the Winter issue of the Journal, information was given on the two plenary sessions to be held in Palm Beach, on Monday morning and on Tuesday afternoon. The biosketches on three of our featured speakers and the identification of the others emphasize that we will be addressed by distinguished individuals representing the various organizations that impact heavily on safeguards policy making and implementation. Now is your opportunity to express your views to this select audience, both during the plenary sessions and at other times during the course of the meetings.

During the recent past, the Program Committee has attempted to achieve greater balance in the papers presented at the annual meetings. This balance is difficult to achieve if one relies solely on contributed papers. This is why, in Albuquerque in 1979, we initiated the idea of having invited papers sessions to complement the contributed papers sessions. This idea met with strong approval in 1979, and has been carried forward more intensively in planning for the 1980 meetings. The Invited Papers Chairman for the Palm Beach meeting, **George Huff**, announces that there will be six invited papers sessions on the program this year. Topics include:

- Physical Protection Requirements and Rules, **T. A. Sellers**, Session Chairman.
- Public Information, **Herman Miller**, Session Chairman.
- Emergency Response for Accounting and Physical Security Systems, **R. Nilson**, Session Chairman.
- Analysis and Interpretation of Materials Accounting Data, **D. B. Smith**, Session Chairman.


Gruemm


Heath


D. Sewell

- Safeguards in ESARDA, **Charles Beets**, Session Chairman.
- Safeguards Measurements Technology, **T. S. Canada,** Session Chairman.

With several sessions of contributed papers also in the offing, the program should have broad appeal for all segments of the INMM membership.

As a closing note, this is my last journal column as Program Chairman. I would like to take this opportunity to thank those committee members with whom I've been associated with during this two year assignment. In particular, the contributions of **Dick Chanda**, Contributed Papers Subcommittee Chairman for the past two years, are gratefully acknowledged. His untiring and conscientious efforts in the difficult process of selecting contributed papers, and in assuring that the contributed papers sessions run smoothly at the meetings, are deeply appreciated. I hope that those of you in attendance at Palm Beach will pass along your personal thanks to Dick for a job well done as he has filled a position that is normally quick to draw criticism, and slow to receive well-deserved praise.

Gruemm Plenary Speaker

John L. Jaech, Chairman of the Technical Program Committee for the INMM Annual Meeting, has announced that Dr. **Hans Gruemm**, Deputy Director General, Department of Safeguards at the International Atomic Energy Agency in Vienna, Austria will be a plenary session speaker for the meeting.

Dr. Gruemm, author of some 150 papers and book contributions on electronic optics, reactor theory, nuclear engineering and research management, is a Fellow of the American Nuclear Society and the Institution of Nuclear Engineering.

He received his Ph.D. at the University of Vienna and has a strong background in nuclear technology, safeguards, education and research management. The Institute is most pleased that Dr. Gruemm will be able to be with us for the 21st Annual Meeting of INMM June 30-July 2 in Palm Beach, Florida.

Nuclear material management professionals set PB parley

By FAYE JOHNSON
Times Staff Writer

NORTH PALM BEACH — In May, 1958, the Institute of Nuclear Materials was created to further the advancement of nuclear materials management in all aspects.

Comprised of more than 600 professionals from all over the world, the INMM studies, evaluates and issues recommendations regarding safeguards involved in the development and application of nuclear materials, James Lee said.

Lee, of North Palm Beach, was recently appointed chairman in charge of local arrangments for the INMM's 21st annual meeting scheduled at the Breakers Hotel in Palm Beach June 30-July 2. The INMM also has chapters in Europe and Japan, Lee said.

A transportation consultant with Tri-State Motor Transit Co. Inc., whose headquaters are in Joplin, Mo., Lee said he got involved in the nuclear program in 1961. "I was working with the Bendix Corp. which was then operating under a contract with the old Atomic Energy Commission," said Lee, who later joined Tri-State.

The only organization of its kind in the world, Lee said the INMM includes accountants, engineers and scientists from various companies, governmental

JAMES LEE

agencies, the Department of Energy and the Nuclear Regulatory Commission, industrial and academic institutions where nuclear materials are used in various research, development and production activities.

"These representatives devise methods of measuring nuclear material for use in plants and reactors," Lee said.

Lee said the 1980 INMM meeting is expected to attract about 400 nuclear safeguard and nuclear materials management experts. "The field of nuclear materials is an ever-expanding one," he said. "The purpose of the annual meetings is to provide the leading professional forum with timely reviews and updated national and international policies, programs, and technical progress in nuclear materials management and physical security."

The guest speaker for the meeting will be R.E. Uhrig, vice president of Florida Power & Light Co. "Regulation of the Nuclear Power Industry: Its Uses and Abuses," will be his topic Other speakers will include William Dircks, director of the Office of Nuclear Material Safety and Safeguards, a division of the Department of Energy; Hans Gruemm, of Vienna, deputy director general of the Austrian Department of Safeguards, and Duane Sewell, assistant secretary for DOE's defense programs, Lee said.

Active in several professional and technical organizations in the nuclear and transportation fields, Lee has served as a member of the INMM's executive committee as well as being chairman of the INMM's membership committee since 1974.

He attended Butler University and the University of Missouri at Kansas City, and in 1951, Lee was licensed to practice before the Interstate Commerce Commission, the Federal Maritime Commission and the Florida Public Service Commission.

A native of Anderson, Ind., Lee came to the area when Pratt & Whitney Aircraft Group opened its West Palm Beach plant in 1958.

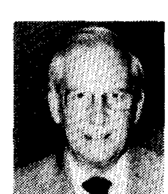
Heath to Speak

Dr. **Colin A. Heath** is Director, Division of Waste Isolation, in the Office of Nuclear Waste Management, U.S. Department of Energy. He is an Invited Speaker at the 1980 INMM Annual Meeting.

In this position, Dr. Heath is responsible for the DOE program to establish the technology and to locate specific sites for the long-term storage and disposal of high-level radioactive wastes.

Dr. Heath joined the Federal Government in October 1976 on the staff of the Nuclear Subcommittee of the Federal Energy Resources Council. Upon dissolution of this Council, he joined ERDA in the field of waste management in February 1977. Prior experience has been in fuel recycle development programs for General Atomic Company in San Diego.

Chanda



Huff

Jaech

Safeguards Group Moves Forward On Definition, LEU Regulations

By Dr. James A. Powers, Chairman
INMM Safeguards Committee
McLean, Virginia

Since accepting the Chairmanship of the Safeguards Committee in November 1979, I have been catching up from **Syl Suda** on all the activities he had in progress and giving attention to some of these that I can most beneficially assist. Unfortunately, I was unable to attend the Safeguards Committee Meeting held at Kiawah Island, South Carolina, November 30, 1979. The meeting was chaired by Syl Suda and he transmitted to me his minutes of the meeting. They are, with some slight modification, repeated here in their entirety for the reader's information.

"A meeting of the INMM Safeguards Committee was held in Kiawah Island, South Carolina, on Friday afternoon, November 30, 1979, following the ANS-NBS-INMM sponsored Conference on Measurements Technology for Safeguards and Material Control.

The attendees were: **Sylvester Suda**, Chairman, **Roy Nilson, Jim de Montmollin, Gene Weinstock, Paul Persiani, Joe Armento** (for Bob Brooksbank) and **Bob Keepin**.

Action items from the July meeting in Albuquerque were addressed:

Item: Draft of petition for a rule change involving physical protection of plants and materials as it applied to low enriched uranium. The draft letter pointed out that NRC has recalled the guide which defines the manner for implementation of the new rule and the INMM could probably achieve similar results by providing useful input to the NRC on its revised guide rather than pushing for a change in the rule itself.

It was agreed that it would be useful for a delegation from the Safeguards Committee to meet with the NRC and offer its assistance in preparing practicable requirements, which could be incorporated in the next issue of the guide, on implementation of the regulation. It was suggested that the Safeguards Committee could make a query or survey of the industry members on the vital issues regarding low-enriched uranium. No specific follow-up action was assigned.

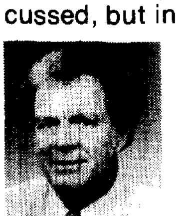
Item: Safeguards objectives and criteria. Briefly discussed, but in the absence of new input there was no progress and no action identified.

Item: Definition of Safeguards. Jim de Montmollin and **Ray Lang**, independently, prepared written submissions for committee consideration. It was agreed that the de Montmollin paper was in a form suitable for publication in the INMM Journal. The usage of the term safeguards that Ray Lang addressed in his memo, while important, would be better handled separately at a later time. Action: to publish Jim's paper in the INMM Journal.

In the absence of the newly appointed Safeguards Chairman, **Jim Powers,** no new business was introduced."

The first item in Syl's minutes deals with the regulations governing low enriched uranium. Roy Nilson contacted me after the Kiawah Island meeting and requested I set up a meeting with NRC to discuss LEU regulations. In coordination with **Wally Hendry**, who led in 10CFR Part 73 discussions, **Ralph Lumb,** who led Part 70 discussions, **Tom Bowie, Hal Foster, Bill Goodwin, Bill Heer, Roy Nilson, Bill Powers** and **Ron Tschiegg**. I arranged a meeting with **Bob Burnett**, Director of NRC's Safeguards Division and members of his staff. The meeting was held January 22, 1980. Wally Hendry's efforts were on behalf of another INMM Committee and will be reported separately. Ralph Lumb spoke very convincingly on behalf of the Institute using the arguments put forth inthe August 1976 INMM Special Report "Assessment of Domestic Safeguards For Low Enriched Uranium." This report had been formally transmitted to former NRC Chairman Rowden by former INMM Chairman **Roy Cardwell** in late 1976. NRC has not responded to this report. For the information of members who may not remember the study, it was prepared by an Ad Hoc Writing Group of the Safeguards Committee chaired by **Dennis Wilson.** Other members were **Dennis Bishop, Ralph Lumb, Gary Molen, Ron Tschiegg** and **Dave Zeff**. It contained these recommendations:

A. A category of special nuclear material be defined as "low-enriched uranium." This category would be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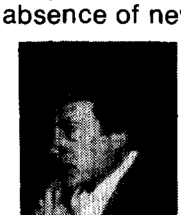
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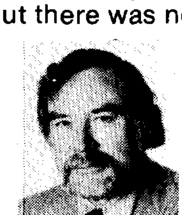
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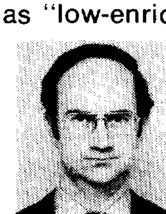
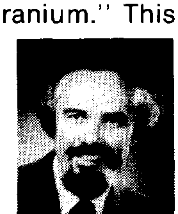

J. Powers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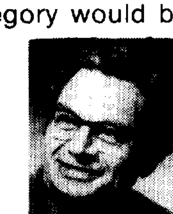
Weinstock

Hershkowitz Gets DOE Branch Post

Martin Hershkowitz has joined the Division of Incident Management, and serves in the capacity of Chief, Information Systems Branch. In this position his primary functionis Program Manager for the Nuclear Materials Management and Safeguards System (NMMSS) Program.

Hershkowitz brings to this position a broad range of experience in program management, information resource management and operations research. His career includes such assignments as: Director of the Office of Data Systems, U.S. International Trade Commission; Senior Staff Operations Research Analyst in the Office of Organization and Management Information, U.S. Department of Housing and Urban Development; Senior Scientist, Operations Research, Inc.; Program Manager for Educational Research and Evaluation, and Group Supervisor for Operations Research, Vitro Laboratories. Other assignments include mathematician, research scientist and computer programmer for the Bell Telephone Laboratories, the George Washington University and the U.S. Department of Commerce and Interior.

He has a wide variety of publications, including editor of a book on educational needs assessment, a pamphlet on goals and needs of Maryland public education, and booklets on the status of the handicapped in the labor force; articles in such journals as the Naval Research Logistics Quarterly, Journal of Reading Behavior, Instructional Science, Computers and Operations Research, Studies in Art Education, NASSP Bulletin, School Science and Mathematics, and Educational Planning; and chapters in three books and in the proceedings from several symposia. He has also been invited to make presentations at a variety of national and international professional symposia, including the Operations Research Society of America, the International Symposium on Computers and Operations Research, the American Educational Research Association, the National Conference on Educational Needs Assessment, the Military Operations Research Symposium; and has chaired a number of these symposia.

The new branch chief has earned undergraduate and graduate degrees in mathematics from the Florida State University and the George Washington University, respectively, and has lectured in mathematics at the University of Maryland, the George Washington University and the Bell Telephone Laboratories education program.

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uranium enriched to less 20% of U-235.

B. Licensees authorizing the possession and use of low-enriched uranium be excluded from the safeguards provisions of 10CFR70.

C. New safeguards requirements for low-enriched uranium proportional to the nature of the threat and relative risk, be included in new regulations.

D. The objective of the safeguards systems for low-enriched uranium should be to detect and respond to the unauthorized removal of 0.02 effective kilograms (ekg) per day of 5 ekg per year from approved uses.

E. The safeguards system for low-enriched uranium should:

1. provide for material and accounting, control and containment system;
2. provide for verification of the performance of the system; and
3. provide the basis for appropriate responses to system compromise."

INMM made a special issuance of this report.

Since our meeting with NRC, the issue has been given greater attention by the Safeguards Division and Mr. Burnett has promised a reply to the Institute. The Safeguards Committee is considering additional steps that might be taken to both speed up the process and help our cause.

During the meeting with Mr. Burnett, Roy Nilson asked the nature of other policy matters being studied in the safeguards area. Mr. Burnett stated the TMI-2 guard force has been criticized for its handling of access controls during the accident and that alternatives to the current practices were being considered. He also identified other regulatory changes being considered, some at the request of the Commission, that include additional physical protection for LEU to **prevent** its theft, and the licensing of individuals requiring access to material balance areas. As one of my duties as Chairman of this Committee, I intend to maintain current awareness of governmental policy changes in the safeguards area and will be reporting on these changes.

In the Winter 1979-1980 issue of the Journal, Bob Keepin reported that an Ad Hoc Public Information/ Response Committee has been formed. Dennis Bishop, **Herman Miller, Joe Stiegler** and I are members. A questionnaire for sending to the membership has been drafted and is in review by the Committee. Our plan, as reported by Dr. Keepin, is to obtain and maintain a current listng of INMM members, by area of expertise, available to assist the Institute or others in the nuclear community on short notice, including emergency situations. Along these lines, the Institute has offered assistance to a nuclear facility in solving a potential problem in its material accounting program. It remains to be determined whether the offer of assistance will be accepted.

As I catch up with all the worthwhile activities Syl Suda and others on the Safeguards Committee had underway at the time I became Chairman, I will report these to you. The need for your Committee's attention to safeguards objectives and criteria is most important and I intend to devote some time to this subject in the coming months.

Education Committee Completes Activities Prior to 1980 Annual Meeting

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

At this writing, we are winding down plans for our first Accounting and Auditing Techniques course. The course was given at Battelle's Columbus Laboratories on May 19-22. We were most fortunate in obtaining the services of **Shelly Kops** and **Cal Solem** (NRC) to serve as instructors for the course. The course was designed to assist participants in seeking cerfification. Along that line, the three-and-one-half-day course provided the initial opportunity for attendees to take the Entry Level Examination for INMM Certification. The week of May 19 was a milestone in that it launched the beginning of the Institute's new Certification Program. Your Education Committee has worked closely with Dr. **Frank O'Hara,** Dr. **Fred Tingey**, Chairman of the Certification Board, and Institute Chairman **Bob Keepin** in launching the first offering of the Entry Level Examination for INMM Certification.

During the final countdown to our Annual Meeting, your Education Committee is holding discussions with NRC staff in the area of training and certification. Initial discussions have been held with NRC staff from the Regulatory Improvements Branch regarding assistance in the certification and training area. Other discussions have centered on the possibility of holding INMM-sponsored training courses at NRC Headquarters. Within the next few months (Annual Meeting time), plans should be finalized for a liaison arrangment with NRC in the overall area of education, training, and certification.

A committee composed of (from left) Harley L. Toy and Francis A. O'Hara of Battelle Columbus Laboratories and Sheldon Kops of (Ret., USDOE — Chicago) met January 8 in Columbus to plan the INMM Accounting and Audit Course. It will be offered May 5-8 at Battelle; Mr. Kops, who retired in February, will teach the course. Dr. O'Hara is a member of the INMM Executive Committee with oversight responsibility for the course's sponsor, the INMM Executive Committee chaired by Mr. Toy.

Early Fall will see **John Jaech** back in Columbus to present his Introductory and Selected Topics Statistics courses. The Introductory course will be held September 10-12, while the Selected Topics course will be held September 15-17, 1980. Current plans call for the offereing of the Entry Level Certification Examination during the course here at Battelle-Columbus.

An update on other educational activities include:

- Continued investigation into feasibility and need for the presentation of a Safeguards Seminar
- Initial investigation has concluded that our annual meetings and sponsored educational programs do qualify as Continuing Professional Education credits. Our present plans call for stating that all INMM-sponsored educational programs and annual meetings qualify for CPE credits.

Our continuing program to provide upcoming meetings, conferences, and workshops is presented below. As stated in the last issue of the Journal, this will be a continuing program. We have been most successful in obtaining such meeting and workshop information from allied professional societies.

UPCOMING PROGRAMS OF INTEREST

American Nuclear Society

ENERGY ADVOCACY CONFERENCE, "ENERGY FOR THE 80's"
June 27-29, 1980
Chicago, IL
Palmer House
Contact: Energy for the Eighties Foundation
Suite 200
1015 15th Street, NW
Washington, DC 20005

INTERNATIONAL EXECUTIVE CONFERENCE ON NON-PROLIFERATION & SAFEGUARDS
September 14-17, 1980
Mexico City, Mexico
General Chairman: **John E. Gray**, President
International Energy Associates, Ltd.
600 New Hampshire Avenue, NW
Suite 600
Washington, DC 20037
202-338-8230

SECURITY WORKSHOP
October 5-8, 1980
Oakbrook, IL
Drak Oakbrook Hotel
General Chairman: Dr. **Frank Bevalacqua**, Vice President of Engineering
Combustion Engineering, Inc.
Nuclear Power Department
1000 Prospect Hill Road
Windsor, CT
203-688-1911, X-3305

ANS WINTER MEETING
November 16-21
Washington, DC
Sheraton-Washington Hotel
Technical Chairman: **M. J. Ohanian**
202 Nuclear Science Center
University of Florida
Gainesville, FL 32611

ANS ANNUAL MEETING
June 7-12, 1981
Miami Beach, FL

U.S. Department of Energy Safeguards Technology Training Program

FUNDAMENTALS OF NONDESTRUCTIVE ASSAY OF FISSIONABLE MATERIAL USING PORTABLE INSTRUMENTATION
October 6-10, 1980
Los Alamos, NM
Contact: **Karen Humphrey**
USDOE Safeguards Technology Training Program, MS 550
Los Alamos Scientific Laboratory
P.O. Box 1663
Los Alamos, NM
505-667-6394 or FTS 843-6394

GAMMA-RAY SPECTROSCOPY FOR NUCLEAR MATERIALS ACCOUNTABILITY
December 8-12, 1980
Los Alamos, NM
Contact: **Karen Humphrey**
USDOE Safeguards Technology Training Program, MS 550
Los Alamos Scientific Laboratory

NOTE: This coming year will be a transition period during which we will endeavor to revise the course offeringsintheLASL/DOESafeguardsTechnology Program. The In-Plant NDA Instrumentation course, usually held in December, will be phased out of the program. Part of the material covered in this course will be included inthe gamma-ray spectroscopy course. The remaining portion will be incorporated into a new course that will deal with advanced instrumentation based on neutron detection methods and will be offered yearly, beginning in 1981.

For further technical informationon course content on the above listings, call **Hastings Smith** or **Norbert Ensslin**, 505-667-6141 or FTS 843-6141.

International Atomic Energy Agency

IAEA/CEC INTERNATIONAL SYMPOSIUM ON THE MANAGEMENT OF ALPHA-CONTAMINATED WASTES
June 2-6, 1980
Vienna, Austria
Contact: International Atomic Energy Agency
Wagramerstrasse 5
P.O. Box 100, A-1400
Vienna, Austria

8TH INTERNATIONAL CONFERENCE ON PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH
July 1-10, 1980
Brussels, Belgium
Contact: International Atomic Energy Agency

SEMINAR ON NUCLEAR POWER FOR EXECUTIVE-LEVEL OFFICIALS IN DEVELOPING COUNTRIES
September 29-October 3, 1980
Vienna, Austria
Contact: International Atomic Energy Agency

SAFEGUARDS WORKSHOP SEMINAR AND SSAC COURSE
October 6-17, 1980
Vienna, Austria
Contact: International Atomic Energy Agency

INTERNATIONAL CONFERENCE ON CURRENT NUCLEAR POWER PLAN SAFETY ISSUES
October 20-24, 1980
Stockholm, Sweden
Contact: International Atomic Energy Agency

SEMINAR ON SELECTION AND IMPLEMENTATION OF SAFETY STANDARDS FOR NUCLEAR POWER PLANTS (IAEA/ISO)
December 15-19, 1980
Vienna, Austria
Contact: International Atomic Energy Agency

REGIONAL SEMINAR ON FUNCTIONS AND ORGANIZATION OF SECONDARY STANDARDS DOSIMETRY LABORATORIES WITHIN THE IAEA/WHO NETWORK OF SSDLs FOR DEVELOPING COUNTRIES IN AFRICA
Location and dates to be announced later
Contact: International Atomic Energy Agency

Institute of Nuclear Materials Management

TECHNICAL WORKSHOP ON PHYSICAL PROTECTION
December, 1980
Place to be announced

Guest Editorial

Rewards of Professionalism?

By Dr. Francis A. O'Hara
INMM Executive Committee
Vienna, Austria

The current administration of the Institute, under the Chairmanship of Dr. **G. R. Keepin**, has had as its major thrust the enhancement of Professionalism. One has only to review recent issues of the **Journal** or listen for a few minutes to any conversation of the Chairman to note the degree of emphasis that has been placed on this subject. Some contributions to professionalism in the Institute include efforts in the areas of public information, standards, eduction, certification, technical working groups, workshops and annual meetings.

Professionalism has two major aspects—the further development of the individual, and the recognition given the organization by those on the outside. Each of these facets of Professionalism has commensurate rewards which result in the promotion of the individual or of the group. The benefits that can accrue to the group are familiar to us all. I would like to take this opportunity to describe some of the rewards that can accrue to an individual. My hope is that my remarks would encourage each of you to more diligently seek and exercise your own Professionalism.

I have been very fortunate, during my relatively short career, to have had several opportunities from which I have reaped personal Rewards of Professionalism. Most of these have been through my association with the Institute over the past 10 years. The most significant of these have been 1) as chairman of an ANSI Standards-writing subcommittee, 2) as leader of a group that restructured the Institute certification process, and 3) as a member of the Executive Committee.

As anyone who has been involved in these kinds of activities realizes, they involve the usual mixture of hard work, frustration and accomplishment. Even though they require much effort and often involve many difficulties, in retrospect, the bitter tend to be forgotten while the sweeter become the memories.

In my case, I feel these rewards have been of three major types. The first is personal achievement, or the sense of accomplishment that comes from seeing a task through to completion. The second is the contribution to the profession (or Society) for which all participants can be justly proud. Finally, there are the friendships generated among associates and colleagues. In my case, I feel that this has been my greatest personal reward. There are obviously other benefits which may be derived, and these may vary from individual to individual.

Each member of the Institute has numerous opportunities to exercise Professionalism. Professionalism has many outlets which may be tailored to the interest of different individuals. Professionalism does require effort and, perhaps, a bit of risk. Professionalism demands involvement and time.

I urge all members of the Institute to become more involved in Professionalism so that together we may reap the personal and organizational rewards of professionalism.

O'Hara

ANL Radioactive Waste Disposal Research

ARGONNE — An important issue facing the nation is the selection of a method for disposing of radioactive waste products produced by nuclear power reactors and by military weapons programs. A number of satisfactory disposal techniques are known, but research efforts continue in order to ensure that the most effective method is ultimately chosen to do the job.

A new program at the Department of Energy's Argonne National Laboratory has begun investigating crystalline ceramic materials with the dual aim of assessing the ability of these materials to contain high-level nuclear wastes and of developing the form of the material best able to immobilize and store high-level wastes. Crystalline ceramics are chemically and structurally similar to minerals which have existed in nature unchanged for millions of years.

Using this material, the most long-lived and toxic of the waste products would be contained within the crystal structure and stored in a specially designed repository.

At issue are the actinide elements neptunium, uranium and plutonium. Highly radioactive isotopes of these elements with half-lives of thousands of years or longer are produced in nuclear reactors and in military weapons programs. (A half-life is the time required for half the atoms of a radioactive element to decay.)

A typical 1,000 megawatt nuclear power plant, after appropriate waste processing, produces only about 70 cubic feet of high-level waste annually, enough to fill a cubic box measuring approximately four feet on each side. About 99 percent of the 9.4 million cubic feet of unprocessed high-level waste material in the United States today has come from military and weapons programs. By far the greatest volume of radioactive waste which comes from a nuclear plant is low-level waste — items like ion-exchange resins and contaminated clothing, tools and paper — which does not need to be isolated from the environment for as long a time as high-level wastes.

Argonne scientists are performing laboratory experiments to examine methods for incorporating nuclear wastes into a variety of crystalline ceramics. The resulting materials are being examined to determine their ability to withstand representative geological temperatures and pressures and to contain waste radionuclides in the unexpected event that the canister containing the waste was somehow penetrated by groundwater.

The long-term goal of the study is to compare the effectiveness of crystalline ceramics with that of glass, another material being investigated as a means of immobilizing high level nuclear wastes. Other techniques, such as encasing glass waste inside metal matrices, are also under investigation at Argonne and other laboratories around the country. Argonne's work on crystalline ceramic waste forms started last winter and is already supplying important information to the Department of Energy (DOE).

Copies of the
Printed Proceedings of the
Annual Meetings of the
Institute of Nuclear Materials Management

The proceedings (1960-1980) are in bound volumes.			Domestic Rates
1st	Columbus, Ohio	1960	$5.00
2nd	Denver, Colorado	1961	$5.00
3rd	St. Louis, Missouri	1962	$5.00
4th	Buffalo, New York	1963	$6.00
5th	Pittsburgh, Pennsylvania	1964	$5.00
6th	Cincinnati, Ohio	1965	$5.00
7th	Columbus, Ohio	1966	$30.00
8th	Washington, D.C.	1967	$6.50
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10th	Las Vegas, Nevada	1969	$37.50
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13th	Boston, Massachusetts	1972	$37.50
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20th	Albuquerque, New Mexico	1979	$20.00
21st	Palm Beach, Florida	1980	$25.00

Mr. Thomas A. Gerdis
INMM Publications Office
P.O. Box 6247
Louisville, Kentucky 40207
Phone: 502-895-3953

Change Is the Only Constant

By D. M. Bishop, Chairman
INMM N.15 Standards Committee
San Jose, California

One of the many truisms associated with standards work is that the products of such efforts (the standards themselves) often last longer than the standards writers who created them. The longevity of such standards is one of several paybacks from the often arduous writing, review and approval process. However, the lack of a similar longevity for standards writers is not necessarily bad, and may be a healthy part of the process.

The N15 Standards Committee is a case-in-point. One of the objectives of this report is to review some of the many changes in personnel that have occurred during the past year, and highlight the typically transitory but often significant value of N15 participation.

Over the last several years, many new faces have appeared at the N15 Standards Committee writing group meetings, and many old friends have moved on to other activities. The reason for the influx is relatively obvious. The decade of the 1970's saw safeguards develop and mature as a profession in an inverse relationship to the general popularity of nuclear power. Safeguards professionals went from a position in the limelight at cocktail parties and the dinner table on key issues related to the current public skepticism concerning nuclear power.

As a result of this increased interest and technical complexity, the N15 Standards Committee has grown to cover the gamut of technical disciplines required to describe current safeguards issues. N15 currently consists of almost 200 professionals from all aspects of industry, government, and the scientific community. As an organization we can be proud, but these days are no time to rest on our laurels. It is a time to creatively and aggressively pursue meaningful standrads objectives to set the stage for future progress.

Reason for the periodic outflow of talented people from N15 is no less significant. Many smart aggressive young people get started in standards work after only a few years in the nuclear business and find after several years that they got promoted, or had a change in career interest which no longer supports continued N15 involvement. Others retire or find that, because of their particular technical expertise, they are able to make a significant contribution in a specific area, but have no ongoing interest in overall N15 activities. Still others get bored with the slowness of the system and the many compromises that form the basis of a consensus standards process. All these reasons support several basic conclusions:

1. N15 is a dynamic consortium of talented people that is constantly changing to be responsive to current safeguards technology needs. This change in general is good and contributes to both quality and timeliness.

2. Like it or not, the consensus standardization process takes a long time. The average gestation period is 2-4 years. A standard typically lives 4-5 years and is reviewed and revised to reflect experience and major changes in technology and requirements. Infrequently are the same people involved from the start to the finish of this life cycle.

Based on these N15 facts of life, if you are interested in participating in a particular area of the consensus standard process, don't look at it as a lifetime commitment. As with other INMM activities, the N15 Standards Committee offers a valuable opportunity for contribution and recognition which can be consistent with your individual interests and expertise. Approached properly, it can be a valuable professional experience without being overly burdensome. Please feel free to get involved by contacting the Subcommittee chairman in your particular area of interest. A listing of the current N15 Subcommittees is shown in an adjacent table.

As indicated above, the N15 Standards Committee has undergone many changes during the past two years. Nothing is more sure than the prediction that continued growth in the safeguards are will stimulate even more change in the future. The following is a brief review aimed at highlighting the many new faces at the

Bishop

Subcommittee and writing group chairman level:

Subcommittee/Writing Group	New Chairman
INMM-5 (Measurement Controls)	**Yvonne Ferris** (Rockwell)
INMM-7 (Audit Records and Reports)	**Marv Schnaible** (Exxon)
INMM-8 (Calibration)	**Syl Suda** (BNL)
INMM-8.4 (Calorimetry)	**Bill Rodenburg** (Mound)
INMM-9.1 (Material Categorization)	**Fran Haas** (Rockwell)
INMM-9.3 (Physical Standards)	**Ron Harlan** (Rockwell)
INMM-10 (Physical Security)	**John Darby** (Sandia)
INMM-10.1 (Terminology)	**Blythe Jones** (Int. Energy Assoc.)
INMM-10.2 (Closed Circuit T.V.)	**Doug McGovern** (Sandia)
INMM-11 (Training and Certification)	**Fred Tingey** (U. of Idaho)
INMM-12 (Site Response Planning)	**Ed Young** (Rockwell)
INMM-13 (Transportation)	**Bob Wilde** (Sandia)
INMM-14 (International)	**Bob Sorensen** (Battelle-PNL)

These individuals provide valuable leadership in their particular areas of expertise. They are backed up by a multitude of individual contributors whose experience and knowledge make it a pleasure to be a part of the INMM-15 organization. Your continued support of this meaningful effort is both requested and appreciated.

INMM — N15 STANDARDS COMMITTEE ORGANIZATION

SUBCOMMITTEE	TITLE	CHAIRMAN	AFFILIATION	PHONE
—	N15 Chairman	Dennis Bishop	General Electric Co.	(408) 925-6614
—	N15 Secretary	Robert Kramer	Northern Indiana Public Service Company	(219) 787-8531
—	N15-NSMB Representative	Lou Doher	Rockwell International	(303) 497-2575
—	ANSI Staff Representative	Mary Crehan-Vaca	ANSI	(212) 354-3360
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) 375-8153
INMM-8	Calibration	Syl Suda	Brookhaven National Laboratory	(516) 345-2925
INMM-9	Nondestructive Assay	Darryl Smith	LASL	(505) 667-6514
INMM-10	Physical Security	John Darby	Sandia Labs	(505) 844-8977
INMM-11	Training and Certification	Fred Tingey	University of Idaho	(208) 526-9637
INMM-12	Site Response Planning	Ed Young	Rockwell International	(303) 497-7323
INMM-13	Transportation (Proposed)*	Bob Wilde	Sandia Labs	(505) 264-7323
INMM-14	International Safeguards (Proposed)*	Bob Sorenson	Battelle-PNL	(509) 942-4437

* Currently under review by an N15 Advisory Group to evaluate scope and feasibility.

Citizenry Needs Information For Making Judgements

By Herman Miller, Chairman
INMM Public Information Committee
Mountain View, California

Communicating is a difficult art, at best; and with the increasing pace of technological, political, social and economic change, and good communication becomes ever more crucial. This is certainly true in the nuclear industry. We must keep reminding ourselves that despite the lobbying and special interest groups, the majority of our citizenry, who are the strength of this nation, need information on which they can make their judgements. With full and accurate information, they make sound choices. A major goal of the INMM PI Committee is to provide such information.

The goal of the INMM Public Information Committee is reflected in the activities of the Bureaus. Our first goal is to generate opportunities and interest in member participation. This we are doing with the implementation of the Bureau activities. **Tom Collopy** and **Ed Johnson** comment on this elsewhere in this latest report. Volunteers are starting to appear.

A further step toward this first goal is being taken with the organization of a Public Information Session at the annual meeting in July 1980. At that meeting we will have papers on "Training for Communicating With The News Media," "How to Communicate With Your Elected Representative," "How to Make More Effective Speeches," "How the Nuclear Industry Communication Program Comes Through," and we also plan to have a Video Interview Training session.

Our second goal is to establish the INMM as the most knowledgeable organization on nuclear material accountability and safeguards. This will be accomplished by sound technical work, properly utilized and communicated. The Safeguards Committee serves a vital function here in providing such information to the PIC. News releases, effective technical papers and good speakers will be used by the News Bureau and Speakers Bureau to move ahead on this goal. In time, we hope the INMM will develop the reputation which attracts inquiries for professionally qualified response.

The third goal of the PIC is to provide technical and other factual information on nuclear energy to our public representatives, so they can act in the best balanced interests of all. Ed Johnson is moving ahead on this.

This is your opportunity to get active and involved. We need your help. Volunteer for one of the PIC Bureaus.

Speaker's Bureau

Where's the speaker? What's on your mind? Share your private discussions. Sign up with the Speaker's Bureau. Only one response has been received to date from a membership of 680. We in the INMM are not carrying our load with the rest of the pro-nuclear groups. Come on gals and guys; sign up if you can. Give your thoughts for a charter for the Speaker's Bureau. If you can't sign up, send your thoughts in anyway. We need ideas, participants, etc., but mainly your show of interest. — **T. J. Collopy**, UNC Naval Products, 67 Sandy Desert Road, Uncasville, CT 06382 (203-848-1511).

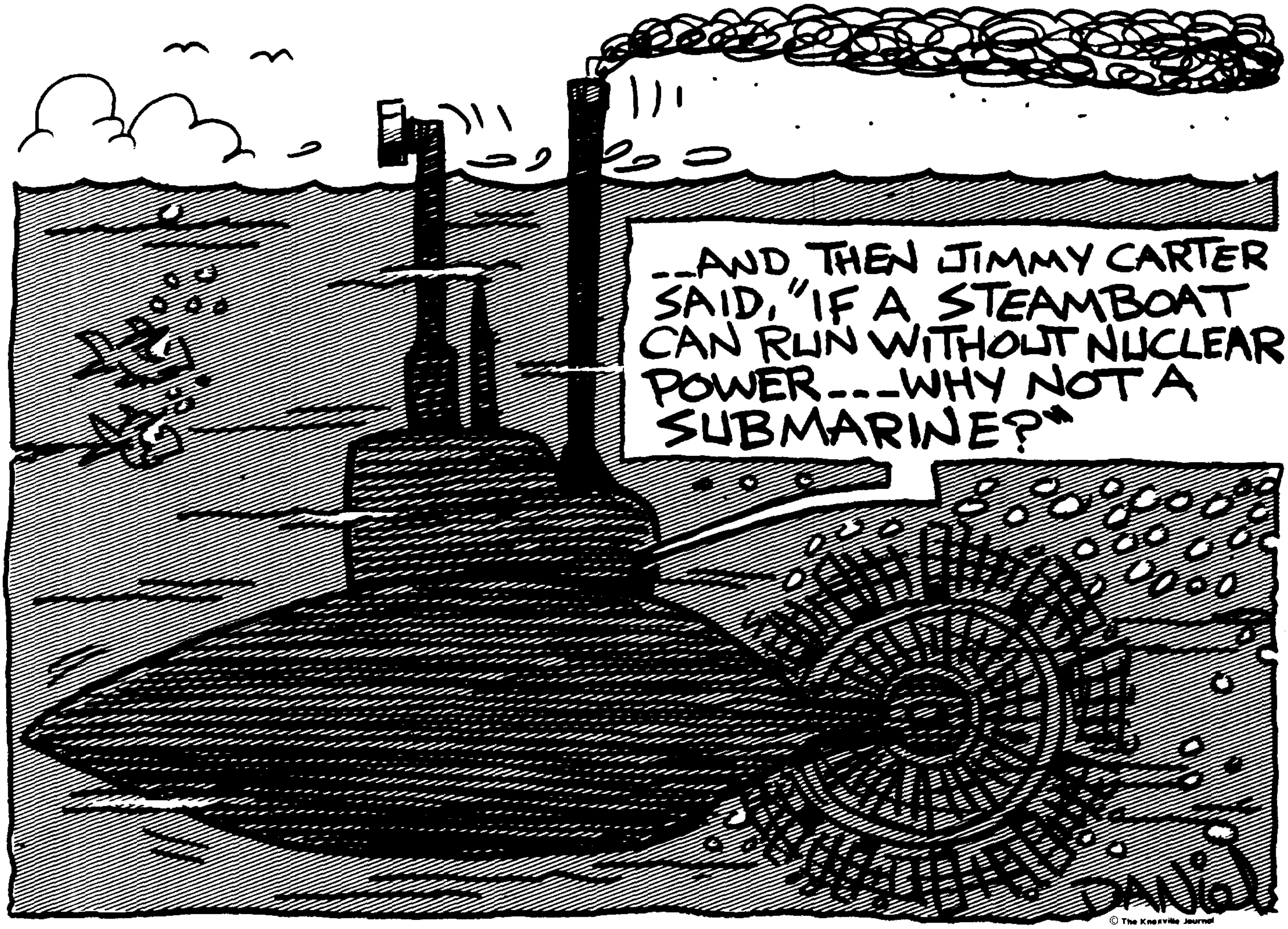
Congressional Information Program

The Communications Bureau has initiated its program for communication with members of Congress and their staff personnel since its initial announcement in the last issue of the Journal of the Institute. The first action that was taken was to develop basic sources of information on Congressional and state legislative activities. This has been accomplished inasmuch as the **American Nuclear Energy Council** has agreed to make available its listings of pending Congressional legislation and voting records thereon by individual members of Congress. In addition, it was determined that the **Atomic Industrial Forum** has been maintaining a record of all state legislative actions and their status; an effort is being made to obtain routine access to this list in the event that our current program is expanded to include state legislative activity.

The following types of Congressional legislation (total of 110 bills) were introduced.

1. Antitrust — 6 bills.


Miller



2. DOE Authorizations/Appropriations — 11 bills.
3. International Nuclear Policy — 4 bills.
4. Intervenor Funding — 7 bills.
5. Licensing — 1 bill.
6. Low-Level Radiation — 3 bills.
7. Moratoria — 7 bills.
8. NRC Authorization — 3 bills.
9. Reorganization — 3 bills.
10. Safety/Reliability — 27 bills.
11. Transportation — 6 bills.
12. Uranium Mining/Lands — 6 bills.
13. Waste/Spent Fuel — 24 bills.
14. Miscellaneous — 2 bills.

This clearly demonstrates the degree of awareness of the Congress in nuclear matters. Concern for nuclear safety has doubtlessly arisen from the TMI incident, but waste disposal remains a continuing issue. Proposed legislation on waste disposal ranges from mandatory state approval (or at least concurrence) on sites for waste disposal to mandating positive action on the part of DOE to establish necessary storage and disposal facilities.

Intervenor funding continues to be an issue and, although its attractiveness to Congress at the present time does not appear to be great, its supporters are relentless in their support. More bills on intervenor funding can be expected this year. In addition there is some indication that intervenor funding by NRC may be volunteered in select instances on a trial basis.

The year 1980 should prove to be even more active for nuclear legislation. It is important that the knowledge and views of INMM members be conveyed to their respective Congressmen to aid them in making informed judgements on nuclear matters. — **E. R. Johnson** (703-471-7880).

NOTABLE NOTES AND QUOTES

Developed Nations Viewpoint:

Susan Page. "Last year, for the first time since the first nuclear plant began operation in 1957, the proportion of the nation's electricity generated by nuclear power fell. "I guess you could say it's pretty grim for the industry," said **Scott Peters,** a spokesman for the Atomic Industrial Forum. He said the trend probably was temporary, and would perhaps ease within a year.

Richard Pollock, director of **Ralph Nader's** Critical Mass Energy Project, said the trend could be permanent and probably would last at least through the decade. "The fact of the matter is national utility executives and power plant analysts are realizing that there are too many financial, safety and environmental problems with nuclear power plants," he said.

"The expansion of nuclear power has become an issue in other countries, too. Sweden is scheduled to hold a referendum in March on whether to put into operation several reactors already built; the Danish government has agreed to hold a referendum before deciding whether to start developing nuclear energy. Nuclear plant construction has been delayed in West Germany, Switzerland, Italy, Spain and Austria.

But France and Japan are continuing to develop nuclear energy, and Great Britain is planning to expand its nuclear energy program. There are 166 nuclear plants now in operation around the world, according to unpublished figures collected by the Atomic Industrial Forum, with 156 under construction and 266 more ordered or planned."

Newsday, February, 1980

Communist Nations Viewpoint:

Eric Morgenthaler. "The U.S.S.R. is fully in favor of nuclear power and would be so even if the dangers were considerably more serious than in fact they are," said a recent commentary by **Kuzma Davidov**, a Soviet journalist.

Moscow's allies share that view. A trade official from Czechoslovakia, for instance, calls nuclear power "virtually the only source" of increasing his country's output of electricity. A Hungarian official declares that his country expects nuclear energy to supply half of its new power between 1981 and 1985. East Germany says it expects to get the "major part" of its electricity producing capacity after 1980 from new nuclear power stations.

Comecon, the Soviet bloc's economic alliance, is embarked on an ambitious program to increase its nuclear power generating capacity to 150 million kilowatts by 1990 from the present range of 15 million to 18 million. That would bring it close to the U.S. level, which is projected at 152 million kilowatts for 1990, up from the present 52.3 million.

Comecon's aim is for nuclear power to account for 25% of the electricity generated in the Soviet Union and Eastern Europe, in 1990, compared with only 4%. By contrast, nuclear power now accounts for 11.4% of the electricity produced in the U.S. and 8% of the production in the European Community."

Wall Street Journal, January 4, 1980

Developing Nations Viewpoint:

Dr. H. N. Sethna, India's Atomic Energy, Programme-Past and Future. "The "no growth" philosophy and curbing of consumption in the energy sector, which is being advocated for good reasons in some advanced countries, has no relevance in our socio-economic conditions. Although our per capita consumption of electricity is very low, the bulk of electrical energy is consumed either in industry or in agriculture. Domestic use of electrical energy is hardly 10%. A significant part of the energy input in India is

from the so-called non-commercial sources, such as firewood, which leads to deforestation on a large scale. Both economic and environmental factors would, therefore, dictate an increase in electrical energy consumption. It is perhaps for these reasons that we have not faced problems of public acceptance of nuclear power in India."

IAEA Bulletin, October, 1979, p. 11

Sigvard Eklund, IAEA's Director General. "In these countries there are citizens' groups who are not interested in further economic growth or technological development. They advocate new life styles by which it is implied that their own standard of living would be maintained and the quality of the environment preserved. It is not clear how the less fortunate human beings, either in their immediate surroundings or in the developing countries, will be able to improve their living conditions in such a 'no growth' economy."

Nuclear Industry, January, 1980

U.S. Viewpoints:

President Carter. "In response to his special Three Mile Island commission, President Carter embraced most of that panel's recommendations and then urged that nuclear-plant licensing resume as quickly as the Nuclear Regulatory Commission can put "its house in order."

"We do not have the luxury of abandoning nuclear power or imposing a lengthy moratorium on its further use," Carter said in a December 7 statement to the press.

Agreeing fully with "the spirit and intent" of the Kemeny commission, Carter asked relevant government agencies to implement "virtually all" of its recommendations — except for abolishing the NRC in favor of a single-administrator agency. That proposal was not supported by Congress, Administration officials said.

Instead, Carter said he will appoint a new NRC chairman, from outside the agency, and ask Congress to strengthen the chairman's executive power.

INFO, December, 1979

Ronald Reagan. "Ronald Reagan called for "wider use of nuclear power within strict safety rules" in a speech declaring his candidacy for the presidency in November.

A policy position paper available from the Reagan campaign headquarters elaborated on his view about nuclear energy: "The questions of safety must be met. These questions are now being looked at by a number of commissions. Whatever the results of these studies, there is no question but that we all want the utmost in protective measures," Reagan said.

But Reagan added, "It seems ironic that the nation which pioneered in nuclear energy is now beset with a national hysteria over nuclear energy and is lagging in its development. In my mind, we have no choice but to continue to operate and construct nuclear power plants if we are to meet the energy and job needs of Americans. I believe it offers our greatest hope for the solution of our energy problems over the next two or three decades."

INFO December, 1979

John Connally. "It is the cleanest source of power. It is the safest source of power," Connally said, adding it was necessary to reduce dependence on OPEC countries for fuel.

He said the United States must realize that there are only three sources of energy available for the remainder of the century — nuclear power, coal and oil and gas."

UPI

Dixy Lee Ray, Washington Governor. "Washington Gov. Dixy Lee Ray says ignorance is the main reason people fear development of nuclear power and opponents of its development use sentimental and emotional arguments rather than facts.

"Fear of nuclear radiation is based on ignorance."

"It is unfortunate that people who lack factual background and understanding in complex technology set themselves up as experts to speak from a sentimental or emotional point of view."

Associated Press, September 26, 1979

Regulations to Protect NRC Employees

The Nuclear Regulatory Commission is considering changing its regulations to strengthen protection for persons who provide information to the Commission in connection with their employment with an NRC-regulated organization or a contractor or subcontractor to such an organization.

The proposed amendments would:

(1) Expand the types of information for which Commission protection applies to include information on antitrust, safety and security matters, in addition to radiological working conditions;

(2) Apply the employee protection provisions not only to licensees but also to holders of construction permits, applicants for a license or permit and their contractors and subcontractors; and

(3) Require that licensees, construction permit holders and applicants post on their premises explanatory material on the prohibition against discrimination and the recourse for remedy available through the Department of Labor.

The revised regulations would implement a November 6, 1978, amendment to the Energy Reorganization Act of 1974, which added a new section on "Employee Protection." The new section identifies specific acts of employees as protected activities and prohibits employers from discharging or otherwise discriminating against employees who engage in those activities. It also gives the Department of Labor new authority to investigate an alleged act of discrimination and, if found appropriate, order reinstatement of the employee, with back pay and compensatory damages. The Department published regulations to implement this authority in the Federal Register on January 8, 1980.

John E. Barry Named Committee Vice Chairman

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

Barry Appointed Vice Chairman

John E. Barry of Gulf States Utilities Company, Beaumont, Texas was appointed Vice-Chairman of the Membership Committee February 1. John has been a very active member of the Committee since his appointment to it last year. He has some innovative and helpful ideas which should enhance the Committee's efforts to attract and continue to interest qualified potential members for the Institute. You will hear more about these plans in future columns.

Institute Continues To Grow

Since our last report, new memberships and renewals have grown to a total of 113 as of this writing. The Institute's activities and safeguards workshops, Annual Meeting, and topical conferences continue to spread its name in the nuclear industry as a dynamic and effective force in the nuclear field. You can help by sending the names of qualified friends and colleagues to **Tom Gerdis,** the Journal Editor, who will arrange for them to receive an invitation to join INMM.

New Members

The following 21 individuals have been accepted for INMM membership during the period December 1, 1979 through February 29, 1980. To each, the INMM Executive Committee extends its welcome and congratulations. New members not mentioned in this issue will be listed in the Summer 1980 (Volume IX, No. 2) issue to be sent out beginning August 1, 1980.

K. J. Bambas, Vice President, Allied-General Nuclear Services, P.O. Box 847, Barnwell, SC 29812, 803-259-1711.

David L. Bouse, Manager, Nuclear Materials Administration, Rockwell Hanford Operations, Energy Systems Group, P.O. Box 800, Richland WA 99352, 509-942-2680.

Gary J. Carnival, Nuclear Materials Control Specialist, Rockwell International, P.O. Box 464, Golden, CO 80401.

W. T. Carter, Superintendent, ND Finance and Budget, Union Carbide Corporation, P.O. Box P - ORDGP, Oak Ridge, TN 37830.

Susan S. Cathey, Engineer, E. I. du Pont, Savannah River Plant, Aiken, SC 29801.

Douglas R. Cavileer, Senior Technical Associate, NUSAC, Incorporated, 7926 Jones Branch Drive, McLean, VA 22102, 703-893-6004.

Howard E. Crowder, Engineering Supervisor, Union Carbide Corporation, Nuclear Division, P.O. Box Y, Oak Ridge, TN 37830, 615-574-2680.

John L. Darby, Staff Member, Sandia Laboratories, Albuquerque, NM 87185.

Philip E. Elting, Manager — Technical Programs, NUSAC, Incorporated, 7926 Jones Branch Drive, McLean, VA 22102, 703-893-6004.

Neil L. Harms, Senior Research Scientist, BATTELLE, Pacific Northwest Laboratories, P.O. Box 999, Richland, WA 99352.

Thomas L. Hebble, Statistician, Nuclear Division, Union Carbide Corporation, Computer Sciences, Bldg. 9704-1, P.O. Box Y, Oak Ridge, TN 37830.

John L. Holst, Technical Operations Manager, Pu Records, Rockwell International, P.O. Box 464, Golden, CO 80401.

Douglas R. Kunze, Senior Technical Associate, NUSAC, Incorporated, 7926 Jones Branch Drive, McLean, VA 22102, 703-893-6004.

Laura Ann Liles, Nuclear Materials Specialist, Los Alamos Scientific Laboratory, MS 324, Los Alamos, NM 87545, 505-667-5886.

Dr. Dennis L. Mangan, Technical Staff Member, Sandia Laboratories, Div. 1759, Albuquerque, NM 87185, 505-844-2850.

Dr. Warren J. McGonnagle, Physical Scientist, U.S. Department of Energy, New Brunswick Laboratory, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439.

Arne E. Penttila, Specialist, Nuclear Safeguards, BATTELLE, Pacific Northwest Laboratories, P.O. Box 999, Richland, WA 99352, 509-375-2054.

Dr. John A. Rorabacher, Manager, Environmental Assessments Division, NUSAC, Incorporated, 7926 Jones Branch Drive, McLean, VA 22102, 703-893-6004.

Benjamin J. Slone III, Engineer, Gulf States Utilities, Riverbend Station, Route 5-B, Box 980, St. Francisville, LA 70775.

Lee

Barry

Melvin A. Soper, Jr., Senior Intrusion Alarm Engineer, Vitro Engineering Corp., P.O. Box 296, Richland, WA 99352, 509-942-6969.

Robert S. Walker, Staff Consultant, International Energy Associates, Ltd., 600 New Hampshire Avenue, N.W., Suite 600, Washington, D.C. 20037, 202-338-8230.

Address Changes

The following 16 changes of address have been received by the INMM Publications Office (Phone: 502-895-3953 via FTS Oper. 352-5011) at P.O. Box 6247, Louisville, KY 40207, as of February 29, 1980.

Wendell L. Belew, 8 Brookline Avenue, Aiken, SC 29801.

Robert U. Curl, Safeguards and Materials Management, EG&G Idaho, Inc., P.O. Box 1625, Idaho Falls, ID 83401.

Dan Heagerty, P.E., Power Services, Inc., 2162 Credit Union Lane, Suite 4E, North Charleston, SC 29406.

R. Davis Hurt, Oak Ridge National Laboratory, P.O. Box X, Bldg. 7601, Oak Ridge, TN 37830, 615-574-7137.

Robert A. Kramer, Nuclear Fuels Engineer, Northern Indiana Power Service Co., RR 3, Box 501, Chesterton, IN 46304, 219-787-8531.

Victor W. Lowe, Jr., L-300, Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, CA 94550.

Herman Miller, National Nuclear Corporation, 1904 Colony Street, Mountain View, CA 94043, 415-962-9220.

G. F. Molen, Savannah River Laboratory, Bldg. 773-11A, Aiken, SC 29801, 803-450-1058.

Dr. Francis A. O'Hara, International Atomic Energy Agency, P.O. Box 200, A-1400 Vienna, Austria.

James P. Patterson, 317 Oak Street, Elmhurst, IL 60126.

William Powers, Safeguards Manager, Babcock & Wilcox Company (CNFP), Nuclear Materials and Manufacturing Division, P.O. Box 800, Lynchburg, VA 24505.

Thomas J. Schmierer, 5010 Crownpoint Court, N.W., Albuquerque, NM 87120.

D. B. Sinden, 6068 Voyageur Drive, Orleans, Ontario, Canada K1C 2P6 Canada.

Julia M. Smith, Brookhaven National Laboratory, Bldg. 130, Upton, NY 11973.

Dr. Fred H. Tingey, University of Idaho, Idaho Falls Center for Higher Education, 1776 Science Center Drive, P.O. Box 778, Idaho Falls, ID 83401, 208-526-9637.

Samuel Untermyer, National Nuclear Corp., 1904 Colony Street, Mountain View, CA 94043, 415-962-9220.

Fourth Loss of Fluid Test (LOFT) at Idaho Site

The fourth in a series of nuclear tests in the LOFT (Loss of Fluid Test) reactor was conducted on February 6 in Idaho.

The test simulated the events which would follow a break in a small pipe connected to a large pipe supplying cooling water to the nuclear fuel core. The 50-thermal megawatt LOFT reactor, located at the Department of Energy's Idaho National Engineering Laboratory, is operated by EG&G, Idaho.

The experiment began with the opening of a valve, simulating a small pipe break. At initiation of the break, the reactor was shut down and the primary coolant pumps also were shut down. Steam and water were slowly discharged throught the break to a suppression tank where the steam was condensed. In response to changing system pressure, emergency core cooling (ECC) systems were activated, as expected.

Throughout the experiment, which lasted about seven hours, instruments recorded water levels, pressures, fuel-rod temperatures and coolant flow rates. Initial results indicate that all significant events of the experiment occurred in the expected sequence, although the precise conditions differed somewhat from those predicted. The primary system pressure dropped lower than predicted during the first 500 seconds of the test. The ECC systems worked as designed and prevents uncovery of the reactor core. The reactor vessel water level was observed to fall initially because of the break and then recover due to the action of the ECC systems and the control room operator. Extensive analysis of the test, including detailed comparisons with computer model predictions, will continue for several months.

The test was the second small break experiment in the LOFT reactor, the largest facility in the NRC's program of confirmatory research designed to study the effectiveness of systems intended to provide emergency core cooling for light water-cooled reactors in the event of a pipe-break accident. Data from the experiments in this research program are being used to help predict the performance of ECC Systems in large reactors, and increase the NRC's ability to confirm independently the margins of safety that have been estimated during licensing reviews.

Austrian, Finnish, German and Japanese scientists, on assignment to INEL, observed the experiment and will assist in the detailed analysis of the test.

Nuclear experiments in LOFT are expected to continue with a variety of pipe break sizes and locations; other types of accidents also will be studied.

NRC Considers Limiting Simultaneous Nuclear Shipments

The Nuclear Regulatory Commission is considering changing its regulations to allow the agency to order a delay in the dispatching of one or more shipments of special nuclear material of moderate strategic significance when there is a possibility that two or more shipments enroute at the same time might together contain what is known as a "formula quantity" of the material.

A "formula quantity" is 5 kilograms or more of high-enriched uranium-235, 2 kilograms or more of plutonium or uranium-233, or a combination of these elements. More stringent precautions to guard against theft or diversion are required for these quantities.

Special nuclear material of moderate strategic significance includes (1) between 500 grams and 2 kilograms of plutonium or uranium-233, (2) between 1 and 5 kilograms 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%.

Current NRC regulations prohibit a single licensee from having enroute at any one time a formula quantity — unless certain conditions are met to safeguard the shipments. The proposed new regulations would allow the NRC to enforce a similar prohibition against multiple shipments by different licensees.

The Commission believes that implementation of the proposed amendments would help to (1) ensure that a formula quantity of special nuclear material could not be lost or stolen while in transit and (2) prevent the loss of additional material to an adversary before an accounting of an original lost shipment has been made.

Chapter Holds Successful Conference, Membership Total Reaches 45

The executive committee meeting of the INMM Japan Chapter was held on February 15. It was reported that 45 members are currently registered at the Japan Chapter and efforts are being taken to increase memberships. In view of the success of the general conference held in September last year, another general conference is being planned this year. The exact dates are not yet settled, but it will be at the end of September or beginning of October. The emphasis of the next general conference will be on the execution of safeguards programs and on practical experiences.

Three articles were contributed to the INMM journal in the past year: IAEA safeguard experiences at the Japanese facility, summary of titles and abstracts of Japanese safeguards publications and safeguards system in Japan.

Contributions to the INMM journal will be encouraged and the Japan Chapter will take action for soliciting contributions to the Journal by Japanese nuclear fuel fabricators, national nuclear energy organizations, utility companies, and equipment manufacturers. The Japan Chapter will take an active participation in the next INMM general conference to be held in Palm Beach, Fla.

Summary of the First General Conference of the Japan Chapter

The first General Conference of the INMM Japan Chapter was held on September 28, 1979 with the registrations of over 100. The participants came from varieties of organizations including national nuclear institutions such as JAERI, PNC and Nuclear Ship Propulsion Agency, universities, nuclear fuel fabricators, electric power companies, nuclear equipment manufacturers, computer companies and electric machinery companies.

The meeting was started with the introductory speech by the program chairman, Mr. **R. Kiyose,** followed by the speech by the chairman of the INMM Japan Chapter, Mr. **Y. Kawashima** and the report of the 20th INMM general conference by Mr. R. Kiyose.

The presentations of the first general conference of the INMM Japan Chapter covered policies and administration, technical matters and practical experiences.

Safeguards system in Japan was reported by Mr. Morishita of the Science & Technology Agency. He described historical development and gave a clear description on the situation in which Japan is placed. He emphasized the need for the active and sincere cooperation by Japan with NPT.

The safeguards programs and its practical experiences at the PNC were described by Mr. Shibata. Mr.

Professor and Mrs. Ryo Kiyose of the University of Tokyo and Dr. Kentaro Nakajima (right), Director of the PNC Fuel Reprocessing Plant at Tokai Mura Japan, enjoyed themselves at the Chairman's Reception at Albuquerque. Prof. Kiyose is Vice Chairman of the INMM Japan Chapter and Dr. Nakajima is a member of the Executive Committee.

Gotoh of Japan Electronic Instrument Co. gave a detailed description on the equipment and facilities for nuclear safeguards programs.

A special lecture entitled "nuclear materials management and international affairs" was given by Mr. Imai of Japan Atomic Power Co. His lecture traced back to 20 years ago when IAEA member Mr. Smith emphasized the necessity of material accounting at the seminar held in Japan. His lecture gave a historical description on the technological development of materials accounting and safeguards programs and raised a question relating to the technological aspects of INFCIRC/153. Mr. Imai emphasized a need for the technological improvement of material accounting and safeguards methods currently being employed and also for the study of international political climate.

Three reports dealing with safeguard technologies were followed: Description of RECOVER system by Mr. Kuroi of JAERI; Information treatment and software program by Mr. Kono of Japan Computer Bureau; and material accounting and safeguard system at Japan Nuclear Fuel by Mr. Osabe.

At the end, Mr. Koizumi of PNC gave a report on the progress of the joint TASTEX project between Japan, U.S.A., France and IAEA.

The first general conference of the INMM Japan Chapter has caused a strong interest among Japanese nuclear specialists in technological and administrative aspects of nuclear materials management, and also in the activities of the INMM Japan Chapter.

Chapter Seeks to Provide Info Exchange in Hanford Area

One of the objectives of the Pacific Northwest Chapter of INMM is to provide information exchange between the many varied nuclear components in the Hanford area. At least four programs are planned during the calendar year to help achieve this goal.

The fall dinner meeting was held on October 24, 1979. Approximately 55 people attended the session. Program chairman for the event was **Etoy Alford**, Washington Public Power Supply System (WPPSS). A program on the "WPPSS Hanford Projects and Nuclear Safeguards" was presented by **George F. Bailey**, Manager, Technical Division, WPPSS.

On February 28, 1980, Dr. **Roy Nilson,** Exxon Nuclear Company, Inc., Richland, was program chairman for the winter dinner meeting. The guest speaker was Dr. **Harold Forsen,** Vice President and Executive In Charge of Laser Enrichment, Exxon, Bellevue. Dr. Forsen spoke on "Laser Enrichment and its Nonproliferation Aspects."

Barbi Wilt has been named Chairman of the Chapter's Public Affairs Committee. She will provide the single-point-of-contact for the Pacific Northwest Chapter activities. She may be reached at P.O. Box 634, Richland, WA 99352 or by phone FTS: 444-7461 (commercial 509-942-7461). [Please note, that phone number will change when General Telephone initiates a new phone system in the Richland Federal Building or about May 1980.

Officers of the Pacific Northwest Chapter of INMM posed for this photo recently. Seated (l. to r.) — Bill DeMerschman, founding chairman; Roy Nilson, chairman; and Barbara Wilt, secretary-treasurer. Standing (l. to r.) — Curt Colvin, Etoy Alford and Dean Engel of the chapter executive committee; and Bob Sorenson, vice chairman.

Chapter Begins Monthly Meetings

The dust and commotion of the move to our new premises having subsided and having been replaced by the normal hubbub of the I.A.E.A's. daily activities, the Executive Committee has had time to take stock of the position and to plan for the future.

A monthly luncheon meeting was instituted in January, 1980 and action is under way to assure an interesting and informative programme for the meetings. By the time you read this, we shall have met again in February and March. At the February gathering, Mr. Hirata has been invited to speak on the activities of our fraternal Chapter in Japan. In March we are hoping to be honoured by the presence of **John Jaech** at our meeting and we may be successful in persuading him to address us, while the April meeting will, it is hoped, be graced by the personality of **Bob Keepin** who might be able to give some of his time to update us on INMM happenings in the U.S.A. which are of interest to our members.

We are fortunate in that **Frank O'Hara** of the Executive Committee of the Institute has joined the Department of Safeguards, I.A.E.A., to work in the Systems Studies Section of the Division of Development and Technical Support. Frank's experience and advice will be of great help to us in the Chapter.

Our membership continues to increase; it now totals 46 as of the moment of writing. We are a vigorous and thriving offshoot of our parent stem and it behooves us to develop our activities to a pitch that will sustain the enthusiasm and the support of our members.

A letter from Vienna would not be complete without a reference to the weather. Will, today the sun is shining out of a clear sky and from my eyrie I can see clear across this corner of Austria into our neighbouring land, Czechoslovakia: the skiers' prayers have been answered — (O Lord, let it snow — but only in the mountains!): and the summer sportspeople are already sniffing the air knowledgeably and declaring Spring to be just around the corner. I hope they're right! — **Iain Hutchinson** — Vienna, 22 February, 1980.


Hutchinson

INMM Workshop Held On Intrusion Detection Systems

By T. A. Sellers, Chairman
INMM Technical Group on
Physical Protection
Sandia Laboratories
Albuqerque, New Mexico

Over 60 people attended the INMM Workshop on Exterior Intrusion Detection Systems, sponsored by the Technical Group on Physical Protection, held December 5-7, 1979 at the Grenelefe Resort in Cyprus Gardens, Florida. Special thanks go to **J. D. Williams,** Sandia Laboratories, and to **Mark Elliott** and **Bob Walker**, International Energy Associates Limited (IEAL) for their assistance in making meeting arrangements, as well as **Bill Myre**, Sandia Laboratories, for his excellent opening talk. Each of the session moderators also did an outstanding job in making major contributions to the successful outcome of the Workshop.

The Workshop, the first to be held under the sponsorship of the INMM Technical Working Group on Physical Protection, began on the evening of December 5th with a registration and "get acquainted" cocktail party. It was encouraging to see many new faces interested in INMM physical security activities as well as some that have been involved for several years. Participants represented a wide range of organizations including government agencies, commercial engineering and consulting firms, and electric utilities including a strong contingent from Ontario Hydro, Toronto, Ontario.

Following a moderator's breakfast on December 6th, all participants met in a general workshop orientation meeting where Bill Myre delivered a talk on the historical evolution of intrusion detection sensors and the importance of integrating intrusion detection component into the overall Physical Protection System. Following this general meeting, the participants separated into eight separate workshops for the remainder of the day and then into another four sessions the next morning. The sessions were conducted by individual volunteer moderators.

Prior to the meeting each attendee had been asked to rank order their preference of topics from a broader list than those actually covered at the workshop. The preference list was used by the Program Committee to finalize the program, select Session Moderators, and schedule the separate workshop sessions for minimum conflict of the interest areas.

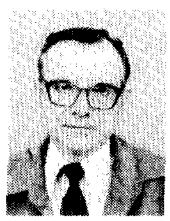
Representing a broad spectrum of interests in physical security, the workshop participants engaged in one and a half days of intensive group discussions on a range of topics related to exterior intrustion detection systems including:

- Performance and acceptance testing of various sensors;
- Alarm annunication;
- Application problems;
- Installation of new and updated systems; and
- Maintenance and repair.

There were a total of 12 workshops, each attended by 12-20 persons. Workshops I through III involved discussions and interchange of information on various aspects of performance and acceptance testing. Workshop I, moderated by **John Hoover,** Arvin/Diamond, discussed testing methods for microwave and electric field sensors. These methods include dragging spheres across the zones, walk testing, and running through the zones. Workshop II, moderated by **Mel Perkins**, Sandia Laboratories, addressed fence

Typical Working Session.

Sellers



Williams

Myre

NRC Names Kendrick Division Director

Dr. **Hugh Kendrick** is the Director of the Nuclear Alternative Systems Assessment Division in the U.S. Department of Energy. He manages programs directed toward formulation and implementation of energy development policies and strategies with emphasis on commercial feasibility, environmental acceptability and nonproliferation. He is responsible for the U.S. Nonproliferation Alternative Systems Assessment Program (NASAP) which also supports the U.S. sponsored International Nuclear Fuel Cycle Evaluation (INFCE) studies.

Dr. Kendrick received his early education in England and graduated with a first class honors degree in Mechanical Engineering from Imperial College at the University of London in 1961. He obtained an M.S. degree in Mechanical Engineering from Cal Tech in 1962 and returned to England to complete his apprenticeship with Vicker-Armstrong (Aircraft) Ltd. He came back to the U.S. and obtained his Ph.D. in Nuclear Engineering from the University of Michigan in 1968, where he conducted solid state physics research on the magnetic properties of materials. He discovered the first order maganetic phase change in chromium.

He joined the Linear Accelerator Division of General Atomic and worked in neutron and gamma ray transport. He developed and implemented novel nondestructive assay methods for the safeguards and quality control of the first core for the Fort St. Vrain HTGR.

He joined Science Applications, Inc. in 1972 and moved to Washington, D.C. in 1973. He has led multidisciplinary teams of engineers, economists and scientists in conducting environmental assessments, inflationary impact assessments, cost-benefit and risk-benefit analyses for many federal agencies including the Occupational Safety and Health Administration, Bureau of Radiological Health, EPA, NRC, NSF and ERDA. The assignments have generally focused on the assessment of different energy sources and production impacts.

Kendrick

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mounted and buried-line sensors, devoting much of the workshop to a discussion of ported coaxial cables. Workshop III, chaired by **Carl Smith**, Sandia Laboratories, discussed all sensors and noted concern over the lack of testing and acceptance criteria in general. The group recommended that some central source establish basic guidelines for performance and acceptance procedures.

Workshop IV, moderated by **Dutch von Ehrenfried**, International Energy Associates Limited, discussed three facets of alarm annunciation: man machine interface, computer graphic displays, and annunciator and display logic. The group identified a lack of human factors engineering in most central alarm station designs and noted that this is an area for future improvement.

Workshops V through VII focused on application problems. Workshop V, chaired by **Bob Woods**, Bettis Atomic Power Lab, discussed microwave and buried-line senors, and in particular, problems associated with ported coaxial cables. Workshop VI, moderated by **Ted Aichele,** Rockwell Hanford, addressed electric field and fence mounted sensors, and in particular, sensitivity, nuisance alarms, and the quality of some electrical terminators which have experienced problems. Workshop VII, moderated by **Frank Leslie**, Harris Government Information Systems Division, discussed all sensors in general, especially combinations of sensors. The group noted a need for better maintenance manuals and the importance of determining the nature of false alarm sources. In addition, improvements toward making console and computer operation simpler for security force personnel in the central and secondary alarm stations were discussed. Workshop VIII, led by **Mike Eaton**, Sandia Laboratories, addressed application problems, in particular, degradation of performance from environmental effects. The group also identified a need for an effective underwater sensor.

Workshops IX through XI were devoted to installations, both new and updated. Workshop IX, moderated by **Debbie McDaniel**, Columbia LNG, discussed aspects of microwave and electric field sensors. Workshop X led by **Dave Hayward**, Sandia, focused on fence mounted and buried-line sensors, and Workshop XI, chaired by **Mel Soper**, Vitro Engineering, discussed all sensors in general. This group noted a need for implementing guidance relative to protection for water intake areas.

Workshop XII, moderated by **Joseph Harper**, Virginia Electric and Power Company, discussed maintenance and repair, emphasizing the need for preventive maintenance and general housecleaning in order to reduce nuisance alarms, provide reliable operation, and to establish a maintenance history for future use.

A summary session for all participants was held in which each moderator presented the highlights of the items discussed during their particular workshop. The summaries were typed and distributed to all attendees within a few weeks after the workshop. Copies of these summaries are available from the Chairman of the INMM Technical Group on Physical Protection (505-264-4472).

Judging by the written responses of the participants, the workshop was a genuine success. As mentioned before, since this was the first Workshop sponsored by INMM Technical Group on Physical Protection, this was particularly gratifying. It is the intention of the Technical Group to continue to hold such workshops and to increase their activities in the coming year.

Special Report

Summary of International Conference On NDE/NDA in Salt Lake City

By Dr. V. Hary Charyulu
Idaho State University
Pocatello, Idaho

The Third International Conference on Nondestructive Evaluation in the Nuclear Industry was held February 11-13, 1980 in Salt Lake City, Utah, USA. About 300 persons from several countries were in attendance at the technical sessions covering important topics and areas of controversy such as: NDE System Optimization, Accoustic Emmission, Ultrasonics, Advanced NDE Techniques and Applications, Radioactive Material Assay and Measurement, Fuel Quality Control, Standards, Reliability and Probability, and Inservice Inspection. A plenary session on the second day of the conference received special compliments from the attendees, as U.S. Senator **James A. McClure** addressed the group on the issues facing the nuclear industry today. The lack of energy policy both at a national level and at international levels, as well as the political issues plaguing the proper execution of waste management programs, and the role of NDE in the fuel cycle were some of the issues he alluded to.

The keynote address, by **Carl Walske** of Atomic Industrial Forum, reviewed the situations and laxicity which led to the Three-Mile Island incident and its subsequent impact on regulatory activities, training of reactor operational staff, public image of nuclear energy, and the role of NDE in the nuclear industry.

An overview session set a stage for the conference by discerning the topics: NDE as a reliable flaw detection technique, degree of reliability realized by NDE for performing safety analyses (especially in regard to catastrophic failure of reactor components), periodic inspection of fuel assemblies and fuel rods to ensure safe and reliable operation of nuclear fuel and cladding; and problems involved in the transfer of NDE technology from laboratories to field inspection. Techniques considered under NDE Systems optimization ranged from ultrasonic-RF signal analysis to reconstruction of three dimensional holographic images while topics considered were improving the signal to noise ratio and analysis of data. Several authors discussed the various techniques utilized in the surveillance and periodic inspection of nuclear power plants and systems, with special references to PWR's, BWR's, NSSS, piping and welds. A stimulating discussion ensued when the utilities view points on preservice and inservice inspection were presented. The session on NDE Standards was very stimulating as the papers presented made a comparison of standards among various countries and a discussion of the problems encountered in complying with the standards. Another set of informative papers were presented in the session on Codes and Reliability-Realibility and Probability where Round Robin UT results of PISC and PVRC were presented.

A considerable amount of work is in progress in many countries of the world in the area of nuclear fuel quality control and the application of both non-destructive assay (NDA) and non-destructive evaluation (NDE) techniques in the nuclear industry. There was a full session devoted to reports on the methods, in-plant experiences, and results from some of the leading international programs in these areas. The importance of NDA, NDE and fuel quality control stems not only from the financial impact, but also from the need to improve the safety and performance of nuclear power reactors. Advances in both conventional and novel techniques of NDE were discussed two separate sessions and their applications were reported in two other sessions. Some of the advances reported on the techniques of accoustic emmission, X-rays, eddy current, magnetic analysis, ultrasonics and neutron radiography. The final session of the conference was an overview session that gave a summary of work being carried out at various U.S. agencies, such as, the Department of Energy and Department of Transportation.

This conference was sponsored by the American Society for Metals in cooperation with American Nuclear Society, American Society for Nondestructive Testing, German Society for Nondestructive Testing, Institute of Nuclear Materials Management, and the Iron and Steel Institute of Japan. Proceedings of this conference will be published by American Society for Metals, Metals Park, Ohio, 44073.

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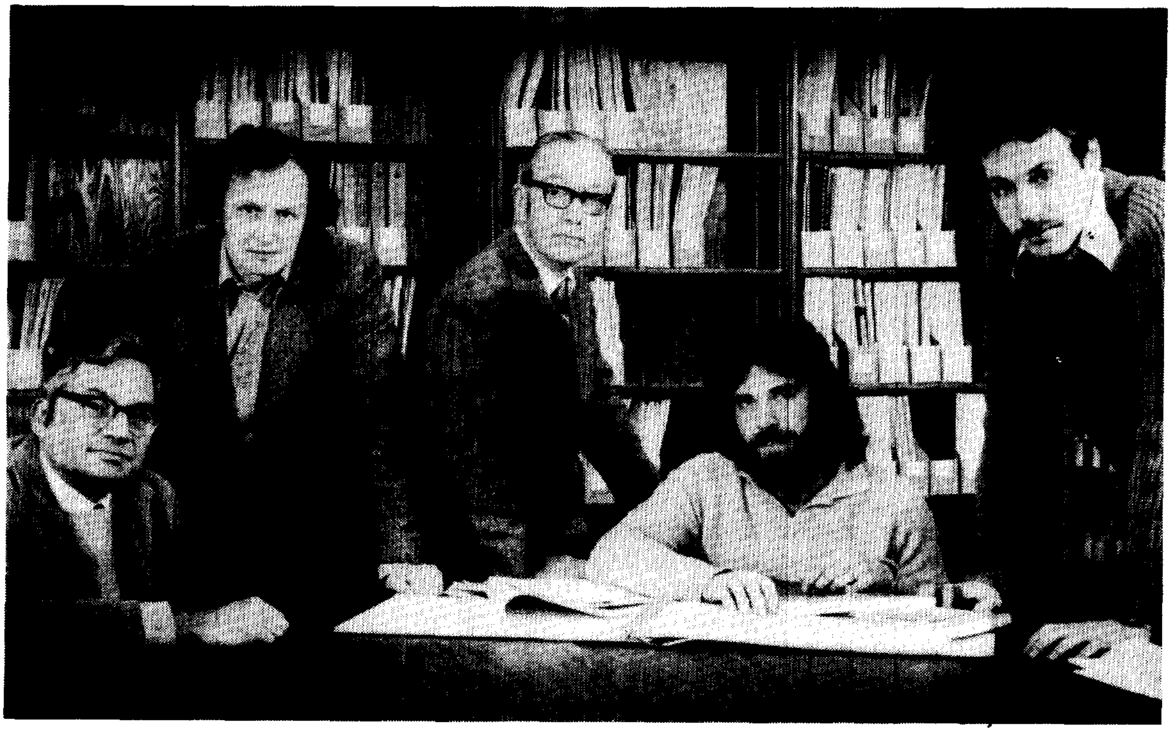


Various staff members with the Technical Support Organization for Nuclear Safeguards at Brookhaven National Laboratory have contributed to the Book Review Section of this journal. The section editor is *Eugene Weinstock* (left). Other contributors (from left) include Tony Fainberg, Willy Higinbotham, John O'Brien and Jonathan Sanborn. Dr. Higinbotham, recipient of the 1979 INMM Distinguished Service Award, is Technical and Editorial Page Editor of *Nuclear Materials Management*. The journal is grateful to these and other safeguards professionals who contribute so much to the technical and philosophical depth and strength of the INMM quarterly publication.

BOOK REVIEW

Review for the INMM Journal . . . Review of "Nuclear Power," James J. Duderstadt, Marcel Dekker, Inc., New York, 1979, ix 388 pp. $27.50 — By Eugene V. Weinstock.

As the energy crisis has commanded more and more attention in recent years, energy has become an increasingly popular subject for study in universities. This, in turn, has stimulated the publication of numerous textbooks on energy in general or on some special aspect of it. The present work, by Professor Duderstadt of the Department of Nuclear Engineering of the University of Michigan, is one such example.

The preface gives as the main purpose of the book "to provide the reader with a sufficient understanding of the technical aspects of nuclear power generation so that he can rationally assess the role that this energy source will play in his particular field and in our society in general." The author also hopes that it will be useful to policy makers who want "more than a superficial understanding of nuclear power generation."

The rather broad audience it is directed at therefore includes college undergraduates and graduates in a variety of disciplines, non-scientists, politicians, and government bureaucrats. Since at least some members of the INMM fall into these categories, and since all members, presumably, are interested in nuclear energy, the book is an appropriate one to review in this space.

The first of its nine chapters consists of an introduction to the energy crisis, a discussion of the criteria for acceptability of energy sources (economic, environmental, safety, etc.), and a summary of the available alternatives. The author's biases come through at the outset. On page 3 he declares, without supporting arguments, that oil and gas prices should be deregulated, and a few pages later describes the safety record of nuclear power as "spotless." Uranium mining is termed a "small radiological hazard," while it is hinted darkly that solar reflectors may influence the environment through the increase in reflectivity; no data are given in either case.

An earnest but superficial account of the development of nuclear power and the growth of its opposition is given in chapter 2. The attitude towards anti-nuclear critics ranges from patronizing to hostile and contemptuous; they are characterized as uninformed, emotional, and vociferous, charges that are certainly true of some but by no means of all of them, but which, in any case, have no place in a supposedly objective textbook. In his eagerness to flay the critics, the author trips himself up on at least one occasion, when, first, he charges them with being opposed to social change and then, in the very next paragraph, with using opposition to nuclear power as "a vehicle for forcing major social change." Unfortunately, in the wake of the Three Mile Island accident (which presumably occurred too late to affect the contents of the book), both the safety record and economics of nuclear power lose some of their luster; thus, although as claimed in the book, nuclear power may have saved over $2 billion in electric generating costs in 1977, the total cost of the TMI accident, including that of replacement power, may well exceed this. On the other hand, a valid point is made that the very abundance of data on nuclear health, safety, and environmental effects makes it more, rather than less, vulnerable to attack than other sources of power.

The basic concepts of atomic and nuclear physics necessary for an understanding of fission and fusion are reviewed in Chapter 3. Nuclear stability, radioactivity, nuclear reactions, fission, criticality, and controlled thermonuclear fusion are among the topics covered. The treatment is necessarily sketchy, but unnecessarily sloppy. Terms like "islands" of light and heavy fission fragments (in a discussion of a chart of the nuclides), tonnes, MWt and MWe, and neutral injection (in a table on thermonuclear reactions) are used without defining them, the concept of radioactive half life is mangled by assertions that it takes U238 "roughly" 4x109 years to decay and that tritium will decay "after a period of about 12 years", which implies that it is stable until then, the reader is assured that "naturally occurring elements are actually a composition of several isotopes", as though mono-isotopic elements like fluorine and gold were either artifical or nonexistent, and the product of the half life and decay constant of a radionuclide is given three times simply as 0.672, without identifying the numerical constant with the natural logarithm of 2, which is approximately 0.693, not 0.672. This is only one of many numerical errors that occur in the book.

In Chapter 4, the various aspects of nuclear fission reactors are described qualitatively in a straightforward way and the characteristics of the different power reactor types are briefly summarized. Another example of the careless and misleading use of language occurs in a discussion of fission-product decay heat, which, it is asserted, "appears after an appreciable time delay."

The biological effects of radiation are the subject of the next chapter. Units of dose and exposure are defined (did you know that there is an SI unit of dose called the **gray,** which is equal to 100 rads?) and some interesting data concerning sources of radiation in the environment and the sensitivity of various organisms to radiation are presented; from the latter, it would appear that bacteria, at least, would survive a nuclear war with relative impunity. There is, however, an unfortunate tendency to belittle the seriousness of radiation exposure. Thus, there is a half-facetious calculation of the dose rate from sunlight (approximately 104 rads/sec.), but since the photon energies are mostly too low to cause ionization in tissue the example would appear to be irrelevant; an inept analogy between radiation exposure limits and highway speed limits is drawn; and it is reported that a fetus "is considered" to be especially sensitive to radiation, as though that were a mere matter of convention rather than a hard scientific fact. Again, unexplained terms appear in the tables.

A long chapter is devoted to nuclear power generation. It includes a more detailed description of the different reactor types than appeared in chapter 4, and a comparison with fossil fuel generation. The treatment is very uneven. At times it's very general and at others unnecessarily detailed, as in the discussion of the "balance of plant" — i.e., the non-nuclear part of the plant — which is almost impossible to follow without a diagram but which, even with one, would probably be incomprehensible to anyone but a power engineer. The start-up of a reactor is also described in great detail, with lots of talk about "load following," but no real explanation of how it affects the turbine or the reactor. The singling out of these highly specialized topics for emphasis is puzzling, since no conclusions are drawn from the long discussions, although they certainly convey to the reader the impression that a power reactor is impossibly complicated. On the positive side, and somewhat surprisingly, there is an interesting discussion of the Price-Anderson Act. However, one of the main purposes of the chapter seems to be to mount an attack on regulators, environmentalists, and anti-nukes, one that, again, may be justified, but not in a textbook. The author's case is also weakened by exaggeration. For example, it is stated that nuclear reactors are designed against "every imaginable accident situation" and in such a way that "under no credible — or even incredible situation" — could radioactive material be released from the core. It is left to the reader to figure out how one goes about designing a reactor against incredible or unimaginable accidents.

The nuclear fuel cycle, a subject of the greatest interest to this readership, is covered in Chapter 7. Unfortunately, it is full of misstatements, unsupported assertions, and contradictions, in addition to more of the other kinds of sins mentioned in connection with the previous chapters. Thus, the numerical example used to support the claim that recycle of uranium and plutonium could reduce the uranium feed requirements by 40% actually works out to a savings of only 27%. Strong economic incentives are claimed for thermal recycle, without any hint of the existence of arguments in the last couple of years that it is only marginally economic. The urgency of solving the waste disposal is pooh-poohed by the astonishing assertion that "significant quantities of radioactive wastes will not be discharged from nuclear power reactors for decades" — yet, only six pages earlier the activity of a single spent-fuel element had been given as 2 million curies! In one place, it is maintained that terrorists would find it very difficult to build nuclear bombs, but a little later that in the absence of controls the risk of the use of such bombs would become unacceptably large. In the same discussion, the reader is assured that much of the information on weapons design is either classified or difficult to acquire, only to be informed shortly after that much of it is openly available in the literature. The development of laser separation techniques is first claimed to contribute no more to proliferation than that of the centrifuge, but in a subsequent passage we are warned that it could change the picture "dramatically", and "might have profound implications for nuclear weapons proliferation." On another occasion, the author commits the very sort of exaggeration which he deplores in the anti-nuclear critics when he suggests that only a "garageful" of centrifuges would be needed to separate U233 from denatured uranium. Some garage. Elsewhere, he warns that failure to supply countries with enrichment technology may drive them to construct Hanford-type production reactors — which is a little like suggesting we give them nuclear weapons to forestall clandestine manufacture.

The discussion of international safeguards is skimpy and unknowledgeable. IAEA inspections are described as "occasional", and the Indian explosion is said to have "signalled the failure of the Nuclear Nonproliferation Treaty". How this could be, in as much as India was not a party to the treaty, is not explained. It is also predicted that Taiwan, Israel, South Africa, Argentina, Brazil, Chile, Egypt, Iran, Pakistan, and Spain "will, in all probability", develop nuclear weapons. From the Indian example, it is concluded that international sanctions or disapproval are ineffective deterrents against proliferation, yet earlier it had been claimed that, except for Pakistan, international reaction to the explosion ranged only from "neutral tolerance to admiration". Finally, it is declared, without supporting evidence or arguments, that the rapid spread of nuclear power would make only a "relatively modest" contribution to proliferation.

The fusion alternative is explored in Chapter 8, which describes the various possible reactions and devices for containing them, such as magnetic mirrors, Tokamaks, and inertial confinement. It is concluded that fusion is afflicted with many problems, some of them similar to those of fission, and that, as a practical source of power, it is a long way off and likely to be much more expensive. Unfortunately, the explanations of the workings of the various fusion systems are apt to be more bewildering than illuminating to the student or other neophyte. Equations are introduced without derivation and, sometimes, without definitions of all the symbols in them. Often, as throughout the book, tables and figures do not correlate well with the text, and there are too many of those "milestone" charts so dear to the hearts of DOE bureaucrats (in fact, most of them are attributed to DOE).

The various energy alternatives — conservation, petroleum, coal, geothermal, solar, hydro, etc. — are considered in the last chapter. Not unexpectedly, except for solar domestic water and space heating, only coal and conservation, in addition to nuclear, are found to offer any hope for the near future. The environmental effects of coal — the emission, the waste-disposal problem, and the CO2-greenhouse effect — are discussed at some length but, as before, inconsistencies, errors, and omissions weaken the case. The chapter concludes with a strong plea for public acceptance of nuclear power and support for the rapid development of the breeder.

The writing style is poor, and sometimes downright irritating. There are grammatical errors, inept phrasing, and an occasional tendency towards overcuteness. Thus, on page 65 we read that "certain nuclei have an enormous appetite for neutrons, but after devouring them, suffer from a case of violent indigestion which causes them to fission." Gamma-ray emission accompanying neutron capture is described as "kind of (sic) a belch", and, in a diagram of the neutron economy, parasitic absorbers are described only as "junk". The author is also enormously fond of the word "enormous", which is sprinkled throughout the text, the record for the number of occurrences on a single page being seven. Sometimes it is modified by another favorite word of his, "rather", as in "rather enormous", a rather elusive concept. The author has been poorly served by his editor, assuming he had one.

It would be nice to be able to like this book. It does have certain strengths — it covers a wide variety of subjects, draws attention to many significant issues in the energy controversy, has an extensive and up-to-date bibliography at the end of some of the chapters, pinpoints some of the irrationalities of the nuclear debate, and emphasizes the importance of comparing risks of alternatives. Also, the author is on the right side of all the important issues. However, the book is so blatantly partisan and carelessly written as to undermine its credibility. It shows every sign of having been thrown together hastily from a set of lecture notes for a course, with a minimum of editing. It's too bad, because the position of nuclear power in our society today is too precarious to allow the luxury of badly written books in its favor.

Letter to the Editor

March 1, 1980
Thomas A. Gerdis, Editor
Journal of INMM
Post Office Box 6247
Louisville, KY 40207

Dear Mr. Gerdis:

The Winter Journal arrived with Harley's (**H. L. Toy**, Battelle Columbus Laboratories) article about Bill (see p. 3, Volume VIII, No. 4). It was very gratifying to know he is remembered. I would like to accept your thoughtful offer and ask for three additional copies for our children: Mrs. Susan M. Vistein, Oak Park, Ill.; Thomas C. Thomas, Columbus, Ohio; and William B. Thomas, Jr., Pittsburgh.

Sincerely,
Mrs. Mary G. (William B.) Thomas
Pittsburgh, Pa.

Editor's Note: Copies were sent to the W. B. Thomas children as requested.

New JAERI Headquarters

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

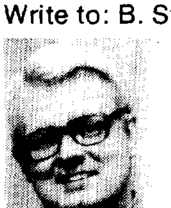
Our immediate past INMM chairman, **Roy Cardwell,** Oak Ridge, Tenn., recently handled what is thought to be the first official request for Institute information from the People's Republic of China. Roy provided **Fan Hsin-san** with three copies of the INMM journal, a 1980 Call for Papers, and the 1979 Annual Meeting Printed Program. Fan Hsin-san is the Director of the Library of Academia Simica in Peking.

Kentucky is the national headquarters for the National Council for Environmental Balance. NCEB President, Dr. **Irwin W. Tucker,** is a Professor of Chemical and Environmental Engineering in The Speed Scientific School at the University of Louisville.

NCEB is a pro-nuclear "organization of sincere academic scientists and engineers dedicated to a balanced approach to solving environmental and energy problems without destroying the economy and people's right to a responsible life with dignity," according to Prof. Tucker. For more information, you can contact him at NCEB, 4169 Westport Road, P.O. Box 7732, Louisville, Kentucky 40207 (502-876-8731).

Together with **Rudolph M. Grube, Armand R. Soucy,** a past INMM Chairman, wrote an article, "Financial Accounting for the Back End of the Nuclear Fuel Cycle: A Utility Viewpoint," which appeared in **Nuclear News** (Nov. '79, p. 55). Mr. Soucy is Assistant Treasurer, Yankee Atomic Electric Company, Westboro, Massachusetts.

Copies of the 1979 Annual Report of the Office of Measurements for Nuclear Technology in the NBS National Measurement Laboratory are available from **B. Stephen Carpenter**, Acting Program Manager for Nuclear safeguards. Carpenter, an INMM member, served in a leadership capacity for the recent Topical Conference on Measurement Technology for Safeguards and Materials Control held this past November 26-29 at Kiawah Island, South Carolina. Write to: B. Stephen Carpenter, Acting Program Manager for Nuclear Safeguards, National Bureau of Standards, Washington, D.C. 20234 (Phone: 301-921-2167).



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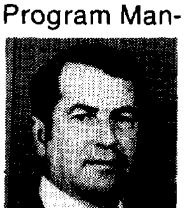


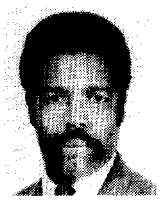
Soucy

Bob Curl, former INMM Treasurer, is back in Idaho Falls after a two-year tour as an IAEA inspector in Western Europe and the British Isles. Bob, shown with his charming wife Kitty, is Manager of Safeguards and Materials Management at EG&G Idaho, Inc. Prior to his international assignment, he was associated with Argonne National Laboratory in Idaho Falls.

The Japan Atomic Energy Research Institute (JAERI) moved into its new headquarters on February 12, 1980. Its new address: JAERI, Fukoku Seimei Bldg., 2-2, Uchisaiwai-cho 2-chome, Chiyoda-ku, Tokyo 100, Japan. Telephone: (03) 503-6111. Telex No.: J24596. Our thanks to **Yoshitaka Kimura**, Deputy Chief of Officer Nuclear Fuel Management at JAERI, for providing this information to the INMM.

In this column (Winter Issue, p. 54, Volume VIII, No. 4), we carried an item about a tee shirt, "More Nukes, Less Kukes," designed by **Jeff Jaech**. He has now gotten a trade mark and set his price at $6.95 plus 60¢ mailing. Sizes are S-M-L-XL and come in 4 colors. If interested, contact Jeff at 4969 North Backer Avenue, Apt. No. 252, Fresno, CA 93726. His phone number: 209-292-4137 (Home) and 209-442-0550 (Work). Jeff is the son of **John L. Jaech**, Richland, Washington, Chairman of the Technical Program Committee for the 1980 INMM Annual Meeting.

The proceedings of the Topical Conference on Measurement Technology for Safeguards and Materials Control, November 26-29, 1979, Kiawah Island, South Carolina, is being published by the National Bureau of Standards. An announcement on the availability of this



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proceedings will be sent to INMM members at some future date.

An improved method for controlling radioactive iodine emitted during the chemical treatment of nuclear fuel is the subject of a U.S. patent issued to DOE. The process was developed by researchers at DOE's Pacific Northwest Laboratory, which is operated by Battelle Memorial Institute. The inventors are **Leland L. Burger** and **Randall D. Steele**, scientists in Battelle's Chemical Technology Department. A process for trapping radioactive iodine in mercurex solutions — mercuric nitrate and nitric acid — has been in use for several years. Burger and Steele have developed a process to electrochemically treat the iodine-containing mercurex solution. The resulting chemical reactions permit the iodine's recovery, as a solid, for processing into a form more suitable for long-term storage.

The winner of the second annual INMM Student Paper Award Competition, **Mark H. Killinger**, was recognized in **The Bremerton Sun** with a news article announcing his award. The article was disseminated by the INMM Public Information Committee. Mark is now with the NMSS Office at the U.S. Nuclear Regulatory Commission.

NUSAC, Incorporated, has hired Ms. **Laura B. Thomas** as a Senior Technical Associate in the Environmental Assessments Division. Ms. Thomas is a planner whose major area of interest is land use and socioeconomic development. Prior to joining NUSAC, Incorporated, Ms. Thomas was employed as the Planning Director for the City of Kent, Ohio, as well as serving as a private planning consultant in northeastern Ohio. Ms. Thomas holds a M.A. from Kent State University.

The Tri-State Motor Transit Co., Joplin, Mo., has generously provided portfolios to attendees at INMM annual meetings for several years. Chcuk Mayer (left), Vice President of the Nuclear Division, and Jim Lee, Consultant to Tri-State will represent the firm at the 21st annual meeting set for June 30-July 2 in Palm Beach, Florida. Lee, Chairman of the INMM Membership Committee, is Local Arrangements Chairman for the 1980 meeting.

Two INMM members — (l. to r.) Joe Indusl and Tony Fainberg of Brookhaven National Laboratory — portrayed Harpo and Chico Marx at the Showtime Revue February 29 in the Buckner Hall Auditorium. The revue preceded the leap year dance at BNL.

For the second consecutive year, U.S. boiling water reactors have led the availability and capacity factor averages for U.S. light water reactor nuclear plants.

Based on preliminary 1979 generation data reported in **Nucleonics Week** and reports from BWR owners, the 23 U.S. BWR units rated over 100 megawatts averaged 74 percent plant availability and 68 percent capacity factor.

BWR availability is calculated from on-line hours reported by BWR owners; capacity factors are size weighted and calculated using turbine nameplate ratings.

A simplified scheme to efficiently remove radioactive contaminants from the gaseous wastes of nuclear facilities has been developed by researchers at the Oak Ridge Gaseous Diffusion Plant (ORGDP). The clean-up process, used to absorb radioactive inert gases such as krypton and xenon, can also be the basis for a mobile emergency decontamination unit that could be transported to the site of a nuclear accident.

The American Nuclear Society has announced its 1980 edition of **THE COMMUNICATORS** directory, a compilation of 500 names of experts on energy topics including nuclear. Names and addresses plus phone numbers and other pertinent data are provided. The publication is intended to be a source book for contacts in answering questions or commenting on controversial issues concerning the major topics of energy — i.e., nuclear safety and proliferation, plutonium and the economics of nuclear power.

Dr. **Lynette J. Steele** is a new Senior Technical Associate in the NUSAC Environmental Assessments Division. Dr. Steele is an economist whose major area of emphasis is econometrics. Prior to joining NUSAC, Dr. Steele was a staff economist with the Occupational Safety and Health Program Area of JRB Associates (a wholly-owned subsidiary of Science Applications, Inc.). Previously, Dr. Steele had been a part-time lecturer in micro and macro economics at the American University, Washington, D.C., a statistician with Inter-


Steele


Lumb

national Business Services, a research assistant with the National Academy of Sciences, and a research fellow at Howard University, Washington, D.C. Dr. Steele obtained her B.S., M.A., and Ph.D. from Howard University.

Dr. **Ralph F. Lumb**, President of NUSAC, Incorporated, McLean, Va., is pleased to announce that the appointment of three corporate executives has been approved by the NUSAC Board of Directors.

David G. Schofield has been appointed Senior Vice President. In his new position, Schofield will have overall technical and administrative responsibility for the firm's Security Programs and Computer Security Divisions. These Divisions provide a variety of high technology security services to the nuclear, fossil energy, and financial industries in addition to governmental agencies such as NRC, DOE, and the U.S. Navy. Schofield, formerly Vice President — Security Affairs, joined NUSAC in 1976 upon leaving government service.

Wilkins R. Smith has been appointed Vice President with technical and administrative responsibility for NUSAC's Quality Programs and Environmental Assessments Divisions. In tthis position, Smith will direct the delivery of a wide range of technical services to industry and government, including quality assurance, environmental impact statements and studies, nuclear material control and accounting, and management systems evaluations. Smith, formerly Manager, Quality Programs Division, joined NUSAC in 1976, after holding management and engineering positions at Combustion Engineering and United Nuclear Corporation.

Jack E. Pevenstein has been appointed Vice President — Marketing and will be responsible for new product and service development and long-range planning. Pevenstein will also be responsible for the planning and execution of joint ventures with NUSAC's parent company, The Wackenhut Corporation — one of the world's largest security organizations. Prior to joining NUSAC in 1979 as Marketing Director, Dr. Pevenstein was employed by Planning Research Corporation (PRC) as Deputy Director of PRC's Applied Research Group — a marketing oriented group responsible for developing new business areas for computer technology application.


Schofield


W. Smith


Pevenstein


The impressive Breakers Hotel in beautiful Palm Beach, Florida will be the site of the 1980 INMM Annual Meeting set for June 30-July 2. Our local hosts, Jim and Janet Lee of North Palm Beach, expect registrants to have a truly fine time at the meeting. We hope you can be among the anticipated 500 registrants for the meeting which is expected to have one of the finest technical programs in Institute history.

All members of the INMM and subscribers to this Journal take note. If you should ever receive an issue of the journal with pages missing, badly smudged, etc., contact us and we will supply you with a replacement copy. Every effort is made to prevent this from happening. However, if a poorly printed copy of the Journal should ever reach you, please phone us at 502-895-3953 (via FTS Oper. 352-5011) to let us know. Our telex number is 810-535-3425. You can write us care of P.O. Box 6247, Louisville, KY 40207.

Proposed NRC Protection Requirements

The Nuclear Regulatory Commission is proposing to amend its regulations to require that transient shipments of strategic quantities of special nuclear materials be protected from theft or sabotage during transit through U.S. sea or airports.

The proposed requirements would be applicable to transient shipments of specified quantities of uranium-233, uranium enriched to 20 percent or more in the 235 isotope and plutonium; they would provide transient shipments with the same degree of physical protection now provided domestic shipments of these materials.

Transient shipments are those originating in one foreign country and terminate in another with a scheduled or unscheduled stop at a U.S. sea or airport.

Carriers of such shipments would be required to have an NRC-approved physical security plan or to engage an agent, with an approved plan, to represent them in this country. In those cases where the carrier plans a stop, the NRC would have to be notified at least five days in advance; if an unscheduled stop is made, the NRC would have to be notified as soon as possible.

Such shipments, while in the U.S., would be subject to the requirements of Part 73 of the NRC's regulations.

The NRC staff is prepared to inspect such shipments to see that they are safeguarded properly when in U.S. ports.

Reports of Activities Of INMM Members

By Thomas A. Gerdis, Editor
Journal of INMM
Louisville, Kentucky

The following 101 items have been submitted to **Nuclear Materials Management** at the request of the editors from INMM members who were **not** able to attend the 1979 INMM Annual Meeting. The editors hope to publish such items at least once a year. If you have an item for the summer issue, please submit by June 1 care of the Journal (P.O. Box 6247, Louisville, KY 40207).

Tom Beetle is a senior officer with the IAEA Department of Safeguards. He has worked as a statistician in the nuclear industry for 15 years. His present activities include consulting with staff members in the Department of Safeguards on statistical problems and development of statistical procedures. This involves work in experimental design, sampling design and data analysis for safeguards applications. He has been a member of INMM for five years and is affiliated with the Vienna Chapter of the Institute.

Roy W. Brown is Manager of the Technical Division at Goodyear Atomic Corporation, Piketon, Ohio. Technical Division activities include: laboratory and engineering development; analytical, process engineering data processing services; and laboratory maintenance. Mr. Brown also has administrative responsibility for GAT's technical support for the planned gas centrifuge uranium enrichment facility at the Piketon, Ohio, site.

R. L. (Bob) Carpenter is Manager of the Analytical Laboratories at Rockwell International's Rocky Flats Plant, Golden, Colorado. He has been associated with Rocky Flats since 1957. He is presently Secretary of ASTM Committee C-26 on the Nuclear Fuel Cycle. He has just recently joined INMM and is interested in plutonium chemistry, accountability and safeguards.

Alan H. Coates is enjoying an active retirement after completion of a term as a consultant to British Nuclear Fuels Ltd. He was Manager of Materials Accounting and Safeguards at the Company's Springfields Works in Lancashire, England, from 1956 to 1978 and has many friends in the field of international safeguards.

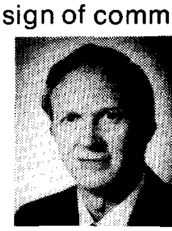
Alberto Cocchi is with Safeguards and Physical Protection Office in E.N.E.L. (Italian Central Electricity Board) and is responsible for the preparation of general criteria and for the coordination of safeguards and physical protection. He also treats problems associated with national and international legislation on nuclear material export-import. As a member of the International Trade in Uranium Committee (Uranium Institute), he deals with the problems relating to the nuclear material trade (with particular reference to non-proliferation policy). He attended an NPT Review Conference in Geneva as Adviser of the Italian delegation. As a member of the Containment and Surveillance Working Group of ESARDA, he is concerned with problems associated with safeguards, and destructive and non-destructive tests on nuclear fuel (also within NDA Working Group of IAEA).

Elizabeth Collins has been an employee of Argonne National Laboratory, at the Idaho Nuclear Engineering Laboratory, since 1961. She implemented the present computerized nuclear materials control system at the Hot Fuels Examination Facility and is currently responsible for fuels management and assists in criticality control at the same facility.

Jack R. Craig recently moved from Pittsburgh to the DOE Richland Operations Office where he serves as an auditor in the Safeguards and Security Division, Safeguards Branch. His duties include the follow of Hanford Contractor development of advanced nuclear materials accountability systems. Jack was first employed in the nuclear industry by Westinghouse in 1969 where he worked in Thermal and Hydraulic design of commercial reactors. He has worked in various

Beetle

Brown



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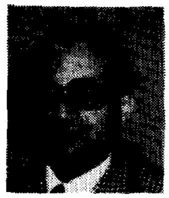

DeMoncada

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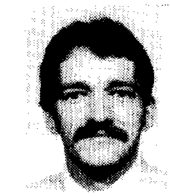


Downing

Erickson

safeguards and materials management positions with the DOE (AEC) since 1974. Jack actively participates in INMM Pacific Northwest Chapter functions.

Arthur B. Crawford is a nuclear engineer with Oak Ridge National Laboratory in the consolidated fuel reprocessing program. His primary involvement is in the development of advanced safeguards techniques for reprocessing facilities. He is a new member of INMM and is looking forward to working in the INMM organization in some capacity.

Scott Dellheim is Director of Scott Protective Resources, Philadelphia, Pa.; Protective Security Management, Counsel, Research and Documentation for government and industry. He is a graduate of New York University; a former Security Supervisor of the Defense Industrial Security Program; member, American Society for Industrial Security Standards and Codes Committee; member, various professional organizations; and has lectured at numerous professional and academic symposia. He was involved in the design of an electronic intrusion detection system for low profile facilities and is the author of articles concerning the social sciences and protective security.

Albano Ferrer De Moncada (M. Sc., Electronic Engineering, Technical University of Lisbon, 1962; Dipl.-Ing., Dr. techn., with distinction, Technical University of Vienna, 1973); worked in the private industry as a project and development engineer in the electrical power field from 1961 until 1969. He did theoretical and applied research in the fields of Electrodynamics, Power Systems and Generalized Systems Analysis at the Technical University of Vienna, from 1969 until 1973. Currently, he is with the North America Section, IAEA Department of Safeguards. He held a research grant from the Calouste Gulbenkian's Foundation and is a member of the Austrian Institution of Electric Engineers (OVE).

Mary S. Dodgen (Mrs. W. H.) was employed by DuPont at the Savannah River Plant, Aiken, SC in 1967. She was involved in technical support for fuel reprocessing and target fabrication facilities, and in development of quality assurance/quality control procedures for the plutonium fuel form facility. In August, 1979, she was appointed Senior Chemist in the SRP Safeguards Group. She is currently coordinating programs to improve material control and accountability and physical safeguards at SRP. She attended the Conference on Measurement Technology for Safeguards and Materials Control at Kiawah Island, Charleston, SC in November 1979.

Darryl J. Downing is a statistician in the Systems Analysis Section in the Computer Sciences Division of the Oak Ridge National Laboratory. He recently became a member of the INMM. His current research efforts have been in analyzing inventory difference data using time series techniques.

Robert F. (Bob) Eggers is a senior research scientist and project leader in the Materials Safeguards Unit of the Pacific Northwest Laboratory, Richland, Washington. The Materials Safeguards Unit is responsible for the conduct of a variety of safeguards studies for both the U.S. NRC and the IAEA. Currently, Bob is contributing technically to and leading a project to develop a set of upgraded inspection procedures or modules for the NRC's Office of Inspection and Enforcement. He has also contributed to light water reactor plant decommissioning and proliferation resistant fuel cycle studies, as part of his safeguards duties. Before joining the Materials Safeguards Unit at PNL, Bob was involved in water reactor safety research and program coordination activities for PNL's Nuclear Waste Program Office. Bob is a licensed professional mechanical engineer (P.E.) in the State of Washington and has a master's degree in physics from the University of Washington.

Dean W. Engel is with Westinghouse Hanford Company, Richland, Wash. He is the Manager of Nuclear Materials Management within the safeguards organization at the Hanford Engineering Development Laboratory (HEDL). Dean serves on the Executive Committee of the recently-formed INMM Pacific Northwest Chapter.

Otto E. Erickson, Jr. is a 30-year employee of the Mason & Hanger-Silas Mason Co., Inc., operating contractors for the U.S. Department of Energy Pantex Plant, Amarillo, Tex. He has been a member of the Institute since 1961. Prior to joining the Amarillo operation, Mr. Erickson was Production Manager and Nuclear Materials Accountability Representative for the Atomic Energy Plant, Burlington, Iowa. His current assignment at the Pantex Plant is Superintendent of Manufacturing Planning and Control.

Anthony Fainberg is with the Technical Support Organization for Nuclear Safeguards at Brookhaven National Liboratory. His interests are in instrumentation, primarily NDA, non-proliferation problems, and the energy question in general. His work with the TSO has included instrumentation evaluation, diversion path surveys and IST (isotope safeguards techniques) studies. He has also contributed to the book review section of the INMM Journal.

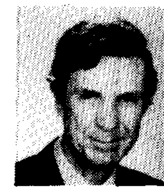
Marco M. Ferraris is Head of the North America Section of the IAEA Department of Safeguards. He is responsible for the implementation of Safeguards in Canada, as well as the U.S.A. as soon as the USA/IAEA Agreement is ratified. Mr. Ferraris is also Chairman of the IAEA team for the Subsidiary Arrangement and


Fainberg


Ferrais


Filsinger


Fraser


Frech


Fry

Facility Attachment negotiations with the USA. In December, 1978, he took part in a Workshop on the Impact of Agency Safeguards on the USA Industry and he is looking forward to attending the next one. In addition, Mr. Ferraris is the Treasurer of the Vienna Chapter of the INMM and has had some difficulty finding and then convincing 44 (plus or minus two) members of the Vienna Chapter to pay their annual contributions (dues) to INMM.

F. Gary Fetterolf is an analyst with Rockwell Hanford Operations in the Nuclear Materials Control Department of the Safeguards and Security Function. Mr. Fetterolf's prime involvement is in assisting computer systems personnel with the development of an on-line nuclear materials accounting system.

James V. Filsinger is a specialist in the Safeguards Section, Pacific Northwest Laboratories, Battelle Memorial Institute, Richland, Wash. He has been working in the Nuclear Materials Accounting group for the past four years. Prior to this, his experience has been in data processing and business systems analysis for a total of 13 years with Pacific Northwest Laboratory. He has a B.A. degree from the University of Washington.

John W. Fraser is Order Control Supervisor for the Bendix Corporation's Kansas City Division. His areas of responsibility include intercontractor procurement, special materials management, weapon component modification and repair project administration, and computer scheduling of customer orders. A first year member of INMM, he has been the SS Accountability Representative for Bendix since 1974.

David F. Frech was employed by Union Carbide at Oak Ridge National Laboratory in 1956. He is with Duke Power Company in the Steam Production Department in Charlotte, N.C. His primary involvement is in the area of new fuel receipt and spent fuel transportation.

Clifford Fry, Tennessee Valley Authority, Chattanooga, Tenn., is the Nuclear Traffic Specialist in TVA's Traffic Branch. He is also a member of the Atomic Industrial Forum's Transportation Subcommittee. Cliff, a graduate of the University of Tennessee, is now in his 30th year with TVA.

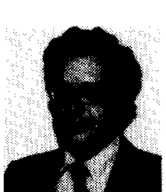
Kenneth B. Gerald is a statistician in the Statistical and Systems Analysis Department, Safeguards and Security Branch at Rockwell International, Golden, Colo. His primary responsibility is reviewing and statistically evaluating the calibration of NDA counters and NDA verification of inventory holdings. He presently serves on the INMM Public Information Committee and on INMM-8.4, subcommittee on nuclear calorimetry calibration. Ken has a Ph.D. in Statistics from Texas A&M University.

Richard J. Gigliotti is Security Manager at UNC Recovery Systems, a Division of United Nuclear Corporation, Wood River Junction, R.I., and has served in police departments in Connecticut and Massachusetts. A former U.S. Army officer, he holds a Bachelor's Degree from Norwich University and has done graduate work at Massachusetts State College, North Adams. His articles on police and security subjects have appeared in various national and international publications. A trained negotiator, Mr. Gigliotti instructs on Hostage Incident Management, "The Crucial First Hour," for Indiana University at Indianapolis. He is a consultant to, and member of, the International Association of Chiefs of Police and is also a member of the American Society for Industrial Security. "The Crucial First Hour" was presented at the 1979 INMM annual meeting in Albuquerque.

Charles E. Gillihan is employed by the Union Carbide Corporation at its Y-12 Plant, Oak Ridge, Tennessee. He is Supervisor of the Internal Control Group of the Nuclear Materials Control and Accountability Staff. He helped to completely revise the accountability system in 1975 and is now involved with revising the present system to a real-time system. The objective to be achieved with the real-time system is to record movement of materials as they occur.

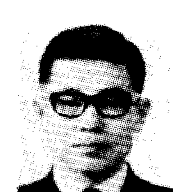
Dr. **Mark K. Goldstein** is a Senior Technical Advisor to the Nuclear Project Division of JGC Corporation, a Japanese engineering and construction firm based in Tokyo. He is responsible for developing a safeguards philosophy for nuclear power plants and reprocessing facilities. His work also involves assisting JGC with international negotiations pertaining to foreign business ventures and the evaluating of the nuclear waste management situation. He is now enjoying life in Japan. Prior to his move to Japan, he was at the East West Center and Brookhaven National Laboratory.

Kazutaka Gotoh was a chief engineer of Safeguards Studies and Physical Protection System Design at Nip-


Gigliotti


Gillihan


Goldstein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Hamlin


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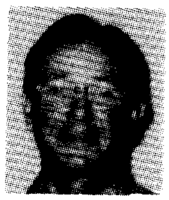
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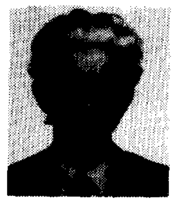

Hoyle

pon Electronics Co., Ltd. Japan, and he is an assistant manager of Quality Control Department of the company. He was a member of the working group which organized the INMM Japan Chapter special one-day seminar last September. He is also a member of Safeguards Research and Development's working group of the Nuclear Material Control Center of the country.

George H. Halsey, General Electric Co., Schenectady, N.Y., retired on March 1 after 44 years of service. Early assignments included thermal and hydraulic design of industrial heating equipment, forced-oil-cooled large power transformer cores, coils, pumps, fans, and oil-water and oil-air heat exchangers. Later assignments at the Knolls Atomic Power Laboratory included supervision of thermal and hydraulic design and Naval Reactor Standards for all General Electric water cooled reactors for the Naval program, ending with a 10-year assignment in nuclear materials management, facility safeguards design, transportation control of radioactive material and measurement of special nuclear materials. Future plans include travel and golf.

A. G. Hamlin is Head of the Nuclear Materials Accounting Control Team (NMACT) of the United Kingdom Atomic Energy Authority. This is a central services unit with responsibility for maintaining standards of nuclear materials accountancy and other safeguards measures throughout the UKAEA. Such standards have to be equivalent to at least the latest internationally accepted level. Mr. Hamlin joined the INMM three years ago on entering the nuclear materials control field after more than 20 years in the nuclear industry.

Reinosuke Hara is a Managing Director of Daini Seikosha Co., Ltd., main manufacturing company in the SEIKO group. He has been in charge of the development, production and sales of high technology products including X-ray and nuclear instruments and systems. Before he joined the company, he worked with the Japan Atomic Energy Research Institute and the International Atomic Energy Agency in Vienna. He serves as a Treasurer of the Japan Chapter of the INMM, and also as a senior adviser of the Japan Atomic Industrial Forum.

L. H. (Herb) Harrison is an accountant by training and is employed by the Kerr-McGee Nuclear Corporation, a subsidiary of Kerr-McGee Corporation. He is located at their conversion facility near Gore, Okla. Primary involvements include the management of administration and accounting, and the nuclear material accountability and safeguards. First associations in nuclear industry began in 1964 and he has been a member of INMM since 1971.

Dr. **Carolyn Heising-Goodman** is a Research Associate in MIT's Nuclear Engineering Department. She is involved in nuclear reactor and fuel cycle safety and safeguards risk assessments. Supervising several graduate research students under contract to EPRI, she is expecting a promotion to the Assistant Professor level in the near future. She was the 1978 INMM Student Award winner for her Stanford Ph.D. thesis entitled: "The Reprocessing Decision: A Study in Policy-Making Under Uncertainty." She recently completed a tour of the French nuclear power program including Marcoule, Cadarache, Eurodif and the Super-Phenix breeder reactor site.

James B. (Jim) Hicks is Section Head, Nuclear Materials Engineering with Goodyear Atomic Corporation, Piketon, Ohio. His primary involvement is with NDA equipment for assay and enrichment measurements of uranium materials for the DYMCAS project, developing procedures and techniques for calibration, maintenance and operation. Prior to this activity, he was a staff physicist with the Development Laboratory at GAT.

Jack Hind is Chief of the Safeguards Branch in the Chicago Office of the U.S. Nuclear Regulatory Commission. His staff is responsible for conducting material control and accountability and physical security inspections at licensees' facilities within an eight-state area in the midwest.

Dixon B. Hoyle is Assistant Director International Nuclear Energy Affairs in Westinghouse's Washington Government Affairs Office. He retired from the Department of State in 1979, where his last post was Director, Office of Export and Import Control for nuclear materials, facilities and technology. He first entered the international nuclear arena in 1957, when he became the first Director of the Office of Materials and Safeguards in the AEC's Division of International Affairs. Included in his international activities while at AEC was service as the Senior AEC Representative and Deputy for Euratom Affairs at the U.S. Mission to the European Communities, Brussels, during 1966-69.

Dr. **Ryukichi Imai** is General Manager for Engineering, Japan Atomic Power Co. His association with nuclear safeguards dates back to the very early agreements Japan negotiated with other countries as well as with IAEA. He is currently the Japanese member to the Standing Advisory Group on Safeguards Implementation. (SAGSI), IAEA. In addition to the final degree in nuclear engineering, because of his other academic backgrounds in mathematics and international politics, his activities and his publications outside of his normal duties in JAPC also cover science policies in general, nuclear energy and non-proliferation as well as national security and politics of energy in general. He is a Special Assistant to the Japanese Minister of Foreign Affairs.

Dr. **Kiyoshi Inoue** is with the Power Reactor and Nuclear Fuel Development Corporation (PNC). He


Imai


Inoue


Janikowski


Kanda


Knief


Knight

supervises the Uranium Enrichment Development Division at PNC Tokai Works. This division is responsible for developing the Japanese centrifuge project, and for supporting technically the Ningyo-Toge pilot plant operations. Until 1974, he had been employed by Hitachi as a nuclear engineer for 15 years in the fields of accelerator experimentation, reactor fuel irradiation and enrichment plant design.

Andrzej Janikowski is with the Operations Division of the IAEA Department of Safeguards. He enjoys statistical methods in application to safeguards and evaluation procedures of inspection data. Being an active inspector, he tries to implement these methods in operations initially in Sweden and since two years, in Canada.

Malcolm Johnson has been Technical Records Manager at the BNFL Windscale in the U.K. for the last two years. He is responsible for nuclear material accountancy and safeguards at Windscale's reprocessing and plutonium fuel fabrication plants.

Dr. **Keiji Kanda** is Associate Professor at Research Reactor Institute of Kyoto University, and Deputy Director of Critical Facility Division. He is currently interested in reactor physics of thorium fuel cycle, design of a high flux reactor, reducing enrichment of research reactor and radiation biology. He is also a member of the American Nuclear Society.

Dr. **Ronald A. Knief** is Associate Professor of Nuclear Engineering at the University of New Mexico. He is currently developing a course on methods of safety and safeguards with ample and able assistance from Sandia Laboratories and LASL. An M.S.-level degree program with a safeguards specialization is a near-term prospect at UNM. Interest in the interaction of safeguards with operations and safety has resulted in visits to many U.S. fuel-cycle and reactor facilities. He also works with Sandia and LASL on international safeguards and related training courses.

Dr. **Ron J. Knight** is a senior research scientist of the Australian Atomic Energy Commission and is currently the Counsellor (Atomic Energy) at the Australian Embassy, Washington, D.C.

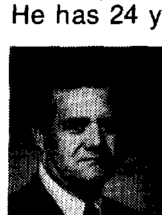
Raymond J. Kofoed is Manager of the Safeguards and Security Department, Battelle's Pacific Northwest Laboratories, Richland, Wash. His responsibilities include nuclear materials management and control of the special nuclear material used at Battelle, physical protection of the U.S. Department of Energy facilities, as well as the Battelle private facilities at the Richland Research Center, the Sequim Marine Laboratory and the Seattle-based Human Affairs Research Center. He has worked in analytical chemistry R&D, with emphasis on optical and X-ray emission spectography, radiochemical counting; process assistance for plutonium finishing operations; conceptual design of physical protection systems and computer applications to nuclear management systems and physical protection evaluation systems.

Erwin U. Kotte is a physicist, who started working in the field of nuclear materials management and safeguards at the Nuclear Research Center Juelich, West Germany. He developed a concept for a nuclear materials accountancy and control system for this facility. He also carried out several research contracts for the IAEA in connection with international safeguards. Since 1977, he has been with the Division of Safeguards Information Treatment of the IAEA Department of Safeguards and has been involved in the development and realization of the Agency's safeguards information system.

Dr. **John W. Leake** is a principal scientific officer in the Instrumentation and Applied Physics Division of AERE Harwell where he has worked for the past 17 years. He has worked on the design of health physics instrumentation, particularly neutron detectors. He is currently Section Leader responsible for the development of special purpose gas ionization detectors and detection systems and for nuclear materials assay instrumentation. He is also responsible for the measurement of plutonium in low level solid waste. He received his Ph.D. degree in 1962 at the University of Liverpool.

Kenneth D. (Ken) Long is the Nuclear Materials Accountability Specialist at the Babcock & Wilcox Company's Lynchburg Research Center in Lynchburg, Va. Ken joined B&W in November 1958 and has been in the nuclear part of the company since February 1, 1967. His primary responsibilities are to keep track of all special nuclear material and source material and report to the government agencies and management about those holdings. Ken is also responsible for shipments and receipts of SNM; this involves packaging and transportation of SNM to insure full compliance with DOE, NRC and DOT regulations. He has been a member of the INMM since 1975.

David M. (Dave) Lund is presently assigned as the Manager of the Safeguards Analytical Laboratory Evaluation (SALE) Program. The program is sponsored by the U.S. Department of Energy and administered by the New Brunswick Laboratory at Argonne, Ill. He has 24 years in the nuclear industry with primary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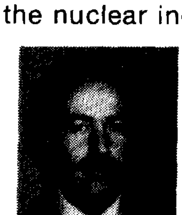
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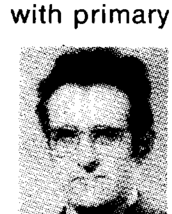
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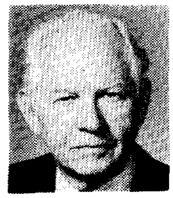
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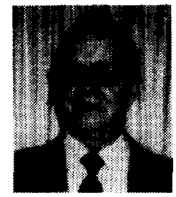
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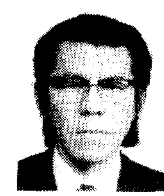
Mishima


Miyasaka

involvement with the analytical measurement of nuclear materials. He particularly enjoys the interface and involvement of the varied laboratories in the SALE Program. Presently, there are 26 U.S. facilities and 20 laboratories outside the United States who participate in the SALE Program which provides reliable materials for analysis and accurate evaluation of the analytical data submitted by the program participants. These are continuing challenges to be met.

Gavin R. Mallett is with the Nuclear Materials Management unit at General Electric's Wilmington Manufacturing Department nuclear fuels fabrication facility. Gavin has 20 years of experience in the nuclear industry which includes seven years involved in the nuclear safeguards program concerning accounting, measurements and statistical activities.

Roger D. Marsh is Head of British Nuclear Fuels Limited's Safeguards Division and is based at the Company's corporate headquarters at Risley Near Warrington in Cheshire, United Kingdom. Responsibilities include implementation of Euratom and IAEA requirements and compliance with supplier-country fissile material use restrictions. He entered the nuclear industry in 1954 and, in 1960, joined the organization which is now BNFL. Previous duties embrace a wide range of headquarters activities including fuel design, policy information, overseas sales and uranium procurement.

After 34 years with Union Carbide Corp.-Nuclear Division at the Oak Ridge Gaseous Diffusion Plant, **William D. McCluen** retired on January 1, 1980. Much of this time was spent in uranium accountability; although in the more recent years, he was in production. The last assignment was as Superintendent, Cascade Operations. He is a Charter Member of the INMM and is a Certified Nuclear Materials Manager, having certificate No. 3.

Jack V. Mertes of BATTELLE (Pacific Northwest Laboratories) has been employed there since 1965 as a senior specialist for nuclear materials accounting. Prior to 1965 when BATTELLE took over the Hanford laboratories, he was a working leader for the General Electric Company in nuclear materials accounting for some 17 years. A member of INMM since 1965, Mertes is active in the INMM Pacific Northwest Chapter.

Tsuyoshi Mishima has been a staff member of Nuclear Fuel Division, PNC, Tokyo since April, '79. He is involved in design and development of nuclear material control systèm of the plutonium facility of Tokai area, and is also a member of design group of a large-scaled plutonium fuel facility coming in the near future.

Shun-ichi Miyasaka is Head of the Division of Safeguards Information Treatment, Nuclear Material Control Center, which serves as the safeguards organization of Japan. His Division has two sections. One is dealing with and evaluating all incoming safeguards information, such as accountancy data dispatched from facility operators and inspection data taken by the Government of Japan, in a routine manner by operating and maintaining an information processing system and a data base system. Another is developing new computer software for relevant safeguards information processing. He has been engaged in the field of radiation shielding research at the Japan Atomic Energy Research Institute (JAERI) for about 20 years. He was appointed as a supervisor of the Division two years ago to establish a computer code system for safeguards in Japan.

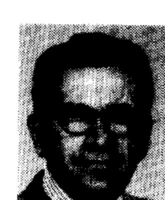
Dale A. Moul is the Manager, Security Programs Division of NUSAC, Incorporated. He is responsible for managing all of NUSAC's security services, which include the preparation of plans and programs for the physical protection of nuclear power generating plants, reprocessing facilities, fuel fabrication plants, engineering laboratory facilities, and other energy related facilities against acts of terrorism and sabotage. In addition, he is a practicing technical professional who specializes in the legal aspects of environmental law and industrial security programs.

Yoshihiro Nakagome is a Research Associate at Research Reactor Institute of Kyoto University, Japan. He belongs to the Division of Nuclear Reactor which is responsible for operation and maintenance for Kyoto University Reactor (KUR, 5000kWt). He has worked in the nuclear materials management and safeguards field since 1973. His research field is nuclear physics (fission) and reactor physics. He is a member of the American Physical Society.

Nicholas Nicholson has been with the Los Alamos Scientific Laboratory since 1967 and is currently Assistant Group Leader in the Detection, Surveillance, Verification and Recovery Group (Q-2). Safeguards projects that he is currently involved with include a shelf monitor system designed to maintain continuous surveillance of SNM in storage and an attribute measurement technique being investigated for the IAEA that utilizes the Cerenkov glow emitted from spent fuel assemblies in storage ponds which is designed to confirm the spent fuel inventory. Nick has a Ph.D. degree in Physics from West Virginia University.


Moul


Nakagome


Nicholson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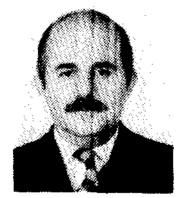

Pontes

Takeshi Osabe is Manger of Nuclear Materials Management of the Japan Nuclear Fuel Co., Ltd. (JNF). His main responsibility is the development and application of nuclear materials accountability system. He is also responsible for coordination on matters pertaining to national and international safeguards, and is currently assigned a committee member of MUF Analysis Working Group and Fuel Cycle Study Committee organized by the Nuclear Material Control Center. Mr. Osabe was recently selected and invited to be a guest lecturer in the International Training Course in Nuclear Materials Accountability at Los Alamos Scientific Laboratory.

Carl A. Ostenak is a staff chemist and nuclear engineer in the Safeguards Systems and Technology Transfer Group (2-4) at the Los Alamos Scientific Laboratory (LASL). He is engaged in design studies of advanced safeguards systems that combine conventional materials accounting methods with near-real-time, on-line measurement and data-handling techniques. Currently, he is participating in the design and evaluation of an advanced materials accounting system for the LASL Plutonium Facility. In addition to serving the INMM, he is a member of the American Chemical Society and the American Nuclear Society.

Raymond J. Parsick is the Head of the Safeguards Evaluation Section which is responsible for evaluation of the effectiveness of safeguards activities by the International Atomic Energy Agency and for recommendations for improvements. He came to the IAEA from the safeguards groups and the reactor safety division at Brookhaven National Laboratory. He has been a member of the INMM since 1971.

James A. Parsons is Manager of Process Design Engineering for the Union Carbide Corporation's Nuclear Division, Oak Ridge, Tenn. His organization provides chemical and process engineering design support to all of the Carbide-operated facilities in Oak Ridge. Special emphasis is devoted to environmental pollution control, waste management, safety analysis, gaseous diffusion plant support, nuclear fuel reprocessing, advanced isotope separation processes, and process design for the gas centrifuge plant now under construction near Portsmouth, Ohio. Jims says his background in nuclear materials management has been of great assistance in fulfilling the requirements of nuclear materials accountability and safeguards for the systems which his group designs.

Frederick J. Perella spent five years as a member of the Nuclear Materials Safeguards Studies group at the National Bureau of Standards until his retirement from there in 1973. Fred has been involved with the manufacture of nuclear fuel elements and the accountability of nuclear materials since 1955. He has been part of the accomplishments in the safeguards and accountability efforts made by U.S. industry and is proud of the contributions in this effort being made by the INMM.

After eight years in Operation's Division (Department of Safeguards) in the IAEA, **Bernardino Pontes** has been transfered to be Head of the Training Unit in Safeguards. He hopes that with his long experience performing inspections in 14 countries (including the U.S. and Japan) and in all types of facilities, he will be able to perform his duties according to the needs of the department. He was in University work in Brazil, his home country, before joining the IAEA.

William Powers was just recently promoted to Manager of Safeguards for Babcock & Wilcox Company, at the Commercial Nuclear Fuel Plant, Lynchburg, Va. Here he will assume responsibility for nuclear material control and accountability, and physical security. Previously Mr. Powers served as Manager of Accountability at Babcock & Wilcox's operation, Apollo, Pa.

Alan E. Proctor is Manager of the Nondestructive Assay Laboratory at Argonne National Laboratory-Idaho. He is currently completing the start-up of the NDA facility, and has been responsible for the selection of assay techniques and the design of much of the equipment currently installed there. When fully operational, the Laboratory will be capable of NDA measurements on all unirradiated materials and some waste containers. As part of the equipment engineering effort, he has developed a new type of Random Driver coincidence curcuit and portable assay equipment for use in vault storage areas. Prior to joining ANL-Idaho, he was involved in research in high temperature gas kinetics and computer-aided analysis of gas kinetics data.

George L. Ragan, an INMM member, has retired from his work in instrumentation and controls at Oak Ridge National Laboratory after 12 years of service. He was the senior author of a paper, "Nondestructive Assay of Subassemblies of Various Spent or Fresh Fuels by Active Neutron Interrogation," presented at the 1979 INMM Annual Meeting in Albuquerque.

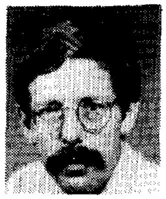
Norman C. Rasmussen is Head of the Department of Nuclear engineering at M.I.T. Most of his recent research has been in the area of nuclear power reactor safety and risk assessment. However, he has devoted part of his research effort to safeguards problems for the NASAP program. This work has included the development of techniques for the evalution of the relative difficulty in proliferating different nuclear fuel cycles.


Proctor

Rasmussen


Razvi


Ricci


Rich


Saiger


Sanatani


Sanders

Junaid Razvi is a senior engineer with General Atomic Company, San Diego, CA, responsible for Safeguards Development work. His involvement at GA centers around monitoring the measurement control programs dealing with highly enriched fuel manufacture, and statistical evaluation of measurement data from analytical/NDA measurements for SNM accountability. In addition, he carries out development work for the evaluation and in-field testing of nondestructive measurement techniques applicable in the manufacture of HTGR fuel. Junaid has a Ph.D. in Nuclear Engineering from Kansas State University, Manhattan. He has been an INMM member since 1978.

Roy J. Ricci is President and founder of Intex Inc., a company specializing in advanced technology products for physical security and water pollution control applications. He and his colleagues at Intex have developed the walk-through metal and weapons detection predominantly used in the industry. A member of INMM since 1974, Dr. Ricci has an Sc.D. in Systems Theory from Stevens Institute of Technology and is a member of other professional societies and trade associations in which he has published papers on physical security and pollution control technology.

Barry L. Rich is Chief of External Coordination for DOE's Office of Safeguards and Security, Washington, D.C. In this position, he is responsible for safeguards and security policy liaison within the DOE system and between DOE Headquarters and other agencies with nuclear security programs. He has been with the Office of Safeguards and Security since early in 1976. Previously, he was associated with reactor design and safety groups within the AEC and ERDA field.

Dr. Dipl.-Ing. **Siegfried Saiger** is a chemist with the Reaktor-Brennelement Union (RBU), Hanau, Stadtteil Wolfgang, West Germany. He is Manager of the Department of Nuclear Fuel Control within the quality assurance organization. He is RBU's Safeguards Consultant and Deputy Safeguards Manager. In this function, he was involved in the negotiations and implementation of international safeguards at RBU. He is responsible for RBU's safeguards program and system research and development work including (quasi)-RTA. He is a member of the ESARDA working groups LEU-C/F-P, DA and NDA as well as ISO TC 85, SC 5, WG 1 and 2.

Dr. **Saurabh Sanatani** is in the Section for Development of Instruments, Methods and Techniques of the IAEA Department of Safeguards and is involved in various projects on development of containment/surveillance measures for international safeguards. Currently, he is the IAEA project officer for the RECOVER (REmote COntinual VERification) program, a cooperative demonstration program between U.S. Arms Control and Disarmament Agency, the IAEA and several countries.

Dr. **Ken Sanders** returned last August from the IAEA where he was Safeguards Inspector and Negotiations Officer for Non-Nuclear Weapons States under EURATOM safeguards. He presently is an International Safeguards Analyst for the NRC in the Materials Control and Accountability Development Branch, which is responsible for: technical support for implementating the U.S./IAEA Safeguards Agreement, technical reviews for licensing exports, evaluation of technical performance of IAEA safeguards, providing technical support to the IAEA, and maintaining technical liaison and other U.S. agencies in support of U.S. efforts to strengthen international safeguards.

Newton H. Seebeck is Director of the Safeguards and Security Division at the DOE Savannah River Operations Office, and is responsible for all aspects of the security and safeguards programs. Newt came to Savannah River with the AEC in 1957, following three years as a counter-intelligence agent in the U.S. Army. He has been a member of INMM since 1963 and worked on the fuels reprocessing task group of the N15.1 Standards Committee. He is currently involved in a major safeguards upgrading project at Savannah River.

Professor **Rudolph (Rudy) Sher** teaches nuclear engineering at Stanford University. For some years, he has been a consultant in the area of NDA instrumentation. He recently returned from a 13-month stay at IAEA, where he worked with the instruments, methods and techniques section of the Department of Safeguards on NDA technology transfer. He has coauthored a book with **Sam Untermyer**, "The Detection of Fissionable Materials by Nondestructive Means," which will be published this Spring by the American Nuclear Society.

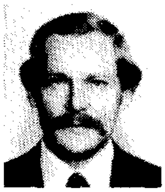
David B. Sinden is the Manager of the Safeguards and Security Division of the staff of the Canadian Atomic Energy Control Board. This Division is responsible for the implementation of domestic safeguards and security policy and the administration of such matters under bilateral nuclear cooperation agreements.

Albert J. Skinner (B.S., Chemistry, University of Georgia, 1950) is Chief of the Materials Control and Accountability Branch, Safeguards and Security Divi-


Seebeck


Sher


Skinner


Smiltnieks


H. Smith


J. Smith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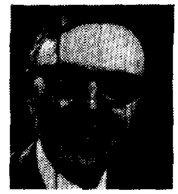

Spencer


Stief

sion, DOE, Savannah River Operations Office. He has been assigned to DOE safeguards-related positions for about 18 years, has been a member of INMM for about 16 years and served on the ANSI Committee for Nuclear Materials Control Systems for Irradiated Fuel Processing Facilities.

Varis Smiltnieks is Business Development Manager of the Technology Division of DSMA ATCON LTD., Toronto, Canada. This division is responsible for systems studies and facility designs in a broad range of high technology engineering fields including nuclear, and has participated in the development and design of such systems for the CANDU reactor as on-power fueling machines, fuel handling equipment and fuel transport and storage. He coordinated the company's involvement in IAEA Safeguards equipment development, reactor safety, security, and access control studies and safeguards equipment maintenance.

Hastings A. Smith, Jr. is with the Safeguards Technology Research and Development group at LASL, where he is currently working on the development of in-line NDA instrumentation using gamma-ray measurement techniques. He is also co-coordinator of the LASL/DOE Safeguards Technology Training Program. Hastings has a Ph.D. in Nuclear Physics from Purdue University.

James L. Smith is a senior technical associate in the Quality Programs Division of NUSAC, Incorporated, McLean, Va. His responsibilities include the performance of quality assurance audits and the development of quality assurance programs and procedures for NUSAC's clients. In addition to INMM, he is a member of the American Society of Mechanical Engineers (ASME) and the American Society for Quality Control (ASQC).

Takeshi Someya is a Safeguards Inspector with the Safeguards Department of the International Atomic Energy Agency. He was involved in establishing the State's Safeguards System of Japan under NPT. His involvement was with processing data of accounting reports and application of inspection activity and C/S measures in particular.

Arthur N. Spencer is a physicist with British Nuclear Fuels Limited at their Capenhurst Works, Chester, U.K. He supervises the Management Services Department which provides supporting services to plant operations, including nuclear materials accounting and the implementation of safeguards requirements in enrichment plants. Prior to his present duties, he worked in the R & D field.

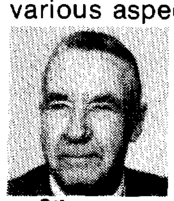
S. S. (Stan) Stief has been employed at the gaseous diffusion plant in Oak Ridge since 1945 and has been with the Union Carbide Nuclear Division since 1946. During this period, he has been in various positions concerned with plant operations. These included uranium handling, nuclear materials management, utilities operation and process engineering responsibilities. For the last nine years, he has been an Assistant to the Plant Manager and also supervises the plant environmental management program.

Edward J. Stimpson retired from the U.S. Atomic Energy Commission in August, 1967 as an auditor of special nuclear materials. He taught vocational technical education courses in the Roane County High Schools until 1974 when he retired for the second time. He is currently Treasurer at the First United Methodist Church, Oak Ridge, and Treasurer of Oak Ridge Chapter of the National Association of Retired Federal Employees. He was designated a Certified Nuclear Materials Manager (No. 22) on January 24, 1967. A native of Mt. Hope, Wis., he earned his bachelor's degree in business education in 1931 at the University of Wisconsin.

Wolfgang M. Stoll is Technical Manager of ALKEM, the only West German plutonium fuel manufacturing company. He is primarily involved with industrial activities in the plutonium field. ALKEM has, under his supervision, developed and used already back in 1967 very sensitive gamma gates and calorimetric measuring devices for safeguards measurements. He is participating in additional R&D efforts on containment and surveillance techniques, but looks to material accounting as only one of a series of tools for the nonproliferation issue.

Robert V. Studley has been employed by E.I. du Pont de Nemours at the Savannah River Plant since 1955. He was involved in design and development of nuclear reactor monitoring and safety system electronics for 14 years. He also supervised the Equipment Engineering Department Digital Systems Development and Process Computer Programming groups. He was appointed Staff Engineer three years ago to assess NDA requirements for SRP processes and to implement measuring systems for nuclear material control and accountability.

Hugh G. Sturman is Head of the External and Technical Services Department at the Headquarters of British Nuclear Fuels Limited (BNFL) in the United Kingdom. One of the responsibilities of this department is the development of new concepts relating to international safeguards and physical protection for implementation within the Company. He has worked in various aspects of the nuclear industry since 1957.


Stimpson


Stoll


Studley


Sturman


Sugimoto


Talley


Terrey


Tischhauser


Vaught

Eizo Sugimoto is Director of the Nuclear Materials Control Center, which serves as the safeguards organization of Japan. He is also Manager for Safeguards Analytical Laboratory in Tokai-mura.

William W. Talley, II, is the Managing Partner of the Resource Analysis & Management Group in Oklahoma City. Associated with the RAM Group since 1974, Dr. Talley supervises the firm's energy consulting activities. Dr. Talley is the Chairman of the Governor's Advisory Council on Energy for the State of Oklahoma. Previously, he served as Executive Director of the Oklahoma Energy Advisory Council. Dr. Talley presently acts as an adviser to the Governor of the State of Oklahoma and the State Legislature on energy policy. Dr. Talley has provided expert testimony and counsel on energy matters to the Department of Energy, the Federal Energy Regulatory Commission, the White House, the Oklahoma Congressional Delegation and the U.S. House of Representatives and the U.S. Senate Dr. Talley received a Ph.D. in Nuclear and chemical Engineering from the University of Oklahoma in 1973.

Marta D. Tarko is with the evaluation section of the IAEA Department of Safeguards. She is mainly involved in devising and performing specific studies for evaluating and reporting the effectiveness of international safeguards. Previously, she had done information and data analysis with the International Safeguards Information System at the IAEA, especially related to material balance accounting for nuclear materials.

D. R. Terrey worked in the safeguards and nuclear materials management fields with the United Kingdom Atomic Energy Authority from 1968, with particular emphasis on non-destrucitve methods for the measurement of nuclear materials. He joined the Division of Development of the IAEA Department of Safeguards in 1975 and is now a member of the Safeguards Evaluation Section. Currently, he is vice-chairman of the Vienna Chapter of the INMM.

Jennie Tischhauser is an analyst/programmer with the Safeguards and Technical Security Division at Sandia Laboratories, Albuquerque, New Mexico. She is part of a team that has designed and implemented a Nuclear Materials Control and Accountability System on an HP 3000 minicomputer. She joined the INMM to broaden her knowledge of other Nuclear Materials systems. Jennie is an active member of ACM (Association for Computing Machinery) and WISE (Women in Science and Engineering).

Masayori Tsutsumi has been an Inspector with the Department of Safeguards, International Atomic Energy Agency, since May, 1977. Previously he had worked at the Plutonium Fuel Fabrication Facility of the Power Reactor and Nuclear Fuel Development Corporation (PNC) Tokai Works, for 10 years. He will resume his old position in May, 1980, where he is expected to develop and apply the Plutonium Inventory Control System (PINC) to the new plutonium facility of PNC, based on his previous experience in plutonium fuels fabrication and knowledge of safeguards techniques.

Samuel Untermyer is a principal engineer with National Nuclear Corp., which company he founded with three associates, including **Herman Miller**. Untermyer was associated with reactor design prior to this time. At Oak Ridge under Prof. Wigner, he developed the original design for watercooled, zirconiom clad submarine reactors. Later, at Argonne, he developed and tested the first BWR. Joining G.E. in 1954, he developed the design for larger BWR's and built a prototype. While at NNC, since 1961, he has developed a wide variety of equipment for detecting and assaying SNM materials. He holds a patent on active coincident detectors having more than two scintillation detectors. He is a Fellow of ASME and ANS.

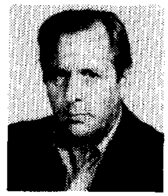
Lynn W. Vaught has been active in the nuclear materials safeguards program since 1972. He was with the Babcock & Wilcox Co.'s, Naval Nuclear Fuel Division, Lynchburg, Va., as an industrial engineer until 1978. Then he joined the Allied-General Nuclear Services, fuel reprocessing facilities located at Barnwell, SC as Supervisor of Technical Security. He was responsible for electronic maintenance and testing of the Nuclear Material Safeguard equipment and procedures; also, he worked in the development of Advance Safeguards methodology. In May, 1979, he accepted the position of Physical Security Specialist with South Carolina Electric and Gas Co., Columbia, S.C. He has responsibility for engineering, test and maintenance of the security program. This includes nuclear, fossil, oil, gas and hydro-electric generating facilities; gas distribution and service operations; computer facilities; all customer/financial service centers and administrative facilities.

William R. Vroman is a chemist with Argonne National Laboratory, Idaho Division. His primary involvement is assisting in the "start up" operation of the NDA Laboratory. In this position, he is also responsible for the continued development and implementation of NDA techniques. Prior to his joining the Special Materials section, he spent the past 12 years in the Analytical Chemistry section at Argonne.

Ella C. Werner, Arlington, Va., a life member of INMM, is now retired. She served as Editor of **The INMM Newsletter**, predecessor to this journal. Members of the Venture Clubs of America (a service club of young professional and business women) in the area named their "Handicapped Student Scholarship" in Miss Werner's honor. She recently took a three-week tour of


Vroman


Werner


White


Williams


Wilson

four Scandanavian countries and is active in Republican Women, Soroptimist International. Miss Werner says she reads INMM Journal "... everything I can understand ... much is over my head." She says she misses her AEC and INMM associates.

Don J. White is Chief of Health Physics, Nuclear Weapon Effects Laboratory. He is also Nuclear Surety Officer and Chairman of the Nuclear Surety Board for White Sands Missile Range, New Mexico. The laboratory operates a variety of devices to simulate nuclear weapon effects, including; a Fast Burst Reactor, Accelerators, EMP Generator, Solar Test Facility, Gamma Range and others.

Robert A. (Bob) Williams is a principal engineer with the Nuclear Fuel Division of Westinghouse Electric Corporation in Pittsburgh, Pa. His current activity involves technical input for design and licensing of a proposed Nuclear Fuel Fabrication Plant to be built near Montgomery, Ala. He has been a member of INMM since 1976.

Raymond F. Wilson is Manager, Technical Records at the Springfields Works of British Nuclear Fuels Limited, Preston, England. He is involved with all aspects of Nuclear Materials Management including Nuclear Materials Control, Accountancy and Safeguards. He has spent 21 years in the Nuclear Industry and prior to his present position was Group Manager for BNFL's production of fuel elements for Magnox Reactors.

Barbara (Barbi) Wilt recently transferred from her Safeguards position as a Physical Scientist with DOE, Richland Operations Office (Hanford), to a safety position as a Health Physicist with RL. Although no longer in safeguards, she is still active in INMM. She is now Secretary-Treasurer of the INMM Pacific Northwest Chapter as well as Public Affairs Chairman.

ASTM Award of Merit to C. D. Bingham

A long-time member of INMM who serves on the Editorial Advisory Committee of the Institute Journal, **Nuclear Materials Management**, has been named a recipient of the Award of Merit by the American Society for Testing and Materials (ASTM).

Dr. **Carleton D. Bingham**, director of the New Brunswick Laboratory, U.S. Department of Energy, Argonne, Ill., who resides in Naperville, Ill., received the award during the January 15-17 meeting in New Orleans of ASTM Committee E-10 on Nuclear Technology and Applications.

Bingham was cited for his contributions to standards development for dosimetry, and radiochemical and analytical techniques for measuring various properties of nuclear materials and for his involvement in Committees E-10 and C-26 on the Nuclear Fuel Cycle.

The Award of Merit, naming the recipient a Fellow of the Society, was established in 1949 by ASTM, a leader in the development of voluntary consensus standards for materials, products, systems and services. The award recognizes distinguished service to the cause of voluntary standardization through productive service to ASTM, marked leadership, outstanding contribution, or publication of papers.

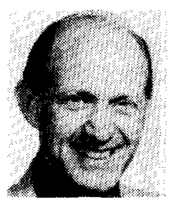
A native of Washington, D.C., Bingham received his B.S. degree in chemistry with honors and distinction from San Diego State University in 1950. He attained his Ph.D. in physical chemistry from UCLA in 1959.

Prior to joining NBL in 1971, he was employed by Atomics International for 12 years in various positions: senior research chemist, manager of the analytical chemistry laboratory, and project engineer for fast reactor chemistry.

In addition, Bingham was a radiological safety engineer and senior radiological safety engineer for the University of California from 1953-1959.

Prior to 1971, Bingham conducted or directed research and application of the chemistry, nuclear chemistry, and radiochemistry of measurement science pertaining to materials, processes, or radiation-related phenomena in portions of the nuclear fuel cycle. Since that time, he has managed and directed research and application of measurement and measurement-related technology to materials essential to the USA nuclear energy programs. He has placed special emphasis on extending the state-of-the-art measurements of uranium and plutonium containing materials for safeguards purposes; providing reference materials which national and international nuclear material measurement processes may be calibrated; and assessing and evaluating the quality of measurements being performed on nuclear materials for safeguards purposes.

Bingham serves as the U.S. representative to advisory groups for the International Atomic Energy Agency on measurements and reference materials for nuclear materials safeguards. He is also the author or coauthor of nearly 50 papers related to this field of expertise.


Bingham

Safeguards System in Japan

By Yoshio Kawashima, Yasuhiro Morishita,
Kaoru Naito and Katsuji Higuchi

1. Safeguards in Japan

Research, development and utilization of nuclear energy in Japan have been carried out only for peaceful purposes according to the provisions of the Atomic Energy Basic Act promulgated on December 9, 1955. Based on this principle of the Act, related laws and regulations have been enacted, such as the "Law for Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Nuclear Reactors" (hereinafter referred to as "Law for Regulation of Nuclear Reactors, etc.") which obligate facility operators to carry out proper management and control of nuclear materials.

Further, Japan has concluded Nuclear Energy Cooperation Agreements bilaterally with the United States of America, United Kingdom, Canada, Australia and France. In these agreements Japan undertakes that nuclear fuel materials, equipment, and facilities supplied by these countries, and special fissionable materials produced by the use of them shall not be diverted for military purposes, and, accordingly, they are to be placed under the safeguards of the International Atomic Energy Agency (IAEA) in order to verify the above undertaking.

On the other hand, Japan ratified the Treaty on the Non-proliferation of Nuclear Weapons (NPT) on June 8, 1976, becoming its 97th State Party. According to the provisions of Article III. 1 and 4 of the NPT, the Safeguards Agreement between the Government of Japan and the IAEA was concluded (signed on March 4, 1977), and became effective on December 2, 1977) in order to verify that no nuclear material in the peaceful nuclear activities in Japan has been diverted to nuclear weapons or other nuclear explosive devices. Consequently, the application of safeguards based on the above-mentioned bilateral agreements was terminated with respect to Japan, and replaced by the application of safeguards under the NPT.

Necessary arrangements were made to establish and maintain the national safeguards system which is required under the NPT Safeguards Agreement between Japan and IAEA. For example:

(1) Relevant laws and regulations were formulated and revised in order to establish and maintain the system of accounting for and control of all nuclear materials subject to safeguards under the Agreement.

(2) In April 1977, the new Safeguards Division was set up in the Nuclear Safety Bureau, Science and Technology Agency, as the central organization responsible for maintaining an effective national system of safeguards, including independent verification of all nuclear materials under the Agreement. The number of safeguards inspectors was substantially increased.

(3) According to legal provisions, the Nuclear Material Control Center (NMCC) was designated in December 1977 as the central organization for computer processing of material accounting data, keeping centralized accounts on the basis of reports collected from the operators and proceeding with the technical and accounting control and analysis of the information received (for example, MUF analysis). Reports on material accountancy in Japan are then submitted to IAEA through the Government. Details of the NMCC's activities are described in Section 3.

(4) The Safeguards Analytical Laboratory was constructed at Tokai-mura to make analysis of samples taken by national inspectors at bulk handling facilities, as a part of independent verification activities. The safeguards system in Japan is outlined in Figure 1.

2. Research and Development of Safeguards Technology

Japan has promoted research and development works in safeguards technology by granting a subsidy for Peaceful Uses of Nuclear Energy or by subsidizing Power Reactor and Nuclear Fuel Development Corporation (PNC) and Japan Atomic Energy Research Institute (JAERI) in order to make the application of safeguards more effective. As the utilization of nuclear energy progresses, further extensive works in the research and development of the safeguards technology are foreseen to be necessary in order to cope with the increase in the quantity of nuclear materials handled and in the number of nuclear facilities in the future.

For example, in 1978, a "Study on Effectiveness of National System Integrating the Techniques of Material Accountancy and Physical Protection" was carried out by one of the Subsidies mentioned above. Further, related research and development works in the field of safeguards and physical protection were carried out by NMCC, JAERI, PNC and other organizations. As a part of international cooperation, the study on the improvement of safeguards for a reprocessing plant called TASTEX (Tokai Advanced Safeguards Technology Exercise) has been carried out jointly by Japan, the United States of America, France and IAEA since 1978.

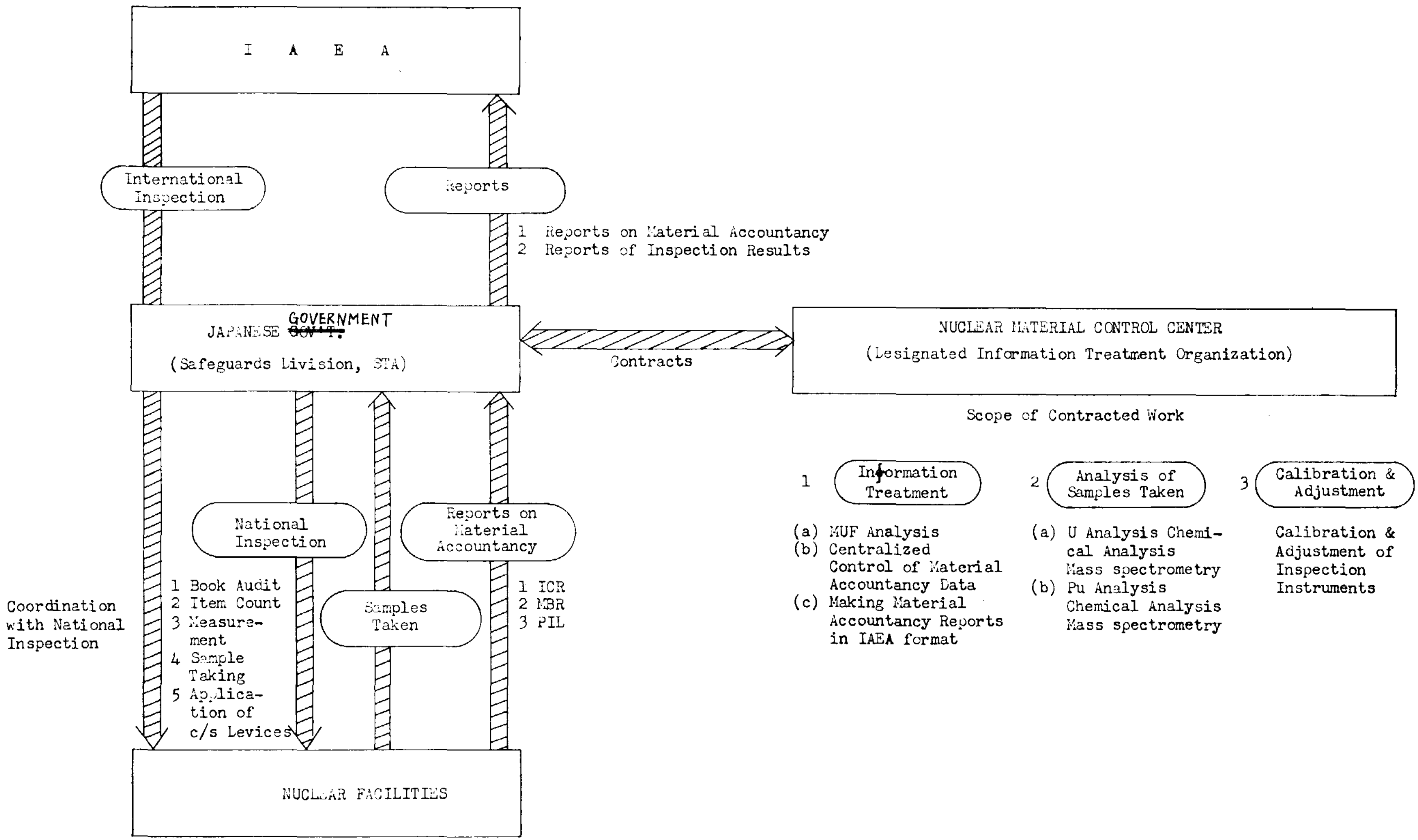


Fig. 1 Safeguards System in Japan

Table 1 shows the tasks of the TASTEX program. The R & D expenses in safeguards technology in terms of fiscal years are shown in Table 2.

3. Activities of NMCC

NMCC was founded in April, 1972 with the support of the Japanese Government and private industries to assist in establishing and maintaining the safeguards system of Japan. The tasks which NMCC is assigned are summarized as follows:

(1) Data-processing of safeguards-related information by using an electronic computer as the central organization legally designated by the Government.

(2) Safeguards analysis and measurement of samples taken by the national inspectors, and maintenance of safeguards inspection instruments, which are carried out in the Safeguards Analytical Laboratory located at Tokai.

(3) Survey and research on safeguards, physical protection and nonproliferation policies from the viewpoint of nuclear material control.

With regard to safeguards information treatment, NMCC started studies on this subject and completed a preliminary report system in 1972 and modified this system in 1973, whereas study on a safeguards evalua-

TABLE 1. INDIVIDUAL TASKS OF *TASTEX* PROGRAM

TASK	TASK DESCRIPTION	PARTICIPANTS	
A	Evaluation of Performance and Application of Surveillance Devices in the Spent Fuel Receiving Areas	Japan US	(PNC) (Sandia)
B	Collection and Analysis of Gamma Spectra of Irradiated Fuel Assemblies Measured at the Storage Pond	France Japan US	(CEA/COGEMA) (PNC/JAERI) (LASL)
C	Demonstration of Hull Monitoring System	France Japan US	(CEA/COGEMA) (PNC) (LASL)
D	Demonstration of the Loadcell Technique for Measurement of Solution Weight in the Accountability Vessel	Japan US	(PNC) (INEL)
E	Demonstration of the Electromanometer for Measurement of Solution Volume in Accountability Vessels	Japan US	(PNC) (BNL)
F	Study of Application of DYMAC Principles to Safeguarding Spent Fuel Reprocessing Plaints	IAEA Japan US	 (PNC/JAERI) (LASL)
G	K-edge Densitometer for Measuring Plutonium Product Concentrations	France Japan US	(CEA/COGEMA) (PNC) (LASL)
H	High Resolution Gamma Spectrometer for Plutonium Isotopic Analysis	France Japan US	(CEA/COGEMA) (PNC) (LLL)
I	Monitoring the Plutonium Product Area	Japan US	(PNC) (INEL)
J	Resin Bead Sampling And Analytical Technique	IAEA Japan US	 (PNC) (ORNL)
K	Isotope Safeguards Technique	France IAEA Japan US	(CEA/COGEMA) (PNC/JAERI) (BPNL)
L	Gravimetric Method for Input Measures	France US	(CEA/COGEMA) (INEL)
M	Tracer Methods for Input Measurements	France US	(CEA/COGEMA) (INEL)

Note: BNL (Brookhaven National Laboratory)
BPNL (Battelle Pacific Northwest Laboratory)
CEA (Commissariat a l'Energie Atomique)
COGEMA (Compagnie Generales des Matieres Nucleaires)
INEL (Idaho National Engineering Laboratory)
ORNL (Oak Ridge National Laboratory)
LASL (Los Alamos Scientific Laboratory)

TABLE 2. EXPENSES OF SAFEGUARDS R & D IN JAPAN
(In million Yen)

FISCAL YEAR / *ITEM*	*1973*	*1974*	*1975*	*1976*	*1977*	*1978*	*1979*
Subsidy for Peaceful Uses of Nuclear Energy	65	46	26	25	10	16	7
R & D by PNC	23	47	41	68	165	162	253
R & D by JAERI	45	33	26	17	68	96	138
TOTAL	131	126	93	110	243	274	398

tion system based on MUF analysis started also in 1972. Then a design information treatment system, an inspection planning system, and an inspection reports processing system were developed in 1974, 1975 and 1976, respectively, followed by the testing of a computer system "NPT-JAPAN" to integrate all these systems in 1977.

However, such a data processing system had been tested and demonstrated on an experimental basis prior to its use for practical purposes at the end of 1977. Since the Safeguards Agreement with IAEA under NPT was put into force in December 1977 and NMCC was authorized, by amendment of the Law for Regulation of Nuclear Reactors, Etc., as the organization responsible for processing and analysis of safeguards data at the same time, NMCC started, from the outset of 1978, to operate such a data processing system, NPT-JAPAN, for the first time on a practical basis.

The NPT-JAPAN was further improved in the course of actual application in 1978 and 1979. In 1979 calculation efficiency was improved and the content of calculation was widened by changing the terminal equipment to a larger-capacity IBM system. The introduction of this new calculation equipment also improved the capability of keeping data confidential whereas the data base was changed to a tree-type, multiple level arrangement, which improved data retrieval and storage, and the NPT-JAPAN program was re-rwitten for the new system designed to permit easier operation, maintenance and improvement.

Accounting reports from about 230 material balance areas are delivered every month from the Government to NMCC, which makes analysis and processes these data, preparing reports and statistical tables as required in accordance with the Safeguards Agreement with the IAEA. These reports are submitted to IAEA through the Government. The data obtained in this way are stored in a data base system of NMCC for reference for future material control. NMCC, in addition, prepares necessary materials for the government inspectors by using the data base system. Inspection results obtained by the inspectors are again processed and analyzed by NMCC to provide data and materials for MUF evaluation.

NMCC has also been expanding its works since 1972 in the field of the safeguards analysis of samples taken by the government inspectors, and of the calibration and adjustment of inspection instruments used by the government inspectors for their inspection activities in nuclear facilities. These tasks have been carried out in the Safeguards Analytical Laboratory at Tokai-mura since February 1979. The laboratory consists of an analytical building, an auxiliary machinery building and a liquid waste tank building, with a total floor area of 749m^2. The analytical building is divided into three areas; they are a non-controlled area, a U-handling area, and a Pu-handling area separated by an air lock. The main analytical and measurement equipments installed are three mass spectrometers, two multichannel pulse-height analyzers, three potentiometric titrators, eleven glove boxes and four hoods.

The Safeguards Analytical Laboratory together with the safeguards information processing system will be of great help in implementing national and international safeguards in Japan.

4. Prospects for Safeguards System

A few years ago, many of those who were concerned with non-proliferation policy started to express their concern about effectiveness of the IAEA safeguards and stressed necessity of exploring alternative measures for non-proliferation of nuclear weapons. The efforts made by many countries during the INFCE period were focused on this problem. However, through the discussion at a series of meetings of the INFCE, the IAEA safeguards have again come up to the surface and been recognized as one of the most effective nonproliferation measures, and therefore some improvement of them is regarded as indispensable.

According to the Safeguards Agreement with IAEA, Japan's national safeguards system is to play an important role for implementing the IAEA safeguards. The IAEA and Japan's safeguards systems are closely related and increase in effectiveness of Japan's system would result in that of the IAEA safeguards system. Many countries, of course, maintain their own safeguards systems, but these systems should not be isolated. In particular, with the advent of the NPT system, the IAEA safeguards system based on this new concept started to spread on a global scale and to integrate the safeguards systems in the NPT countries. In this regard, the IAEA system is not only related closely to the Japan's system, but also extended to cover Euratom safeguards system and even to safeguards systems of some nuclear weapon states, such as the United States, United Kingdom and France.

Prospects of the Japan's safeguards system, therefore, will depend upon to what extent safeguards systems in the world could succeed in developing an effective safeguards system on a global basis. To this end, it is highly desirable for the countries concerned to mutually exchange their experiences of implementing international safeguards and results of their R&D works in improving safeguards technologies, to the extent possible.

NRC Adopts New Rules on Classified Information

The Nuclear Regulatory Commission is adopting new regulations to establish procedures for granting security clearances to employees of its licensees who require access to classified information about the protection of nuclear material. The rules will also provide procedures for the control and protection of classified information at the licensee's premises.

The classified information primarily involves measures for the physical protection of formula quantities of special nuclear materials (uranium 233, uranium 235 and plutonium), as well as the control and accounting data for such materials. Information on inventory discrepancies is included during the period of time it is classified.

The rules provide procedures for obtaining security clearances (access authorizations) for individuals and the means for obtaining security facility approval. They do not indicate which individuals must have access authorizations.

NRC estimates that the number of facilities possessing NRC-classified information will be limited to no more than 12 fuel cycle facilities, with related transportation activities, and 4 to 8 reactor sites. Site-specific physical security information concerning light water power reactors is not included at this time; and the rules do not include, and are not part of, the Commission's previously proposed clearance rule for persons having access to or control over special nuclear material.

The new requirements are contained in two new parts to the NRC's regulations. Part 25 provides procedures for applying for security clearances for licensee personnel, licensee contractors or agents and certain other persons (such as individuals involved in NRC adjudicatory proceedings on license applications). Any of these individuals who need to have access to classified information in connection with NRC-regulated or licensed operations must seek an appropriate access authorization from the NRC.

The new Part 95 provides that licensees who need to possess classified information received or developed in conjunction with their license must request NRC approval of the facility where the information will be kept and the procedures that will be used to control and safeguard it. Persons assigned to protect the information in the facility must have an NRC security clearance at a level appropriate to the degree of sensitivity of the information being protected.

The new regulations will be effective on **May 19, 1980** (75 days after publication in the Federal Register on March 5, 1980). They were published in the Federal Register in proposed form on July 2, 1979, for public comment. Several minor changes were made as a result of the comments received.

Median 1979 R&D Salary: $2,385 Per Month

The 1979 monthly median salary for engineers and scientists engaged in research and development in the U.S. was $2,385, a recent study by Battelle's Columbus Laboratories shows.

The study, conducted for the U.S. Department of Energy, reports that the monthly median salary for researchers and supervisors with a bachelor's degree was $2,201; master's degree, $2,462; and doctor's degree, $2,688. These figures are based on salaries of degreed nonsupervisory and supervisory researchers at 322 establishments.

Battelle, which has conducted the study annually since 1968, sampled 91,315 scientists and engineers in 1979. These researchers work in industry, nonprofit research institutes, federally funded contract research and development centers, educational institutions, and the federal government.

Of the researchers surveyed, 8.6 percent did not hold any academic degree; 45.7 percent had bachelor's degrees; 26.2 percent had master's degrees; 18.5 percent had doctor's degrees; and 1.0 percent had medical degrees.

According to Ms. **Jean Newborg**, who headed the study, a comparison of monthly median salaries for nonsupervisory researchers with bachelor's or master's degrees shows those working as mining/petroleum engineers and aeronautical engineers earned the highest salaries while agricultural and biological researchers earned the lowest. For nonsupervisory researchers with doctor's degrees, mining/petroleum engineers earned the highest monthly median salaries, and psychology researchers earned the lowest. The survey presents salary information for 19 scientific and engineering occupations.

Ms. Newborg said a trend analysis of 162 of the establishments that have participated during the past five consecutive years shows median salaries for researchers increased 6.8 percent in 1979. This compares with increases of 7.0 percent in 1978, 6.0 percent in 1977, and 6.2 percent in 1976.

MICROSCOPIC PROCESS MONITORING*

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ABSTRACT

Microscopic process monitoring is a material control concept being developed at the Oak Ridge National Laboratory for application to future large reprocessing facilities. It is expected that reprocessing facilities will be equipped with abundant process instrumentation and an interactive computer system to access and interpret the resulting data. The microscopic process monitoring methodology would take maximum advantage of these resources in an effort to quickly and reliably detect nuclear material diversion. This process monitoring strategy is currently being tested on a small scale; larger demonstrations are planned.

DEFINITION OF PROCESS MONITORING

Many studies have indicated that current domestic and international safeguards practices need to be upgraded to provide adequate safeguards for future large spent fuel reprocessing plants.[1,2,3] Safeguards systems must be developed that are capable of quickly detecting the diversion of a relatively small quantity of nuclear material from the bulk processing parts of a reprocessing operation. Some of the strategies proposed for achieving an enhanced level of safeguards performance, while attractive in concept, rely on complex and expensive instrumentation. Every effort should certainly be made to develop instruments capable of accurately and reliably measuring nuclear material concentrations and inventories in the environment of a reprocessing plant. Fortunately, added safeguards protection can be achieved through use of the wide variety of instrumentation normally available in a reprocessing facility for process control and other non-safeguards purposes.[4] Thus we are investigating safeguards systems that could be based largely on process control instrumentation.

For the purposes of this paper, a process monitoring system is defined as a type of material control system that uses process control data or other readily available information about process status in order to quickly detect either the diversion of nuclear material from the process or unauthorized process operation. It is to be emphasized that process monitoring does not require direct measurement of nuclear material concentrations or inventories; thus the feasibility of implementing process monitoring is not dependent on the successful development of dedicated safeguards instrumentation. It is necessary, however, to develop a methodology for combining and correlating the potentially large quantities of process control data upon which a process monitoring system would be based. One such methodology, currently being developed at the Oak Ridge National Laboratory, is called miscroscopic process monitoring.

MICROSCOPIC PROCESS MONITORING

The development of microscopic process monitoring (MPM) has been motivated by the conviction that a process monitoring system should use all available measurement information, both because this permits a maximum understanding of the status of the process and because use of a wide variety of process measurement data would tend to minimize the dependence of the process monitoring system on any single type of measurement. The MPM methodology offers a mechanism for taking advantage of all varieties of process measurement data, not only volumes, masses, flow rates, and other variables of obvious safeguards importance, but also temperatures, densities, liquid-liquid interface levels, and other parameters that may be only indirectly affected by nuclear material diversion. To make use of such data, a process monitoring methodology must exploit the correlations between the various measured parameters and the status of the nuclear material in the process. As the name "microscopic" implies, the MPM methodology is based on local correlations between a small number of process variables over a small period of time, thus avoiding the complexity of modeling wide-range or long-term correlations. Use of a wide variety of process data, lack of dependence on the availability of any particular type of measurement in any particular location, and use of local or "microscopic" mathematical models are the salient characteristics of MPM.

Microscopic process monitoring compares measured values of available process variables with predicted values. The predictions are based on previous measurements of the variable in question or on contemporary measurements of other variables. Figure 1 illustrates the basic MPM methodology. The data base must contain current values of

*Research sponsored by the Nuclear Power Development Division, U. S. Department of Energy under contract W-7405-eng-26 with Union Carbide Corporation.

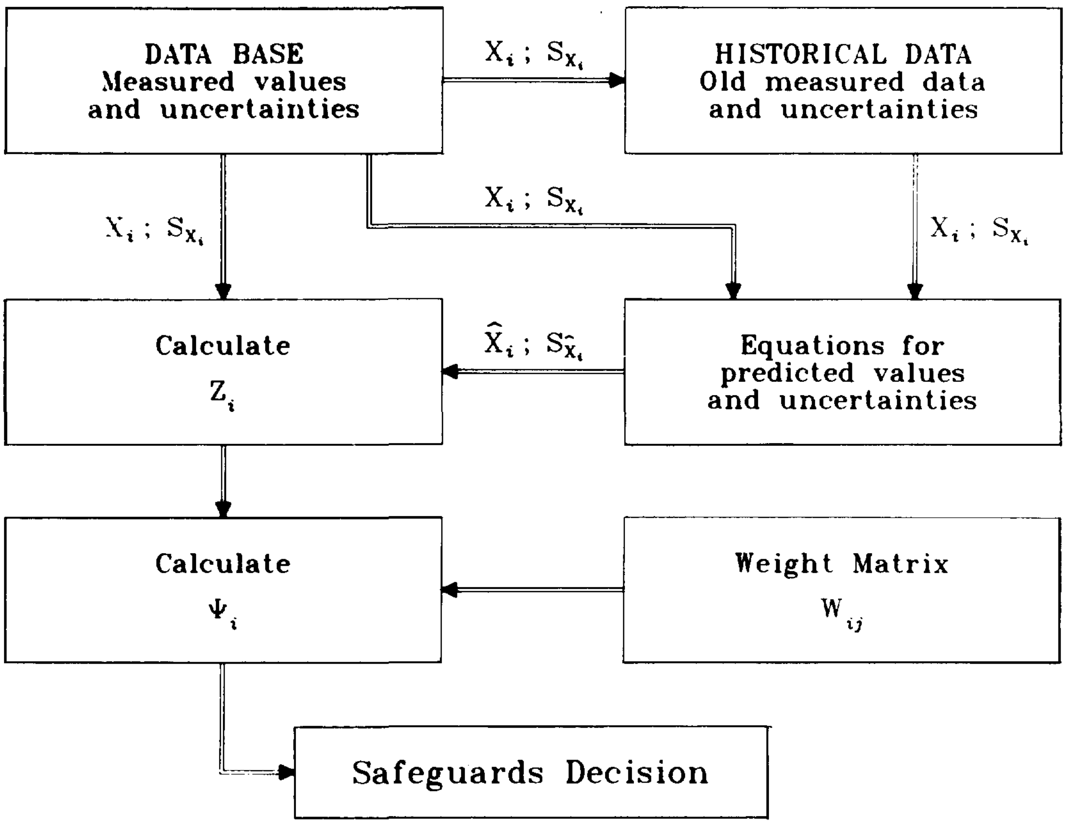

Fig. 1. Microscopic process monitoring methodology.

N measured parameters as well as estimates of the uncertainty associated with each measurement. These two categories of information can be thought of as vectors labeled X and S_X respectively. Each X_i (i = 1, N) in X represents the most recent measured value of the ith process variable. Similarly, each element S_{X_i} belonging to S_X represents the most recent estimate of the uncertainty associated with the measured value X_i.

Corresponding to each measured value, the MPM methodology requires a predicted value. The predicted values, $\hat{X}$, are based on extrapolations from earlier measurements or on simple models describing the relationships between different variables. In addition, the uncertainties of the predicted values must be estimated. These are organized into a vector labeled $S_{\hat{X}}$. In the course of applying MPM to a small system of batch operated tanks, simple, one-line equations for calculating the predicted values have been developed and successfully used. It should not generally be necessary to use complicated process vessel models or other elaborate methods to predict parameter values. As currently envisioned, the MPM methodology will only require that parameter values be predicted a few minutes into the future. It thus appears that MPM can be based on a large number of simple models or prediction equations and that extensive modeling efforts will not be necessary for successful implementation of the technique.

The first step in the MPM logic is to generate a statistic, labeled Z, that provides a measure of the significance of the difference between $\hat{X}$ and $\hat{X}$. We then generate ψ, an M x 1 vector, by premultiplying Z by an N x M weight matrix, W. The function of the weight matrix is to combine individual elements of the Z vector in a way that emphasizes their safeguards importance. The ψ vector now contains the distilled information upon which a safeguards decision can be reliably based.

AN EXAMPLE OF THE MICROSCOPIC PROCESS MONITORING LOGIC

As an example of how the MPM logic works, consider the case of a tank volume measurement. An easy way to predict the volume of solution that should be in the tank is to extrapolate from two or more previous volume measurements. If the current volume measurement disagrees with the prediction, the MPM system will automatically initiate a prescribed interrogation procedure designed to determine the cause of the discrepancy. In general, there are four possible mechanisms for a discrepancy between predicted and observed volumes: (1) there was a random error in some component of the volume measurement; (2) there is a systematic error or a systematic malfunction in some component of the volume measurement; (3) the process is not behaving as expected; or (4) solution is missing. The MPM logic is designed to distinguish between these mechanisms.

The random error mechanism could be identified by repeating the comparison when the next volume measurement is taken or, better yet, by automatically causing the instrument to repeat the measurement several times. The latter approach would require that the MPM system be capable of communicating with the individual measurement instruments.

A systematic error or malfunction in the volume measurement could be identified by examining the individual components of the measurement. The measured level, density, and temperature could be compared in turn to their predicted values in the hope of isolating the malfunctioning component. It might not always be possible to immediately identify an instrument failure, but continued observation of the components should eventually reveal the problem.

The third mechanism, unexpected process behavior, could be identified by including in the MPM logic a repertoire of equations that would predict the tank volume resulting from any foreseeable change in process operations. These equations would use measured values of parameters in neighboring vessels and streams to determine if a batch transfer of solution, an altered flow rate, or some other processing event could explain the discrepancy. Information on the status of valves, steam jets, air lifts, and pumps would be useful in this context. The MPM system would automatically search for an explanation of the volume discrepancy among these possibilities.

An actual loss of solution would, in the absence of outside information, be identified primarily by eliminating the alternatives. It should be emphasized that this reasoning process will be undertaken automatically by the MPM system, requiring little or no human intervention until the MPM logic has evaluated all available information and an actual safeguards decision is required. The weighting matrix, W, is the means used by the MPM system to combine relevant pieces of measurement information and thus distinguish between the mechanisms described above.

THE ADVANTAGES OF MICROSCOPIC PROCESS MONITORING

An important feature of MPM is its use of a wide variety of real-time measurement data for safeguards purposes. In theory, an MPM system could draw on nearly every measurement datum available on a facility's interactive computer. There are two advantages inherent in this approach. First, the performance of an MPM system would not be critically impaired if it proves impossible to accurately measure a specific parameter in a specific location. In fact, MPM was conceived as a material control strategy that would use only readily available measurement technology. The second advantage of MPM is that it would be difficult to defeat the system by tampering with the measurement instruments or their transmitted data. This advantage also derives from the depth of the measurement base upon which MPM is founded. An alarm decision would be based on an understanding of the relationships between different parameters. A diverter would have to tamper with several instruments in a quantitatively consistent manner in order to mask a theft of nuclear material. This is especially important in the international safeguards environment where tampering is a major concern.

CONCLUSION

The MPM strategy is being tested on a small series of well-instrumented tanks at the Oak Ridge National Laboratory. These tests should demonstrate the basic feasibility of the MPM concept and permit us to optimize the details of the MPM methodology. A large-scale demonstration of MPM is tentatively being planned and will be documented as it develops.

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Performance Goals For International Safeguards*

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Abstract

The safeguards applied by the International Atomic Energy Agency are based on technical performance goals and criteria that have been developed, but not officially adopted, by the Agency. The goals derive in part from the external consequences that safeguards are intended to prevent and in some cases on internal considerations of feasibility. To the extent that these goals may not be attainable, as may be the case with large-throughput bulk reprocessing plants, the Agency is placed in a difficult positon.In this paper safeguards goals and criteria and their underlying rationales are critically examined. Suggestions for a more rational and workable structure of performance goals are offered.

IAEA safeguards are commonly viewed as a system for detecting national diversion of nuclear materials, a perception that is reinforced by an official statement that the purpose is the timely detection of nuclear materials and the deterrence of such diversion by the risk of early detection.[1] Despite the emphasis on detection of diversion, the product of the system is the inverse: continued assurance that the state is complying with treaty obligations to refrain from using peaceful nuclear activities to further any military purpose.[1] Data is collected and analyzed periodically to provide that assurance.

One might envision an abrupt diversion of a substantial quantity of material, with safeguards system providing a timely indication of the diversion. However, the limiting cases, which determine the desired safeguards performance characteristics, would involve quantities at the threshold of detectability, with the State attempting to conceal the diversion. In the general case, a diversion would be detected by a process of elimination: alternative explanations of apparent violations and non-compliance would have to be evaluated before a conclusion could be reached that diversion may have occurred. Hence, the safeguards system routinely collects and analyzes data to verify that declared activities are in compliance with agreements. The system is based on a **capability** to detect diversion, and that capability is a major factor in determining the degree of assurance that safeguards provide.

The detection capability is certainly the most visible, and perhaps the only readily quantifiable, element of the assurance provided by safeguards. Internally, it has often been the design objective of the technical safeguards system. Externally, the quantified detection capability has usually been taken by policymakers to be the measure of system performance, despite the fact that the objective of safeguards is the broader one of providing assurance of compliance, and that in the general case a finding of possible diversion will be reached through an inability to otherwise explain a failure to verify compliance and not by direct indication of diversion. Here we will speak of performance goals of the technical system that provides the detection capability, recognizing that safeguards objectives include the broader function of providing assurance.

A capability for detection can be described in terms of (1) the threshold quantity to be detected, (2) the probability of detection, (3) the probability of false alarm, and (4) the time from diversion to detection. These characteristics are all interdependent, and within a particular state of the art, many combinations are possible. The IAEA is obligated to strive for the most effective safeguards that it can, within the limitations of resources, acceptability, and technology.[3] At the same time, the IAEA is obligated by the Statute to provide "safeguards", whatever the functional capability may be. The choices among the four operational characteristics are there by limited by the internal constraints that the IAEA must operate under. The balance among them can be determined by the external consequences of diversion that the safeguards are intended to prevent; e.g., fabrication of a single explosive, the consequences of false alarm, etc.

Current, Tenative IAEA Performance Goals

The IAEA operates safeguards under a set of goals that have been generally accepted, but not formally adopted, by the Agency. Briefly stated, these are:

A capability to detect diversion of enough fissile material to make one explosive:

— diverted at one time, or spread over one year;
— with a probability of detection 95% or better;
— with a probability of false alarm 5% or less;
— the detection to be "timely" in relation to the time required to install the material in an explosive device.

A view has been strongly held by some US policy makers that, for the detection to be "timely," it must be accomplished soon enough to allow preventive diplomatic action to be taken before the diverted material could be converted to weapon-usable form.[4] That view

*The views expressed herein are those of the authors, and do not necessarily reflect those of Brookhaven or Sandia Laboratories or the Department of Energy.

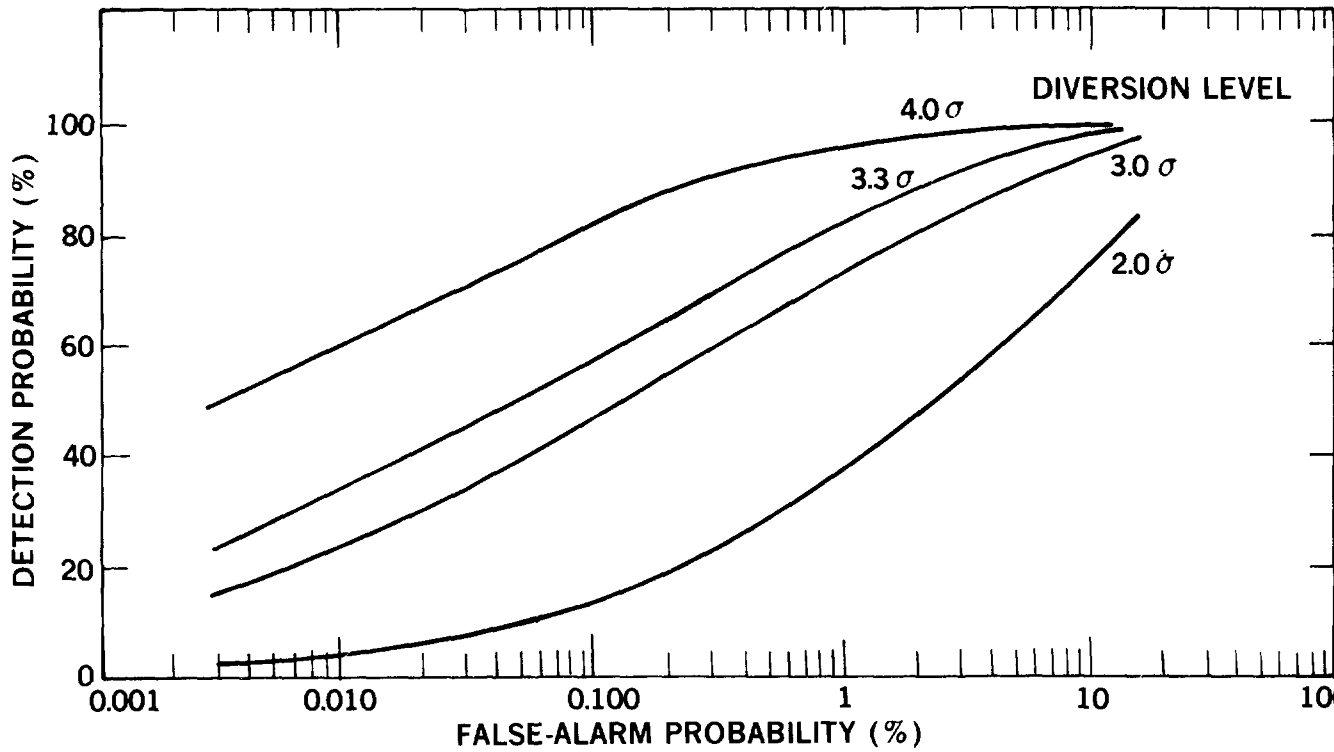

FIGURE 1: DETECTION PROBABILITY VS ONE-SIDED FALSE-ALARM PROBABILITY FOR VARIOUS DIVERSION LEVELS

of the purpose of safeguards is directly contrary to the statement of Deputy Director-General Fischer.[2] Nevertheless, the IAEA has adopted **de facto** an approximation of that definition of timely detection.[5]

Problems With Current Goals

The current **de facto** goals might be satisfactory, if only on the basis of reassuring policy makers who have different understandings of the objectives of safeguards, if they were attainable with reasonable cost and impact. However, with large-throughput, bulk processing plants there is little prospect that the goals can be met. A nominally-sized 1500-te/yr LWR reprocessing plant meeting current NRC standards for accountability would have more than an order of magnitude greater uncertainty of kilograms of plutonium per year than the goal quantity of 8 kilograms.[6] Furthermore, detection of covert diversion of any quantity within the time estimated for conversion to weapon-usable forms, estimated by the IAEA to be one to three weeks for plutonium oxide (days for metal) might not be possible, in view of the fact that detection of concealed diversion is by an elimination process. Only very small reprocessing plants could be expected to meet such a requirement.

The goals for probability of detection and probability of false alarm have been tentatively set by the IAEA at 95% minimum and 5% maximum, respectively.[7] These goals are apparently internally-derived, on the basis of limits of statistical distributions. It is not clear what significance they have, if any, in terms of external consequences of those kinds of failure. It would appear that a false alarm, if what is meant is an erroneous conclusion by the IAEA Board of Govenors, would be a very serious matter. In view of the numbers of bulk-processing facilities that will be safeguarded in the future, it appears that a much lower false alarm probability, perhaps 0.1 or 0.01 percent, would be required. At the same time, the deterrent value of estimated* detection probabilities on the order of 95% is not obviously better than some lower value, say in the range of 50%.

The significance attached to one significant quantity — the quantity required to fabricate a single explosive — seem exaggerated when considering a national diversion. The objective of safeguards is to provide assurance that non-proliferation undertakings are not willfully violated, as indicated by Fischer,[2] not to sound an alarm so that the fabrication of the first unit can be prevented. Evidence of willful and intentional violation of safeguards agreements, even if the quantity were less than a significant quantity (or if there were no actual diversion at all) should be a principal concern. From external considerations, the significance of the quantity diverted would seem to depend on the State and on accompanying evidence of violations, and not on an absolute quantity.* It is necessary for internal considerations, so that detection capability can be defined, to set some value that can relate to the other performance measures such as timeliness and probabilities of failure, and thereby to external con-

*Detection probability must remain an **a priori** estimate, since no statistical population of diversion events will be generated.

*One explosive's worth has much more significance in the case of subnational diversion. Perhaps that significance has been extended to national diversion through a blurring of the distinction.

sequences. However, the significance that is attached to one explosive's worth in terms of international consequences seems unwarranted.

The interrelationships among the fundamental performance measures for the detection system are shown in Figure 1. To meet the 95%-detection/5% false-alarm criteria a diversion must be at least 3.3 times as large as the sigma of the measurement uncertainty (neglecting all modes of failure other then measurement error). With that same measurement precision, false-alarm probability could be reduced at the expense of probability of detection. False-alarm probabilities of 0.01 to 0.1 percent could be achieved with corresponding detection probabilities of 34% and 48%, respectively. These seem to be more reasonable values in terms of safeguards objectives than the values currently specified in the Safeguards Manual.

Timeliness interacts as strongly as the other criteria shown in the figure, if the allowable time for detection becomes very short. The effect would be to further degrade the threshold detection level beyond the 3.3 sigma. Since the IAEA has stated that the conversion time for separated plutonium is very short[8] — days or weeks — a clear, unambiguous detection of diversion in comparably short times would have to be at the expense of other performance values.

It appears that rigid adherence to the propoosed performance goals will be counterproductive, resulting in system designs that are grossly unbalanced at best, with a potentially-serious loss of confidence in safeguards if stated goals are not met. What is needed is a critical reexamination of the rationale upon which current goals are based. We have already discussed threshold-quantity and failure-probability goals. Let us turn now to the question of timeliness, which has received major emphasis in US policymaking circles.

Implicit in the timeliness requirement as it is espoused by some US policymakers is the assumption that when conversion time for one explosive is completed some kind of point of no return is reached, after which corrective diplomatic action is pointless or ineffective, and the diverting State must henceforth be accepted as a member of the nuclear club. It is not at all apparent or self-evident why that should be so, but in all the voluminous literature on non-proliferation we are aware of no discussion of that fundamental assumption. It is accepted as a rule of some kind of game, which defines winning or losing in terms of who wins the race at the end of conversion time. A number of arguments against that point of view are offered.

1. The non-proliferation objective is the prevention of the acquisition of nuclear armament by another State, and the threshold is a nuclear-weapon capability with effective delivery systems, not the final assembly of unit no. 1. This process affords considerably more time and opportunity to detect a clandestine weapons program, through both international safeguards and national intelligence activities.

2. An important and officially stated objective of the IAEA is to deter diversion, a function which depends on the consequence of discovery and not on the time at which a violation is discovered. Since the nature of the response of the international comunity to a violation would probably not be any different whether or not conversion had occurred (even assuming that there was some way of knowing whether it had), the deterrent value should be the same in either case. This point can be illustrated by the example of India. There, knowledge of preparations before the test explosion did not lead to the application of effective response measures, and pressures to restrain them continue more than five years later. If the detection-time/conversion-time dependency were correct, such pressures after the test explosion would be pointless. In fact, it would be harmful to US objectives to convey the impression to a potential diverter that once he converts the material into a weapon he is "home free".

3. The objective of diplomatic pressure would presumably be to restore the **status quo ante**; that might include return of the diverted material and assurance that the weapon program itself had in fact been terminated. The accomplishment of neither of these objectives depends on whether the material has been fabricated into a weapon, since, clearly, it can be returned at any stage and, at least in principle, there is no clearly delineated point or threshold beyond which a weapons program cannot be terminated.

4. The claimed shortness of conversion times robs the first weapon assembly of much of its significance, since it implies that the fabrication of a weapon is easy, even for a nation with no prior experience. If so, it cannot have great significance as a threshold.

5. The concern over a single explosive is much more valid in the case of subnational diversion, where the threat is more immediate and the significance of additional numbers of weapons relatively less. The preoccupation with the minimum time to fabricate a single explosive seems to be the result of a blurring of the distinction between physical protection against subnational groups and safeguards against national diversion.

Thus, while timely warning is certainly of value, there is no apparent logical basis for requiring that detection time — the time from diversion to detection — not exceed conversion time, or that there is necessarily any direct, quantitative relationship.

A Suggested Structure For IAEA Performance Goals

The roles of external and internal goals for the IAEA should be clarified. Internal performance goals are necessarily related to feasibility; they are technical, and they govern the performance of the technical system in providing the capability for detection. External goals are political; they are determined by the broader purposes that the safeguards operation is intended to serve: providing assurance that non-proliferation commitments are honored and deterring violations of them.

We suggest the following structure for technical-system performance criteria.

1. Current and near-term performance standards should be based on what it is feasible to do. The current standard is the reference point for negotiation of an agreement, and the IAEA is obligated to apply whatever measures current technology will permit. It can do no more.

2. The standards should not be static. To stimulate improved capabilities and to enhance future

safeguards performance, standards could be scheduled for higher levels in the same way that progressively-tighter air quality and automobile economy standards are scheduled by law to become effective at future dates. Operating systems could be grandfathered, to avoid costly retrofits after commitments are made.

3. External goals are needed to guide the evolving internally-driven performance standards and to drive R&D. Quantitative external goals need not be universal, fixed values. There are no clear limits for external goals that are based on external considerations alone; the significance of a diversion sufficient for one explosive depends to a large extent on who the diverter is. Any threshold of detection capability would in principle allow a sufficient amount of material for the fabrication of one or more explosive devices to escape detection, if long-protracted or multiple diversions are assumed. External goals can, however, deal with ranges of (over) performance goals on the basis of external utility in the planning of R&D programs.

Specified performance goals have a major impact on the design of the technical system to detect diversion, and on the perceptions of the effectiveness of the safeguards operation. They should be carefully determined so as to be credible, rational, and internally-consistent.

Notes

1. The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on Nuclear Weapons, INFCIRC/153, IAEA, May 1971, par. 28.

2. The safeguards objective of providing assurance of compliance is clearly stated in numerous official documents. Some examples:

a. Statute of the International Atomic Energy Agency, 1956, Articles III, XII C.

b. Treaty on the Non-proliferation of Nuclear Weapons, 1968, Article III.1.

c. Treaty for the Prohibition of Nuclear Weapons in Latin American, 1967, Articles 12, 13.

d. The Agency's Safeguards System (1965, as provisonally Revised and Extended in 1966 and 1968), INFCIRC/66 Rev. 2, IAEA, September 16, 1968, par. 46.

David Fischer,Assistant Director General of the IAEA stated that "The concept that the main purpose of safeguards is to serve a a burglar alarm which would give time to the diplomatic police to rush in before the safe is blown open represents. . .a complete reversal of the basic concept of IAEA safeguards that has been accepted for the last 24 years. . .The cardinal objective of safeguards is to give assurance of the **absence** of diversion. . ." David Fischer, **International Safeguards 1979,** Rockefeller Foundation/The Royal Institute of International Affairs, September 1979, p. 30, 31.

3. INFCIRC/153, par. 6

4. NRC Commissioner Gilinsky stated before the Senate Energy Committee that:

"Safeguards . . .are an alarm that warns of illicit activity. To be effective the warning has to come in time for us to do something about it" — Congressional Record, February 2, 1978, p. S1077.

5. International Atomic Energy Agency, IAEA Technical Safeguards Manual, IAEA-174, 1976, par. 5.1.1.

6. Based on 2 sigma = 1% of throughput and two material balances per year which are assumed to be independent.

7. IAEA Safeguards Manual, par. 5.1.3.

8. NRC Commissioner **Victor Gilinsky** and **Professor Albert Wohlstetter** are quoted as saying that conversion time for plutonium oxide is "hours", or "practically zero." Congressional Record, February 21, 1978, p. Sl077.

Hazards of Transporting

RICHLAND, Washington — A series of studies assessing the hazards of transporting energy materials has been completed by the Department of Energy's Pacific Northwest Laboratory.

The Transportation Safety Studies Project was conducted for DOE's Environmental Control Technology Division by a multidisciplinary team of scientists and engineers. The research project, comprised of 18 studies on the risks of transporting radioactive and hazardous fossil energy materials, was performed by Battelle Memorial Institute, contract operator of the government laboratory.

Each study evaluates the probability and consequences of accidental release of materials, and compares the risk of transporting hazardous materials with the risk to society from other types of accidents and natural disasters.

According to Project Manager **Russell E. Rhoads** of Battelle's Energy Systems Department, the reports generated during the seven-year project will assist DOE in making decisions on alternative energy systems and help government agencies establish new safety regulations.

"The risk assessment methods we developed during the project have significantly improved safety evaluations for transportation of hazardous materials," Rhoads said. "By using a consistent approach for a variety of materials, this methodology is useful for comparing the safety and costs of different energy options."

Completion of the project required a team effort from several battelle research departments. Principal contributors from the Energy Systems Department included **Charlette A. Geffen, William B. Andrews, John G. DeSteese, Dr. Ronald J. Hall, Dr. Thomas I McSweeney, H. Kenneth Elder, A. Lynn Franklin, Jess Greenboarg** and **Scott W. Heaberlin.**

ROLE OF EXISTING INTERNATIONAL ARRANGEMENTS AND INSTITUTIONS, INCLUDING IAEA NUCLEAR NON-PROLIFERATION TREATY AND REGIONAL ARRANGEMENTS

by D.A.V. Fischer
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The nuclear industry hardly needs to be reminded that we live in an uncertain political world. Politics, not economics or technology dictate the price of oil. Politics, not economics or technology dictate the length of time it takes to put up a nuclear power plant. Politics, not economics or technology dictate, in fact, the whole future of the nuclear industry.

These political uncertainties are particularly unhappy for an industry for which the lead-times and the planning horizons are of the order of ten to twenty years. We have to decide today how to meet the needs of a generation that is still at primary school, and we are bound to make gross mistakes.

And it is equally true that politics and not technology will determine the success or failure of our efforts to stem the spread of nuclear weapons.

Let me be more specific. It is not the technical efficiency of safeguards, nor the technical fixes discussed at INFCE, nor the restraints of the spread of sensitive technologies, but political rivalry and insecurity and the extent we can mitigate them which will mainly determine whether and how fast nuclear weapons will spread.

I shall return to this theme later, but let us first look at the situation as it is today in regard to the NPT, regional arrangements and IAEA safeguards. Then, let us look at some recent experience.

The tables below show the present worldwide coverage of NPT. For present purposes, you can ignore the countries in table I. Most of them are developing countries that have not joined the NPT but have no nuclear activities of any kind at this stage. They are chiefly in Africa and in the Arabian Peninsula. The nuclear-weapon States, France and China in table II, have not yet joined the NPT.

Tables III and IV list the countries which have ratified the Non-Proliferation Treaty. There are 110 in all, including three Nuclear Weapon States, the United States, Britain and the Soviet Union.

As you will see, the NPT countries include almost all the main industrial nations of the world - Canada, Western Europe, Eastern Europe and Japan. The only exception is Spain, but Spain will probably have to join the NPT or, at least, accept full-scope safeguards if and when it joins the Common Market in the early 1980s.

The countries in table III are those NPT States that have concluded safeguards agreements with the Agency, as is of course required by the NPT, in other words, agreements that put all activities in these countries under IAEA safeguards.

The nuclear weapon States are not required to conclude safeguards agreements, but Britain and the United States have offered to put their civilian activities under safeguards. The agreement with Britain is in force. The agreement with the United States is now before the Senate.

The countries in table IV are also NPT Parties, but they have not yet concluded their safeguards agreements with the Agency. All but two of them have no nuclear activities so that in most cases the absence of an agreement has no practical significance. The two exceptions are Venezuela, where there is a research reactor, but this is already under safeguards from an earlier non-NPT agreement, and Libya which is reported to be buying a nuclear power plant from the Soviet Union.

Although the picture is not completely satisfactory, I think it is extremely significant that 107 non-nuclear-weapon countries have now joined the NPT and have formally accepted the political commitment not to acquire nuclear weapons or nuclear explosives.

This is a major international achievement. Its success was by no means certain five years ago. There was powerful opposition to the NPT in countries like Germany, Italy and Japan. Wise statemanship overcame these obstacles. As a result, the industrial world and much of the developing world is committed today to prevent the further proliferation of nuclear weapons.

But, unfortunately, the structure is not yet complete. There are countries which have nuclear facilities - sometimes only a research reactor, but sometimes an extensive nuclear power program and which still remain outside the NPT. However, there is a significant difference between the countries in table V and those in table VI. In the seven table V countries, as far as we know, all nuclear facilities are at present under IAEA safeguards because of earlier supply arrangements. A typical case is Brazil. All nuclear plants in Brazil have either been supplied by the US or by the FRG and are under our safeguards. I should draw attention to one point. Pakistan is shown here, but we are no longer certain whether all nuclear plants in Pakistan are under safeguards. I shall come back to this point later.

The other important countries in this group are Argentina and Chile. However, there are reasonable prospects that an NPT-type regime will in time also be accepted by these countries outside the framework of the NPT. I shall return to this point later.

Now, let us come back to the last group - the five countries of table VI. In each of these countries, there is some unsafeguarded nuclear plant. I have already referred to Spain. The unsafeguarded plant here is not very significant; it is a power reactor jointly operated with France and, as I have said, Spain is likely to accept full-scope safeguards. Egypt is also in this category, but the plant here too is not very significant. It is a small research reactor obtained from the Soviet Union many years ago under bilateral safeguards.

This leaves India, Israel and South Africa. In each of these countries, the unsafeguarded plant is capable of making nuclear explosive material. Each of these countries is in an area of political tension. Each of these countries has turned its face against the NPT. It is here, obviously, where the danger of proliferation lies - in fact, has already been demonstrated.

The message I am seeking to get across is that where safeguards stop, the risk of proliferation begins. We should be concerned about improving safeguards and about remedying their deficiencies. Even more important, however, is to ensure that they cover the full range of nuclear activities in all countries: Firstly, in the last five countires I have mentioned, where there are unsafeguarded plants and especially the three (or perhaps four with Pakistan) where these plants are able to produce weapons material. Secondly, in the seven countries of table V which are at present, because of their dependence on foreign supplies, under full-scope safeguards, but where there is no legal barrier to building an unsafeguarded plant because the countries have not yet joined the NPT or accepted full safeguards under the Tlatelolco Treaty.[1]

This must be of top priority, and it is obviously a political matter.

Let me now turn briefly to the only existing regional denuclearization arrangement, the Tlatelolco Treaty, or to give it its full title, The Treaty for the Prohibition of Nuclear Weapons in Latin America. This Treaty is older than the NPT and owes its existence to a Mexican initiative in the mid-1960s. Most South American countries have ratified the Treaty and taken the additional legal steps needed to bring it into full force. Like the NPT, this involves the acceptance of IAEA safeguards on all nuclear activities. However, most of these countries are also NPT-countries and are required to accept full-scope safeguards under the NPT.

The countries that have not yet ratified the Treaty include Argentina and Cuba, and the Parties where the Treaty is not in full force are Brazil and Chile. You will remember, however, that in practice all nuclear plants in Argentina, Brazil and Chile are already under safeguards as a result of bilateral agreements like the German/Brazilian Agreement. Cuba is buying a nuclear power station from the Soviet Union and negotiating a safeguards agreement with the Agency to cover the plant.

Summing up, the non-proliferation picture in Latin America is mixed, but it is considerably better than it was a few years ago when prospects of region wide application of the Tlatelolco Treaty seemed rather remote. It is my impression that Argentina, Brazil and Chile are slowly moving towards full-scale application of the Treaty. There are many problems, chiefly questions of legal principle, but if the three countries do accept the full application of safeguards under Tlatelolco, it will be a noteworthy achievement. Latin America will be the only part of the world in which nuclear weapons and nuclear explosives are banned by law throughout the region.[2]

The success of the NPT has brought about a rapid growth in IAEA safeguards. The safeguards budget has grown from just over $1 million in 1970 (the year the NPT came into force) to nearly $16 million this year and nearly $20 million in 1980. The number of inspectors has grown commensurately and will amount to about 140 next year. This is a highly trained and qualified group but in numbers is hardly more than an infantry company. This is only a handful of men to verify that nowhere in the world or, at least, in the non-nuclear-weapon countries, is nuclear energy being diverted to military ends.

This underlines the point that the effectiveness of safeguards derives more from political than from technical considerations. Above all, there is the freely given political commitment by the Governments that are Parties to NPT neither to make nor to acquire nuclear weapons. International treaties are fragile things but we must not underestimate their force, particularly in times of peace. The Treaty guaranteeing the inviolability of Belgium - that famous "scrap of paper" - was scrupulously observed from 1830 to 1914 despite the temptations posed by the Franco-Prussian war. It must also be borne in mind that ratification of the NPT and conclusion of NPT safeguards agreements are voluntary acts by the Governments concerned. They are unlike many famous "unequal" treaties, for instance, Versaille, that have been accepted reluctantly and under duress by the defeated party. Finally, if a country finds that the NPT has become intolerable because some extraordinary event "relevant to the treaty" has jeopardized its supreme interests[3], the country is free to withdraw from the NPT.

One must therefore start from the assumption that since the countries concerned have voluntarily ratified the NPT and the concomitant safeguards agreement, they intend to comply with their provisions.

The second political factor is the continued willingness of States to cooperate with us in providing the information we need to apply safeguards effectively and in opening the doors of their nuclear industry to international inspection. This is no small matter.

Thirdly, the effectiveness of IAEA safeguards depends crucially upon the efficiency of the Agency's Board of Governors as an executive body, and the political support of the Board. The Board which consists of 34 nations from all regions of the world, decides the size of the Agency's budget, the scope of the Agency's safeguards programme, approves all safeguards agreements, and is the Court which would decide the issue, if the Director General ever considered that a State had broken a safeguards agreement.

Technically as well as politically, the concept of international safeguards is still very new and is rapidly evolving. Safeguards approaches, techniques and instruments are being improved each year. Our detection capability is sufficient for the Board to consider that it was reasonable to conclude in 1978 (as in 1977 and 1976) that there had been no diversion anywhere of a significant quantity of Agency-safeguarded nuclear material.

This was essentially a technical conclusion. If you reflect for a moment, however, you will see that it is strongly reinforced by the political aspects of the matter. To give one example, let us assume that a major industrial country in Western Europe or in the Far East were foolish enough to divert bomb quantities of plutonium from a safeguarded reprocessing plant and were detected, as it certainly would be. The political consequences for the country and the region would obviously be so disastrous as completely to outweigh any military advantage it could have gained from obtaining a few kilograms of unsafeguarded plutonium.

I would like to stress this point, since I feel that we sometimes pay too much attention to the technical perfection of safeguards and too little to the political considerations that may militate strongly against diversion. As a result, we are liable to have a situation in which safeguards are heavily concentrated in industrial countries where diversion is rather unlikely, but where there are large and sophisticated fuel cycle facilities that gobble up safeguards manpower. Another illustration is that for technical reasons a very large safeguards effort had to be devoted last year to a single CANDU-type reactor in a country that is internationally well-known for its strong dedication to non-proliferation. This safeguards effort was technically quite justified, but politics might point in other directions - to the concentration of safeguards on relatively small R&D fuel cycle facilities in countries where the temptation to divert may be far higher.

There is no easy answer to this problem. Obviously, if the IAEA is to do a good job, we must be able to detect diversion promptly and with a high degree of probability. It is also very difficult for an international body to take into account political considerations.

If the IAEA is to differentiate between Member States, we must do so on the basis of defensible objective criteria.

In assessing the risk of proliferation and determining their own non-proliferation policies, however, the leading nations can be much more flexible (unless they choose to tie their own hands) and can and should take specific political realities into account.

Let me give two practical examples. In the last couple of years, two countries have been reported to be acquiring the capacity to make nuclear explosives; South Africa and Pakistan. Neither country is a Party to NPT, and neither has therefore any legal obligation to inform the IAEA that it is building or acquiring enrichment plants or to put the plant under safeguards. The IAEA is thus dependent on public reports, but if they are correct the implications are clear and interesting.

Firstly, as I have remarked, both countries are in areas of political tension. Secondly, the problem of proliferation arises not because of deficiencies or inadequacies in IAEA safeguards but because of their absence. As I have said, where IAEA safeguards end, the problem of proliferation begins. These two considerations also apply to Israel where the unsafeguarded DIMONA reactor is a source of unsafeguarded plutonium.

Thirdly, Pakistan's reported plans again underline the fact that nuclear power and nuclear proliferation are separate issues. Pakistan's only existing nuclear power plant is a natural uranium CANDU-type reactor; acquiring enrichment capacity would have no relevance to this plant.

Fourthly, the reports would mean that the latest two countries acquiring the capacity to make nuclear explosives have both chosen the enrichment route rather than the plutonium route. Are we then looking at the right problem when we give so much attention to reprocessing and plutonium as the likely path to weapons and to the development of proliferation resistant fuel cycles?

Fifthly, both cases and particularly that of Pakistan would show again how difficult it is in practice to prevent the spread of sensitive technology. They raise some question, therefore, about the efficacy of endeavours to control the spread of knowledge such as those reflected in the London Club Guidelines and current U.S. legislation.

The reports would also show that if a country is bent on getting unsafeguarded nuclear explosive capacity, by hook or crook, it will do so even if it is by no means amongst the industrially most advanced nations. Good scientists are still more important than materials and machinery.

Finally, both cases emphasize the paramount importance of world-wide acceptance of the NPT or, at least, of full-scope safeguards. India's nuclear explosion was bound to provoke a response from Pakistan, and Pakistan's reported plans are now impacting on Indian policy. The consequences could be a vicious circle of increased tension and insecurity, and the waste of valuable resources in one of the poorest regions in the world.

Despite the shadows cast by these two events, the world community has been remarkably successful in the last twenty years in reducing the pace of proliferation. Three countries joined the Nuclear Club in the years from 1944 to 1954; two in the next decade, and only one in the last decade ending in 1974, although nuclear technology and nuclear power were then rapidly spreading.

The success of this effort has been due to the political support that East and West and developing as well as industrial countries have given to the NPT and to the Agency.

As I have said, the danger of further proliferation begins at those boundaries where the NPT and IAEA safeguards end, and we must do our utmost to push those boundaries back until the non-proliferation regime encompasses all States having significant nuclear programmes.

The second message I would like to leave with you is that in the NPT and in the IAEA the world already has all the major international machinery that it needs for non-proliferation purposes. It is essential to use both instruments to their fullest potential; not to create new machinery.

Let me take the example of INFCE. Three tangible projects appear to be emerging from INFCE:

- an international system for the storage of separated plutonium;
- an international study of arrangements for storing spent fuel;
- an initiative to rebuild the shattered framework of nuclear supply assurances.

Both plutonium storage and spent fuel storage are already being dealt with in the IAEA by ad hoc groups of experts. Experience has shown that the IAEA can provide a variety of effective international forums for negotiating a new set of ground-rules to restore confidence in supply arrangements. In other words, the IAEA provides the machinery needed to develop all three projects.

Finally, all three of these projects are worthwhile, but it seems doubtful whether any of them will bring about any significant additional countries into the NPT. Plutonium storage can provide useful assurances that plutonium is only released for bona fide purposes, and that surplus plutonium is kept in international custody. Storage and management of spent fuel seems to be an urgent technical problem rather than a non-proliferation concept. Re-establishment of confidence in supply commitments can help to reduce commercial incentives to build new national reprocessing or enrichment plants. All three concepts, however, are essentially designed to keep temptation away from the virtuous rather than to claim or to reclaim those who have not yet entered into the fold.

To put it more bluntly, it is difficult to see how any new international concepts or institutions will change the mind of those countries in the Middle East, South Asia and Southern Africa that for political reasons have chosen to keep open the option of making nuclear weapons. In these cases, we must look to bilateral diplomacy and to solutions that are specific to the problem of the countries or areas concerned rather than to new universal remedies, such as new pieces of international machinery.

Finally, no one doubts that the further proliferation of nuclear weapons is one of the major problems of our time. However, it is becoming less and less linked with the peaceful development of nuclear power, and it is high time that the two questions were treated separately. If we were to shut down and dismantle every nuclear power plant throughout the world, and even every nuclear submarine, nuclear cruiser and nuclear aircraft carrier, the problem of weapons proliferation would still be with us and we would hardly have reduced its dimensions by one inch. Conversely, when the world trebles its nuclear power output by 1985, this will hardly touch the quite separate question of weapons proliferation. I hope, therefore, that the time may come when economics and technology, including safety technology, rather than the political problems of proliferation will once again determine the future of an internationally safeguarded nuclear industry.

References:

1. Columbia has, however, brought the Tlatelco Treaty fully into force.
2. The Antarctica Treaty of 1 December 1959 also proscribes all military activities and specifically nuclear explosions in Antarctica.
3. The Treaty on the Non-Proliferation of Nuclear Weapons, Article X.1.

TABLE I

NON-NPT COUNTRIES HAVING AT PRESENT NO SAFEGUARDABLE NUCLEAR FACILITY OR MATERIAL

Albania	Burma	Guyana	Naura	Seychelles
Algeria	Cap Verde	Hong Kong	Niger	Solomon Islands
Angola	Comoros	Kuwait	Oman	Trinidad & Tobaga
Bahrain	Cuba*	Malawi	New Guinea	Uganda
Bhutan	Djibouti	Mauritania	Qatar	United Arab Emirates
	Equatorial Guinea	Monaco	Sao Tome-Principe	United Repuglic of Tanzania
	Guinea	Mozambique	Saudi Arabia	Zambia

* Cuba is acquiring a nuclear power plant from the USSR and is negotiating a safeguards agreement to cover this plant.

TABLE II

NON-NPT NUCLEAR WEAPONS STATES

China	France*

* France has stated that it will act as if it were an NPT party.

TABLE III

NON-NUCLEAR WEAPON STATES PARTY TO NPT WHICH BY 32 MARCH 1980 HAD CONCLUDED THE NPT SAFEGUARDS AGREEMENT WITH THE IAEA REQUIRED BY ARTICLE III OF THE TREATY

Afghanistan	Fiji	Ireland	Mauritius	Portugal
Australia	Finland	Italy	Mexico	Romania
Austria	Gambia	Jamaica	Mongolia	Samoa (Western)
Belgium	German Dem. Rep.	Japan	Morocco	Singapore
Bulgaria	Germany, Fed. Rep.	Jordan	Nepal	Sudan
Canada	Ghana	Korea, Rep.	Netherlands	Suriname
Cyprus	Greece	Lebanon	Newzealand	Swaziland
Czechoslovakia	Holy See	Lesotho	Nicaragua	Sweden
Denmark	Honduras	Liechtenstein	Norway	Switzerland
Dominican Republic	Hungary	Luxembourg	Paraguay	Thailand
Ecuador	Iceland	Madagascar	Peru	Uruguay
El Salvador	Iran	Malaysia	Philippines	Yugoslavia
Ethopia	Iraq	Maldives	Poland	Zaire

TABLE IV

NON-NUCLEAR WEAPON STATES PARTY TO NPT WHICH BY 31 AUGUST 1979 HAD NOT YET CONCLUDED THE NPT SAFEGUARDS AGREEMENT WITH THE IAEA REQUIRED BY ARTICLE III OF THE TREATY

No.	Country	Ratification or accession to NPT	No.	Country	Ratification or accession to NPT
1	Nigeria	27 Sept. 1968	23	Burundi	19 March 1971
2	United Rep. of Cameroon	8 Jan. 1969	24	Tonga	7 July 1971
3	Botswana	28 April 1969	25	Socialist Rep. of Viet Nam***	10 Sept. 1971
4	Syrian Arab Republic	24 Sept. 1969	26	Dem. Kampuchea	2 June 1972
5	"China, Rep. of"	27 Jan. 1970	27	Benin	31 Oct. 1972
6	Malta	6 Feb. 1970	28	Ivory Coast	6 March 1973
7	Mali, Rep. of	10 Feb. 1970	29	Bahamas	10 July 1973
8	Lao People's Dem. Rep.	20 Feb. 1970	30	Gabon	19 Feb. 1974
9	Togo	26 Feb. 1970	31	Grenada	19 Aug. 1974
10	Tunisia	26 Feb. 1970	32	Sierra Leone	26 Feb. 1975
11	Upper Volta	3 March 1970	33	Rwanda	20 May 1975
12	Costa Rica	3 March 1970	34	Libyan Arab Jamahiriya	26 May 1975
13	Liberia	5 March 1970	35	Venezuela*	26 Sept. 1975
14	Somalia	5 March 1970	36	Guinea Bissau	20 Aug. 1976
15	Bolivia	26 May 1970	37	Panama*	13 Jan. 1977
16	Haiti	2 June 1970	38	Liechten-stein*/**	20 April 1978
17	Kenya	11 June 1970	39	Congo Rep. of**	23 Oct. 1978
18	San Marino	10 Aug. 1970	40	Tavalu **	19 Jan. 1979
19	Guatemala	22 Sept. 1970	41	Sri Lanka**	5 March 1979
20	Central African Empire	25 Oct. 1970	42	Dem. Yemen**	1 June 1979
21	Senegal	17 Dec. 1970	43	Indonesia**	12 July 1979
22	Chad	10 March 1971			

* Agreement negotiated and approved by IAEA Board of Governors, but not yet in force.

** The grace period of 18 months provided for in Article III.4 of the NPT for the conclusion of the agreement has not expired.

*** An NPT Safeguards Agreement was concluded with former Republic of Viet Nam.

TABLE V

NON-NPT COUNTRIES IN WHICH ALL PRESENTLY KNOWN NUCLEAR ACTIVITIES ARE COVERED BY SAFEGUARDS (RESULTING USUALLY FROM SUPPLY AGREEMENTS WITH OTHER COUNTRIES)

Argentina	Colombia	Turkey*
Brazil	Korea, Dem. Peoples Rep.	
Chile	Pakistan (?)	

* In process of ratifying NPT.

TABLE VI

NON-NPT COUNTRIES HAVING SIGNIFICANT UNSAFEGUARDED NUCLEAR FACILITIES

Egypt*	S. Africa
India	Spain**
Israel	Pakistan (?)

* The unsafeguarded plant is a small research reactor provided under USSR safeguards.

** The unsafeguarded plant is a nuclear power reactor operated jointly with France.

*** In all listed countries except Egypt, there are also some IAEA-safeguarded facilities.

Editor's Note: Since this was finalized, the editors learned from D. A. V. Fischer that the total NPT membership (March 31, 1980) is now 113 countries including 110 non-nuclear weapons states.

What Do We Mean by 'Safeguards?'

By **J. M. de Montmollin**
Sandia Laboratories

Note on the Definition of Safeguards: Safeguards is a word with many meanings; general and specific to the nuclear industry. Because of the confusion in its meaning in the public mind, the preparation of an expository paper to define the term as applied to INMM functions was proposed as an INMM Safeguards Committee project. In the accompanying article, **Jim de Montmollin** has done a superb job of pulling together information from numerous sources and presenting it prespicuously.

One of the initial objectives of a paper on the definition of safeguards was to sort the uses into carefully defined bins and to suggest appropriate modifiers for each use. The futility of that exercise became apparent soon enough.

Safeguards is an ever evolving term. The genesis of safeguards in the nuclear field goes back to 1945 when it was first applied to techniques for international non-proliferation, then to domestic systems of nuclear material control and accountability, and finally to include physical protection techniques. It was also applied in 1953 to what is now referred to as reactor safety. Indeed, within DOE field organizations, there is presently a general decrease in the use of safeguards in reference to nuclear material accountability and an increase in its use for security functions.

In the accompanying article, Jim de Montmollin focuses on what I regard as the "classical" definition of safeguards. It is one that is preserved in treaties and international agreements, and for that reason, it is one that will surely survive, if not prevail — **Sylvester Suda,** INMM Safeguards Committee.

The term "safeguards" has been widely used in many different contexts. Sometimes it is used in a very general sense, where the meaning is clear. However, in the specialized field that has developed around the subject, it is often used in a more restrictive and specialized way. It is frequently unclear what specialized meaning is intended, since different groups within the safeguards community have tended to adopt different usages. Most of these usages are firmly established, and we do not suggest that it is necessary or even feasible to change them. However, much misunderstanding can be avoided if we are aware of how the term has evolved into differing usages, and if we are careful to be specific when the meaning may be unclear.

Webster defines safeguards as a means of protection against something that is undesirable. The first use of the term in connection with nuclear matters was consistent with that definition. The Three-nation Agreed Declaration on Atomic Energy, November 1945, spoke of "enforceable safeguards against its use for destructive purposes," and "effective safeguards by way of inspection and other means to protect complying states against the hazards of violations and evasions."[1]

The IAEA Statute (1956) contains numerous provisions relating to safeguards. Several different control functions, all called safeguards, are intermixed in the Statute:

1. Controls on Agency-held materials, materials furnished by the Agency, and Agency-sponsored projects
   a. Physical protection
   b. National diversion
   c. Health and safety
2. Measures applied by the IAEA at the request of States or groups of States, such as NPT. These are concerned solely with national diversion.

When the IAEA was founded, its principal function was to extend the benefits of nuclear energy throughout the world, while ensuring so far as possible that the assistance it provided was not used to further any military purpose.[2] The safeguards provisions that were originally written into the Statute describe the functions listed under **1** above. The draft Statute was amended to include the function of providing safeguards at the request of States parties to bilateral or other agreements.[3] Article III of the Statute and the introduction to Article XII were thus broadened, with the qualification that those safeguards would be at the request of the parties concerned. Since protection against subnational diversion, including physical protection, continues to be a sovereign power of the State, IAEA "external" safeguards operations of the type described in **2** above are implicitly limited to protection against national diversion.

The Agency function of supplying materials and sponsoring projects that was envisioned in the Statute as the principal IAEA activity has not developed as expected originally. Meanwhile, the IAEA assumed the responsibility for administering "external" safeguards for many bilateral agreements, including U.S. export agreements, and safeguards required under the Treaty of Tlatelolco (1967) and the Non-Proliferation Treaty (1968). Thus, IAEA safeguards operations have been almost exclusively of the external type described in **2** above.

Objectives of IAEA Safeguards

The meaning of the term "safeguards" is inherent in the objectives. The ambiguity in usage reflects the fact that there are various objectives, from the very general to the specific, and unless it is clear what the objectives are in a context, what is meant by safeguards is likely to be unclear.

The Statute refers to ". . . safeguards designed to ensure that special and other fissionable materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose. . ."

The Agency's power to ensure that these things do not happen is limited. In the case of Agency-supplied materials or Agency projects, which is the basis for most of the Statute, Article XII states that the Agency may demand corrective action, require the return of materials, and suspend the offending member State. For external safeguards these are obviously inappropriate (safeguarded States are not necessarily members, and the IAEA in general does not supply any materials). In practice, the Agency's capability to ensure that violations do not occur is limited to deterrence by means of the threat to expose them. Furthermore, the Agency is concerned only with the actual diversion, not the further prevention of military use following diversion.[4]

The means whereby the IAEA "ensures" that there is no diversion rests on a capability to detect a diversion. However, since an attempted diversion is a rare and unusual event (none is believed to have occurred), and since continuing, positive assurance of no diversion is desired, safeguards operations are actually directed at the verification of compliance with agreements covering authorized peaceful uses.[5] Information is collected and analyzed periodically to verify compliance, or, to support findings that compliance could not be verified and that diversion may have occurred. The objective of safeguards may thus be generally stated to be to provide assurance that agreements are complied with, and to deter violations by means of a capability to detect them. That objective is stated in various forms in several documents.[6]

The IAEA Safeguards Manual[7] defines safeguards as follows:

> "Nuclear and non-nuclear materials, services, facilities, equipment, and information which are to be used for legally-defined purposes may be deliberately diverted from those purposes. The actions aimed at the detection and deterrence of this diversion are known as safeguards.
>
> Potential diverters are facility operators, individuals and States. IAEA safeguards are aimed at the timely detection of diversion in or by States having undertaken to accept safeguards in accordance with an agreement between the IAEA and the State and the deterrence of such diversion by the risk of early detection by the IAEA."

That definition includes diversion of things other than nuclear materials, as does the Statute. It is not limited to State diversion; it refers to diversion "in or by States." It defines diversion as separation from authorized uses for any purpose, not just military. And, it refers to detection as the objective, not the verification of compliance with agreements. Finally, it seems to describe only external safeguards, while most of the safeguards described in the Statute are internal.

The Manual is concerned with safeguards systems and operations, one element of which is a capability to detect diversion should it be attempted. The statement of objectives in terms of diversion rather than verification probably is the result of concentration on that function by technical systems designers. A similar statement of objectives appears in INFCIRC/153;[8] however, that document is principally concerned with verification and not detection.

The Manual is primarily intended to cover systems to implement INFCIRC/153, but the definition in the Manual covers subnational as well as State diversion. The definition in the Manual is, in that respect, more consistent with the Statute and the NPT. The role of IAEA safeguards with respect to subnational diversion (and physical protection) is more easily understood if we make a distinction between IAEA safeguards objectives and direct operations by the IAEA. Operations, as described for example in the Manual and INFCIRC/153, cover verification of compliance with agreements by the State. The subject of diversion cannot be neatly categorized as national or subnational by arbitrary definitions of safeguards scope. What appears to be subnational diversion may be a cover for diversion by the State, and inadequate protection against subnational diversion may allow another State to eventually acquire diverted materials. Thus, IAEA-structured safeguards are a comprehensive system in which domestic safeguards play an essential role. Actual operations are divided between the State and IAEA, with the IAEA role being the verification of State compliance and the State role the operation of material-control-and-accounting and physical-protection systems. IAEA verification operations are by audit of State records and independent measurements and observations.

The basic agreements, such as the Statute and the NPT, as well as the Safeguards Manual, include as subjects for safeguards non-nuclear materials, facilities, equipment, and information. IAEA safeguards operations have almost entirely concentrated on the accounting of nuclear materials, with associated containment and surveillance. (However, some assurance that facilities and equipment are not misused may be gained incidentally.) Activities which address some of these other areas, such as controls imposed by the London Suppliers Group, are not generally referred to as safeguards, although they are clearly within the Statute, NPT, and even the Manual definitions. In practice, safeguards generally means IAEA safeguards, and more specifically, IAEA safeguards operations.

Domestic Safeguards

Still other meanings have been associated with the term "safeguards" in the United States. The original Atomic Energy Act of 1954 mentioned safeguards in the broadest sense defined by Webster. It appears in connection with protection of classified information[10] and reactor safety.[11] "Security safeguards" is used in specifying export conditions; apparently that referred to what we usually call physical protection.

U.S. domestic controls on nuclear materials developed slowly, and the term "safeguards" was not applied to them before the mid-1960's. When materials were owned entirely by the government, the concern was the protection of valuable assets from inadvertent loss, health risks, and the protection of classified information. Concerns over theft began to develop in the 1960's, and about that time the term "safeguards" began to appear in the titles of organizations in the AEC that were involved in such matters. When concern over subnational diversion and sabotage became widespread and highly visible, safeguards became generally used as the term describing U.S. systems for physical protection* and materials accounting. Safeguards is used in that sense in the Energy Reorganization Act of 1974.[12] The Nuclear Non-Proliferation Act of 1978[13] did not include a proposed amendment defining safeguards in very general terms; instead, it referred to earlier definitions in the 1954 and 1974 Acts, which will likely contribute further to the confusion.

In current usage in the U.S., domestic safeguards has come to mean a system that includes material control and accounting and physical protection, for the purpose of preventing theft of materials and sabotage of facilities by individuals or subnational groups. In a broader sense it includes related functions and measures such as investigations, rewards and penalties, and means to recover materials or mitigate consequences. To some extent, other countries have come to accept the U.S. usage in applying the term to domestic systems.

Summary

This long, and perhaps tedious, account is intended to illustrate how widely the use of the term "safeguards" has varied, and to suggest the need to consider the context in which we use it. We do not suggest the adoption of new terms or definitions; we have too many already. Generally, in the context of U.S. domestic safeguards we can expect it to mean measures taken against theft and sabotage by means of physical protection and materials accounting. In the international context, it may mean the entire system of measures to control unauthorized uses of nuclear energy by anyone. In narrower contexts it may exclude domestic systems. Further, it may mean measures that are the responsibility of the IAEA, and still more specifically, those measures actually operated by the IAEA, which address directly only national diversion of fissile materials for whatever purpose.

* Including protection against only sabotage that would generate a nuclear hazard or fear of such.

REFERENCES

1. Much of the material in this paper was obtained from **Paul C. Szasz,** "The Law and Practices of the International Atomic Energy Agency," Legal Series No. 7, IAEA, Vienna, 1970.

2. IAEA Statute of the International Atomic Energy Agency, Article II.

3. IAEA Statute, Article III A.5.

4. Szasz, P. 533.

5. This point is discussed at length by de Montmollin and Weinstock, "The Goals of Measurement Systems for International Safeguards," presented at the ANS Topical Meeting on Measurement Technology for Safeguards and Materials Control, Kiawah Island, SC, November 26-29, 1979.

6. For example:

   IAEA Statute, Articles II, III A.5, XII A.6, XII C.

   Treaty on Non-Proliferation of Nuclear Weapons, 1968, Article III.

   Treaty for the Prohibition of Nuclear Waspons in Latin America (1967) (Treaty of Tlatelolco), Articles 12, 13, 18.3.

   The Agency's Safeguards System (1965, As Provisionally Revised and Extended in 1966 and 1968), INFCIRC/66, Rev. 2, IAEA, September 16, 1968, par. 46.

   The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on Nuclear Weapons, INCIRC/153, IAEA, May 1971, par. 1, 2, 6(c), 7, 18, 19, 31, 46 (a), 71, 72, 73.

7. IAEA Safeguards Technical Manual, International Atomic Energy Agency, IAEA-174, 1976, par. 1.1.

8. INFCIRC/153, par. 28.

9. Recommendations for the Physical Protection of Nuclear Material, INFCIRC/225, IAEA, June 1972.

10. Atomic Energy Act of 1954, Public Law 83,703, Sec. 3.

11. Ibid, Sec. 29.

12. Energy Reorganization Act of 1974, Public Law 93-438, October 11, 1974.

13. Nuclear Non-Proliferation Act of 1978, Public Law 95-242, March 10, 1978.

NTIS Publication

Nuclear Reactors Built

This compilation contains information about facilities built, being built, or planned in the United States for domestic use or export which are capable of sustaining a nuclear chain reaction. Civilian, production, and military reactors are listed, as are reactors for export and critical assembly facilities.

The publication (48 pages, 8x10½, paperback) is available as DOE/TIC-8200-R40, for $4.75 from National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.

INSPECTION FREQUENCY REQUIRED TO MONITOR MEASUREMENT, RECORDING, OR SURVEILLANCE DEVICES

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Introduction

A problem encountered recently is identical from a mathematical viewpoint to certain types of problems encountered in nuclear materials safeguards. The general form of the solution to the problem in question is therefore of interest in safeguards applications.

The specific problem which prompted the investigation is stated as follows. An automatic recording instrument is used in atmospheric monitoring. It is subject to randomly occurring breakdown. The instrument is checked at routine intervals to assure that it is functioning properly, and if it has experienced a breakdown since the last inspection, it is repaired. The question is, what should be the time interval between the routine checks to provide a specified probability that the recording instrument is functioning properly for at least a given percentage of the time over a specified interval of time? For example, how often should the instrument be checked such that, with probability 0.95, it functions properly, say, at least 90% of the time over a one year period?

To cite two obvious safeguards applications of this general problem solution.

1. How often should a surveillance camera used in monitoring certain activities in a facility be checked to assure that it functions properly a specified percentage of the time?

2. How often should a physical standard be measured to assure that the measurement system in question is in control a specified percentage of the time?

The stated problem is solved in general terms. An application is then made to the specific problem that prompted the study. Applications to specific safeguards problems are left to the reader.

Mathematical Model

A key assumption is that instrument breakdown occurs at random, i.e., there is no wear out mechanism contributing to the failure. Under this assumption, let

t = time to failure (say in hours)

H = time between routine inspections

x = time that the instrument is <u>not</u> functioning properly during <u>a given</u> interval between inspections.

The quantities H and x are expressed in the same units as t.

At some starting point just after an inspection, if the instrument does not break down during the time interval H, then x equals zero. If it breaks down at time $t < H$, then x is $(H - t)$.

For the random breakdown model, the probability density function for the random variable, time to failure, is the exponential function [1]:

$$f(t)\,dt = \lambda e^{-\lambda t}\,dt \quad , \; 0 \leq t < \infty \tag{1}$$

By integrating (1) from H to ∞, it is seen that t exceeds H with probability $e^{-\lambda H}$. Thus, the probability density function for x is written:

$$\left.\begin{aligned} x &= 0 \text{ with probability } e^{-\lambda H} \\ &= (H - t) \text{ with probability } \lambda e^{-\lambda t}\,dt, \\ &\quad 0 \leq t \leq H \end{aligned}\right\} \tag{2}$$

Moments of x

The first four moments of x are found. The derivations are in Appendix A. For convenience in notation, let

$$e^{-\lambda H} = q \tag{3}$$

and

$$\lambda^{-1} = \theta \tag{4}$$

Then

$$E(x) = \mu = \theta(q - 1) + H \tag{5}$$

$$E(x - \mu)^2 = \theta^2(1 - q^2) - 2Hq\theta \tag{6}$$

$$E(x - \mu)^3 = 2\theta^3(q^3 - 1) + 3Hq\theta(2q\theta + H) \tag{7}$$

$$E(x-\mu)^4 = 3\theta^4(3-2q^2-q^4) - 12Hq\theta^3 (1+q^2) - 12H^2q^2\theta^2 - 4H^3q\theta \quad (8)$$

Moments of Summed x Values

Of particular interest is the random variable that is the sum of a number of x values. Let y be the sum of the x values over n intervals of time, each of length H.

$$y = \sum_{i=1}^{n} x_i \quad (9)$$

Then, as is well known [2]:

$$E(y) = n\mu \quad (10)$$

$$E(y - n\mu)^2 = n\,E(x-\mu)^2 \quad (11)$$

$$E(y - n\mu)^3 = n\,E(x-\mu)^3 \quad (12)$$

$$E(y - n\mu)^4 = n\,E(x-\mu)^4 + 3n(n-1)[E(x-\mu)^2]^2 \quad (13)$$

Equations (10)-(13) along with (5)-(8) provide the moments for y and may be used to determine an approximation to the density function for y. For large n, as a consequence of the Central Limit Theorem, we would expect y to be approximately normally distributed. If this were true, then the standardized third moment,

$$\sqrt{\beta_1} = \frac{E(y-n\mu)^3}{[E(y-n\mu)^2]^{3/2}} \quad (14)$$

would be zero, and the standardized fourth moment,

$$\beta_2 = \frac{E(y-n\mu)^4}{[E(y-n\mu)^2]^2} \quad (15)$$

would be 3.

However, one need not appeal to the Central Limit Theorem. Rather, compute the quantities E(y), $E(y-n\mu)^2$, $\sqrt{\beta_1}$, and β_2, and make the required probability statements by approximating the density function of y by one of Pearson's family of distribution [3]. How this is done is indicated in the application.

Application

For the atmospheric monitoring problem, assume that experience data provides a value for λ.

$$\lambda = 0.00139 \quad (\text{hours}^{-1})$$

Suppose the plan is to check the monitoring device every 4 days, or 96 hours.

$$H = 96 \text{ hours.}$$

Over a one year period of operation (or 360 days), the number of x_i values is 360/4 or 90, so that

$$n = 90$$

and

$$y = \sum_{i=1}^{90} x_i$$

Find y_0 such that

$$\text{Prob}(y < y_0) = 0.95$$

Also, find y_1 such that

$$\text{Prob}(y < y_1) = 0.99$$

As a word of caution, when performing the calculation, it is important to carry as many significant figures as possible in the intermediate calculations. Thus, for

$$H = 96 \text{ and}$$

$$\lambda = 0.00139 \quad ,$$

use

$$q = e^{-\lambda H} = 0.875079972$$

and not simply q = 0.8751, for this rounded value leads to totally erroneous results for the higher moments.

In applying (5)-(8), the results are

$$E(x) = \mu = 6.1295$$

$$E(x-\mu)^2 = 359.039$$

$$E(x-\mu)^3 = 21911.74$$

$$E(x-\mu)^4 = 1{,}597{,}653$$

In applying (10)-(13), for n = 90,

$$E(y) = 552$$

$$E(y-n\mu)^2 = 32{,}314$$

$$E(y-n\mu)^3 = 1{,}972{,}057$$

$$E(y-n\mu)^4 = 3{,}241{,}472{,}124$$

Finally,

$\sqrt{\beta_1} = 0.339$, $\beta_2 = 3.104$

Thus, on the average, the instrument would <u>not</u> be operating for 552 hours, with a standard deviation of about 180 hours. This is over 8640 total hours, and corresponds to a (100)(552)/8640 or 6.39% expected "down" time.

In finding y_0 such that y is less than y_0 with probability 0.95, a table of Pearson's distribution [4] gives, by interpolation on $\sqrt{\beta_1}$ and β_2:

$$y_0 = 552 + 1.740 \sqrt{32314} = 865 \text{ hours.}$$

For 0.99 probability,

$$y_1 = 552 + 2.558 \sqrt{32314} = 1012 \text{ hours.}$$

Note that 865 hours is 10.0% of the total of 8640 hours, while 1012 hours is 11.7% of this total.

Note further that had the Central Limit Theorem been applied, then the 0.95 and 0.99 factors of 1.740 and 2.558 would have been 1.645 and 2.326 respectively. In this case, the y_0 and y_1 values would have been

$$y_0 = 552 + 1.645 \sqrt{32314} = 848 \text{ hours } (9.8\%)$$

$$y_1 = 552 + 2.326 \sqrt{32314} = 970 \text{ hours } (11.2\%)$$

Expected Coverage

The probability statements made in the previous section are associated with a given time interval over which the statement is to apply, i.e., they are functions of n, the number of intervals of length H in the time interval in question. If limiting results are all that are of interest, then one need only perform calculations for E(x) or μ. Specifically, the expected percent coverage, defined to be 100 minus the expected percent downtime, is given by

$$E\ (\text{COVERAGE}) = 100\ (1-\mu/H)$$

$$= 100[-\theta\ (q-1)/H] \quad (16)$$

For the example under considertion, with $\theta = 0.00139^{-1}$ and $q = \exp(-0.00139H)$, some values of E(COVERAGE) as a function of H, the time between routine inspections, are tabulated.

H(Hrs)	E(COVERAGE)(%)	H(Hrs)	E(COVERAGE)(%)
16	98.90	80	94.64
32	97.81	96	93.62
48	96.74	112	92.60
64	95.68	128	91.61

References

[1] Hahn, Gerald J. and Shapiro, Samuel S., "Statistical Models in Engineering", John Wiley and Sons, New York, pages 105-108 (1967).

[2] Hahn and Shapiro, op cit, page 234.

[3] Hahn and Shapiro, op cit, pages 220-223.

[4] Johnson, N.L., Nixon, Eric, and Amos, D.E., "Table of Percentage Points of Pearson Curves, for Given $\sqrt{\beta_1}$ and β_2 Expressed in Standard Measure". Biometrika, 50, No. 3 and 4, 1963.

APPENDIX A

Equations (5)-(8) are derived. Using the notation of the text, the key equations that are used in the derivations are:

$$\int_0^H \lambda e^{-\lambda t}\, dt = 1 - q \qquad (A.1)$$

$$\int_0^H \lambda t e^{-\lambda t}\, dt = \theta - \theta q - Hq \qquad (A.2)$$

$$\int_0^H \lambda t^2 e^{-\lambda t}\, dt = 2\theta^2 - 2\theta^2 q - 2H\theta q - H^2 q \qquad (A.3)$$

$$\int_0^H \lambda t^3 e^{-\lambda t}\, dt = 6\theta^3 - 6\theta^3 q - 6H\theta^2 q - 3H^2\theta q - H^3 q \qquad (A.4)$$

and

$$\int_0^H \lambda t^4 e^{-\lambda t}\, dt = 24\theta^4 - 24\theta^4 q - 24H\theta^3 q - 12H^2\theta^2 q - 4H^3\theta q - H^4 q \qquad (A.5)$$

with $x = H - t$,

$$E\ (x) = \int_0^H (H - t)\ \lambda e^{-\lambda t}\, dt$$

$$= H - Hq - \theta + \theta q + Hq$$

$$= \theta\ (q - 1) + H \qquad \text{(equation (5) in text)}$$

To derive (6), note that

$$E\ (x - \mu)^2 = E\ (x^2) - \mu^2 \qquad (A.6)$$

$$E\ (x^2) = \int_0^H (H^2 - 2Ht + t^2)\ \lambda e^{-\lambda t}\, dt$$

From (A.1), (A.2), and (A.3), this simplifies to

$$E\ (x^2) = 2\theta^2 - 2\theta^2 q - 2H\theta + H^2 \qquad (A.7)$$

so that, from (A.6), (A.7), and (5),

$$E\ (x - \mu)^2 = \theta^2 - \theta^2 q^2 - 2H\theta q \qquad \text{(equation (6) in text).}$$

To derive (7), note that

$$E\ (x - \mu)^3 = E\ (x^3) - 3\ \mu E\ (x^2) + 2\mu^3 \qquad (A.8)$$

$$E\ (x^3) = \int_0^H (H^3 - 3H^2 t + 3Ht^2 - t^3)\ \lambda e^{-\lambda t}\ dt$$

From (A.1)-(A.4), this simplifies to

$$E\ (x^3) = 6\theta^3 q - 6\theta^3 + 6H\theta^2 - 3H^2\theta + H^3 \qquad (A.9)$$

so that, from (A.7)-(A.9), and (5),

$$E\ (x - \mu)^3 = 2\theta^3 q^3 - 2\theta^3 + 6H\theta^2 q^2 + 3H^2 q\theta \qquad \text{(equation (7) in text)}$$

To derive (8), note that

$$E\ (x - \mu)^4 = E\ (x^4) - 4\mu E(x^3) + 6\mu^2 E(x^2) - 3\mu^4 \qquad (A.10)$$

$$E\ (x^4) = \int_0^H (H^4 - 4H^3 t + 6H^2 t^2 - 4Ht^3 + t^4)\ \lambda e^{-\lambda t}\ dt$$

From (A.1)-(A.5), this simplifies to

$$E\ (x^4) = 24\theta^4 - 24\theta^4 q - 24H\theta^3 + 12H^2\theta^2 - 4H^3\theta + H^4 \qquad (A.11)$$

so that, from (A.7), (A.9), (A.10), (A.11), and (5),

$$E\ (x - \mu)^4 = 9\theta^4 - 3\theta^4 q^4 - 6\theta^4 q^2 - 12H\theta^3 q^3 - 12\ H\theta^3 q - 12H^2\theta^2 q^2 - 4H^3\theta q,$$

(equation (8) in text).

Titles and Abstracts of Recent Safeguards R&D Publications:

Lawrence Livermore Laboratory, Safeguards Technology Program

Editor's Note: This is another listing of safeguards reports which should be of interest to many Journal readers. The material was provided by David C. Camp, manager of the Safeguards Technology Program, Lawrence Livermore Laboratory, University of California, P.O. Box 808, Livermore, California, 94550.

W.L. Pickles and J.L. Cate, Jr., "Quantitative Nondispersive X-Ray Fluorescence Analysis of Highly Radioactive Samples for Uranium and Plutonium Concentration", Advances in X-ray Analysis, 17, 337-347, 1974.

Fluorescent x-ray energy spectra were successfully acquired from uranium and plutonium in 400:1 ratios in samples containing 2 Ci/gram of mixed fission products. The analytical system consists of a silver transmission anode x-ray tube, a low-Z scattering chamber, a magnetic β-ray trap, a beam monitor probe, a commercial Si(Li) detector, a set of modified electronics to handle the large γ-ray overload rate, and a computer analyzer using a higher-level language to handle data reduction.

The computer programs used to obtain peak areas from the closely spaced uranium and plutonium (Lα 1+2) peaks were constructed to make use of knowledge of upper-edge tailing gained in this experiment. Programs are being developed to properly remove background under the uranium and plutonium peaks. Absorption effects in the larger samples have been measured using the ratio of uranium (Lℓ) to uranium (Lγ) peak area and are incorporated in the data-analysis schemes. A titanium monitor probe, consisting of a fixed titanium plate near the sample, introduces a constant-area titanium K x-ray line into the spectrum. The program uses the area of this peak to correct for effects of total exciting flux, geometry, and system dead-time losses. Standard samples of various types are used to generate calibration curves from which quantitative results are obtained.

Samples are taken from dissolved high-burnup power-reactor fuel rods. The liquid sample is acidic and has a radiation level at one foot of approximately 2 R/hr β and 300 mR/hr γ. Sample preparation involves only the evaporation of the liquid sample on a 1/2-mil polycarbonate substrate and subsequent sealing with another layer of polycarbonate film. The samples are then mounted in standard 35-mm slide-holders.

Preliminary testing on a limited number of prepared uranium and plutonium samples indicates a precision of about 1% and an accuracy of about 2%, over a range of 1 to 58 μg total mass. The samples have not yet been verified by independent chemical analysis. The system has been installed at the AEC Savannah River facility for extensive testing.

R. Gunnink, J. Niday, and P. Siemens, "A System for Plutonium Analysis by Gamma-Ray Spectrometry", UCRL-51577, 4/1974.

Procedures have been developed for analysis of the isotopic abundances and total amounts of plutonium in solution. The technique involves analysis of the gamma rays emitted from the sample and uses a computer-based spectrometer system.

A prototype system installed at the Savannah River Reprocessing Plant currently analyzes for ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{241}Am when it is present. Precisions within 0.05% for ^{239}Pu and about 1% for ^{240}Pu and ^{241}Pu can be obtained in counting periods as short as 10 minutes.

This is the first in a series of reports which will describe the technique, show the system components, list and describe the computer programs, and evaluate the operating performance.

R. Gunnink, "A Simulation Study of Plutonium Gamma-Ray Groupings for Isotopic Ratio Determination", UCRL-51606, 6/1974.

A promising nondestructive method for measuring plutonium isotopic abundance ratios is the analysis of neighboring gamma rays in a spectral grouping whose members belong to different isotopes. We have made a preliminary study of all such peak groupings capable of yielding this kind of information. This report describes the groups studied and the procedures used, and it contains the results we have obtained using a computer program we developed for predicting the ultimate levels of precision that can be obtained.

R. Gunnink, "Status of Plutonium Isotopic Measurements by Gamma-Ray Spectroscopy", UCRL-76418, 6/1975.

A nondestructive method for determining plutonium isotopic abundance ratios, based on the detection and measurement of the gamma rays emitted, is now being accepted as routine for solution samples.

The analysis of solid samples is of more general interest, but more difficult to achieve. One major problem is the nonuniform packaging and inhomogeneity of these samples. This results in calibration difficulties because of the uncertainties in the gamma-ray attenuations. One way of minimizing these experimental problems is to select one or more sets of neighboring peaks in the spectrum whose components are due to the different isotopes and to accurately measure the observed peak intensities. Since the detection efficiencies are nearly the same for adjacent peaks, the isotopic ratios are largely dependent on the branching intensities, the half-lives and the observed peak intensities.

There are eight groups in a typical plutonium spectrum that potentially can yield information on isotopic ratios. A computer program was written to assess the potential of each grouping. The findings of this study and some of the problems associated with the various peak groupings are discussed.

The 100-keV grouping was selected for additional study. Preliminary experimental results indicate that isotopic ratios of 1% and better can be obtained using this multiplet of peaks.

R. Gunnink, J.E. Evans, and A.L. Prindle, "A Re-Evaluation of the Gamma-Ray Energies and Absolute Branching Intensities of ^{237}U, $^{238-241}Pu$ and ^{241}Am", UCRL-52139, 10/1976.

Promising new techniques for making quantitative measurements of plutonium require highly precise values of the gamma-ray energies and intensities for the isotopes involved. Using high isotopic purity sources and state of the art Ge(Li) detectors, we have reevaluated the energies and absolute emission probabilities of the gamma rays following the decay of ^{237}U, ^{238}, ^{239}, ^{240}, ^{241}Pu, and ^{241}Am.

R. Gunnink and J.E. Evans, "In-line Measurement of Total and Isotopic Plutonium Concentrations by Gamma-Ray Spectrometry", UCRL-52220, 2/1977.

This report describes preliminary experiments studying the feasibility of gamma-ray spectrometry for in-line measurements of plutonium in solutions. We measured the isotopic content of the plutonium by direct counting and the total plutonium content by a differential attenuation technique. Two separate experiments on different solutions were performed with each technique. Our results show that both isotopic and total measurements can be made with precisions around 0.25 to 0.5%.

David C. Camp, "A Review of LLL Developed Instruments, Techniques, and Methods Applicable to Alternative Fuel Cycle Technologies", UCRL-52326, 9/1977.

The report presents summaries of instruments and techniques developed specifically for safeguards applications and other LLL programs which may have such applications. Among the former are automated analytical techniques for assay of U and Pu, high-resolution gamma-ray spectrometry techniques, energy and wavelength dispersive X-ray fluorescence methods, and safeguards evaluation programs. Related activities include radiation detection instruments, environmental monitoring systems, and plant safety monitoring developments.

R. Gunnink, "Gamma Spectrometric Methods for Measuring Plutonium", Proc. American Nuclear Society Topical Meeting (Williamsburg, Va., 1978), NBS Special Publication 528, p. 49, UCRL-80464, 2/1978.

Nondestructive analyses of plutonium can be made by detecting and measuring the gamma-rays emitted by a sample. Although qualitative and semiquantitative assays can be performed with relative ease, only recently have methods been developed, using computer analysis techniques, that provide quantitative results. This paper reviews some new techniques developed for measuring plutonium. The features of plutonium gamma-ray spectra are reviewed and some of the computer methods used for spectrum analysis are discussed. The discussion includes a description of a powerful computer method of unfolding complex peak multiplets that uses the standard linear least-squares techniques of data analysis. This computer method is based on the generation of response profiles for the isotopes composing a plutonium sample and requires a description of the peak positions, relative intensities, and line shapes. The principles that plutonium isotopic measurements are based on are also developed, followed by illustrations of the measurement procedures as applied to the quantitative analysis of plutonium liquid and solid samples.

David C. Camp, "An Introduction to Energy Dispersive X-Ray Fluorescence Analysis", UCRL-52489, 6/1978.

The physical principles of energy dispersive x-ray fluorescence analysis are discussed. A phenomenological description of atomic excitation and the subsequent radiation of x-rays, on which the physical principles are built, is presented. The atomic shell structure and nomenclature, x-ray nomenclature and energies, x-ray intensities and fluorescence yields, and a brief description of the competing Auger and Coster-Kronig transitions are discussed. Radiation absorption and scattering are also discussed, including photoelectric absorption, coherent radiation scattering, and Compton or incoherent scattering. The condition for obtaining polarized radiation is described and its advantages for massive samples are illustrated. Tables give the energies of many prominent K-, L-, and M-series x-rays from Z=1 to Z=100, and theoretical K- and L-series x-ray intensities for even Z from Z=10 to 100.

K.F. Hofstetter, G.A. Huff, R. Gunnink, J.E. Evans, and A.L. Prindle, "On-Line Measurement of Total and Isotopic Plutonium Concentrations by Gamma-Ray Spectrometry", in Proceedings of Analytical Chemistry in Nuclear Fuel Processing, p. 266-274, Science Press, 1978.

The feasibility of γ-ray spectrometry for an on-line measurement of plutonium in solutions is being investigated. The capability of this non-destructive method to analyze and inventory plutonium load-out tanks and storage tanks of reprocessing facilities without breaching the containment of plutonium is being evaluated. The isotopic content is determined by direct γ-ray counting of plutonium solutions circulating through a thin cell. The total plutonium concentration is measured by differential γ-ray absorptimetry on solutions flowing through a transmission cell. Several plutonium solutions have been studied in the concentration range of 150-500 g/ℓ having isotopic compositions typical of light water reactor fuel. The results indicate that both the isotopic and total plutonium measurements can be made with precisions of 0.2 - 0.5% and no significant bias when compared to mass spectrometric and coulometric analyses.

A.L. Prindle, J.E. Evans, R.J. Dupzyk, R.J. Nagle, and R.S. Newbury, "The Half-Life of ^{239}Pu", International Journal of Applied Radiation and Isotopes, Vol. 29, 517-524, 8/1978.

The half-life of ^{239}Pu was obtained by two methods, that of isotopic-dilution mass spectrometry and that of measuring the alpha-particle specific activity, to give values of 24,089 $\pm$ 23 and 24.019 $\pm$ 21 yr., respectively.

W.D. Ruhter and D.C. Camp, "Nondestructive Assay of Mixed Uranium-Plutonium Oxides by Gamma-Ray Spectrometry", UCRL-52625, 1/1979.

Gamma-ray spectroscopy measurements have been made on mixed uranium and plutonium oxides in sealed containers to determine the uranium and plutonium enrichment and isotopics. Experimental results obtained using two different methods were in good agreement with the known contents. The first method is applicable to thick samples of freshly reprocessed mixed oxide and determines isotopic abundances from measured absolute gamma-ray intensities. Measurement times depend on plutonium enrichment, but for mixed oxide enriched to 12% in plutonium, the fissionable content can be determined to better than 0.5% in 2 hr. The second approach utilizes intensity ratios of selected pairs of gamma-rays to determine plutonium enrichment and uranium and plutonium isotopics. This method requires at least 12 hr to determine the plutonium enrichment to an accuracy of 0.5%. However, it cannot be applied until the ^{238}U daughter activities in the mixed oxide reach equilibrium, which requires at least 5 mo. after separation. Preliminary conclusions drawn from these two noninvasive and nondestructive measurement techniques, and recommendations for future experiments are discussed.

D.C. Camp, W.D. Ruhter, and S. Benjamin, "Nondestructive, Energy-Dispersive X-Ray Fluorescence Analysis of Product Stream Concentrations from Reprocessed LWR Fuels", UCRL-52616, 1/1979.

Energy-dispersive x-ray fluorescence analysis (XRFA) can be used to measure nondestructively pure and mixed U/Pu concentrations in process streams and hold tank solutions. The 122-keV gamma ray from ^{57}Co excites the actinide K x-rays which are detected by a HPGe detector. A computer- and disk-based analyzer system provides capability for making on-stream analyses, and the noninvasive measurement is easily adapted directly to appropriate sized pipes used in a chemical reprocessing plant. Measurement times depend on concentration and purpose but vary from 100s to 500s for process control of strong to weak solutions. Accountability measurements require better accuracy thus more time; and for solutions containing plutonium, require a measurement of the solution radioactivity made with an automatic shutter that eclipses the two exciting sources. Plutonium isotopic abundances can also be obtained. Concentrations in single or dual element solutions from less than 1 g/l to over 200 g/l are determined to an accuracy of 0.2% after calibration of the system. For mixed solutions the unknown ratio of U to Pu is linearly related to the net U/Pu K x-ray intensities. Concentration values for ratios different than the calibration ratio require only small corrections to the values derived from a calibration polynomial. Minor fission product contamination does not prevent concentration determinations by XRFA. The computer-based system also allows real-time dynamic concentration measurements to be made.

R. Gunnink, A.L. Prindle, J.B. Niday, A.L. Van Lehn, and D.W. O'Brien, "Operations Manual for the TASTEX Gamma Spectrometer System", Lawrence Livermore Laboratory Rept. M-106 (ISPO.67), 3/1979.

This manual describes the characteristics of a computer-based gamma spectrometer system designed to measure the concentrations of the isotopes of plutonium in solutions such as may be found in process accountability and storage tanks in a reprocessing facility. The system was developed as part of the Tokai Advanced Safeguards Technology Exercise (TASTEX), which is a cooperative program for testing advanced safeguards instrumentation at the Power Reactor and Nuclear Fuel Development Corporation reprocessing facility at Tokai-mura, Japan. This manual for operating the system describes the detector and sample cell assembly, the computer-based spectrometer, and the systems software for data acquisition and analysis, and gives operating instructions, calibration procedures, and sampling and analysis procedures. Examples of the procedures and computer analysis are also given.

R. Gunnink, A.L. Prindle, J.B. Niday, A.L. Van Lehn and Y. Asakura, "TASTEX Gamma Spectrometer System for Measuring Isotopic and Total Plutonium Concentrations in Solutions", Journal INMM, VIII, Proc. Issue, 429-437, 1979, UCRL-82335, 6/1979.

We describe a computer-based gamma-ray spectrometer system using a germanium detector for rapid nondestructive measurement of isotopic and total plutonium concentrations in solutions at nuclear reprocessing plants. We have measured isotopic concentrations with an accuracy of $\pm 0.5\%$. We discuss cell design, calibration techniques, and preliminary results. This system is being installed at the Tokai reprocessing plant in Japan.

D.C. Camp and W.D. Ruhter, "Nondestructive Energy Dispersive, X-Ray Fluorescence Analysis of Product Stream Concentrations from Reprocessed Nuclear Fuel", ANS Topical Conference, Kiawah Island, S.C., UCRL-83628, 11/1979.

Energy dispersive x-ray fluorescence analysis can be used for quantitative on-line monitoring of the product concentrations in single- or duel-element process streams in a reprocessing plant. The 122-keV gamma ray from ^{57}Co is used to excite the K x-rays of uranium and/or plutonium in nitric acid solution streams. A collimated HPGe detector is used to measure the excited x-ray intensities. Net solution radioactivity may be measured by eclipsing the exciting radiation, or by measuring it simultaneously with a second detector. The technique is nondestructive and noninvasive, and is easily adapted directly to pipes containing the solution of interest.

The dynamic range of the technique extends from below 1 to 500 g/l. Measurement times depend on concentration, but better than 1% counting statistics can be obtained in 100s for 400 g/l concentrations, and in 1000s for as little as 10 g/l. Calibration accuracies of 0.3% or better over the entire dynamic range can be achieved easily using carefully prepared standards. Computer-based analysis equipment allows concentration changes in flowing streams to be dynamically monitored. Changes in acid normality of the stream will affect the concentration determined, hence it must also be determined by measuring the intensity of a transmitted ^{57}Co beam. The computer/disk-based pulse-height analysis system allows all necessary calculations to be done on-line. Experimental requirements for an in-plant installation or a test and evaluation are discussed.

Editor's Note: The purpose of this series is to assist INMM members in locating safeguards articles and reports. Some are published in journals which INMM members might be expected to read or scan. Some are published in journals which generally are not associated with safeguards. Some are published by institutions or in specialized publications with limited circulations. Each institution which is engaged in the development or application of safeguards techniques should appoint a responsible individual to collect titles and abstracts once a year and send them to W.A. Higinbotham, Brookhaven National Laboratory, Upton, New York, 11973, or Thomas A. Gerdis, P.O. Box 6247, Louisville, Kentucky, 40207.

ASSESSING ERRORS RELATED TO CHARACTERISTICS OF THE ITEMS MEASURED

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ABSTRACT

Errors that are related to some intrinsic property of the items measured are often encountered in nuclear material accounting. An example is the error in nondestructive assay (NDA) measurements caused by uncorrected matrix effects. Such errors cannot be assessed by remeasurement of the items, and they cannot be fully assessed by measuring standards, although standards that span the range of the item characteristics might give upper and lower bounds. Nuclear material accounting requires for each material type one measurement method for which bounds on these errors can be determined. If such a method is available, a second method might be used to reduce costs or to improve precision. If the second method is less expensive than the first, then cost might be reduced by substituting the second method for the first in the measurement of some items. If the measurement error for the first method is longer-tailed than Gaussian, then precision might be improved by measuring all items by both methods.

1. INTRODUCTION

How measurement error is assessed depends on both the measurement methods available and the demands of the application. In particular, the complexity of the assessment and even whether an objective assessment is possible depend on these factors. Consider first, however, the simple case that is usually used to illustrate what is desirable in error assessment.[1,2] In this case, the sequence of measurements is assumed to have independent, identically-distributed errors. This property of the errors is assumed to hold regardless of what items are chosen for measurement or whether some items are measured more than once. This model is often reasonable when the non-negligible sources of error are confined to the measuring instruments.

In this simple case, error assessment involves deriving a bound for the mean of the error distribution and estimating the variance of this distribution. The mean of the error distribution is the systematic error. The bound for the mean is based on properties of the measurement method including bounds on uncertainties in instrument calibration. The estimate of the variance is based on separating the errors from the item-to-item variations in the quantity being measured. This is done by properly designing the sequence of items measured--for example, by remeasuring a working standard or some process items. The first step in an error assessment is a check on the assumptions in the error model, which in this case is the assumption of independent, identically-distributed errors. If this check cannot reject the model, then the error characteristics required by the application can be obtained.

When the errors are independent of the choice of items to be measured, the assumption that the errors are statistically independent and identically distributed can be relaxed.[2,3] The measurements can be regarded as being made in stages (e.g., by week, by operator, by laboratory), and the errors can be assumed to be composed of within-stage errors and among-stage errors. This generalization will often be necessary in applying the assessment procedures discussed below.

When the dependence of the errors on the items selected for measurement cannot be ignored, error assessment by remeasurement of working standards and process items is not completely adequate. In this case, a realistic error assessment is more complex and may be impossible. In nuclear material accounting, such dependence occurs in many important situations. This dependence is mentioned by Jaech in his discussion of the use of standards to assess errors [Ref. 3, p. 88]. It is carefully considered in a clinical-chemistry application by Lawton et al.[4] This dependence is illustrated by the following four examples:

The first example is dependence of the errors on an interfering material. Dependence from this cause occurs in measurements by NDA. The relation between what the instrument senses (e.g., gamma emissions) and the desired value, which is usually the total quantity of some material, is influenced by the matrix material. This relation is further complicated by the configuration of materials in the container. In some applications of NDA methods, these properties of the items can be carefully controlled, even well enough that this source of error can be ignored. But often NDA methods are attractive because sampling is difficult due to material inhomogeneity and the small quantity of nuclear material present. Under these circumstances, considerable dependence may be present.

Under the circumstances of this example, remeasurement of working standards or process items will usually not lead to an adequate error assessment. (This problem is discussed by Lawton et al.[4]) Remeasurement of process items is inadequate because each remeasurement gives the same realization of the error component caused by the matrix material. Thus, these errors are indistinguishable from the item-to-item variations in the 'true' values being measured. Remeasurement of working standards might be adequate if a set of standards were created that reproduced the distribution of the matrix characteristics causing the error. Creating such standards seems difficult. Although remeasurement of a single standard has nearly the same inadequacy as remeasurement of process items, remeasurement of a set of standards that spans the range of the distribution might provide useful upper and lower bounds.

The second example of dependence on the items measured is the effect of inhomogeneity on sampling error. In sampling from a container of nuclear material, physical constraints may both prevent the material from being mixed completely and prevent sampling that selects any portion of the material with equal probability. Thus, the representativeness of the sample selected will depend on the inhomogeneity of the item sampled. Sampling also involves other errors that are item dependent such as moisture absorption. Repeating the sampling operation does not adequately assess such errors since the two realizations will not have independent errors. Sampling experiments on well-characterized material, such as the example given by Jaech [Ref. 3, p. 115], are also not adequate unless the variations actually encountered are reproduced in the experiment.

As the third example consider errors in calibration curves caused not by estimation of the parameters of the curve but by imperfections in the chosen functional form of the curve. Procedures exist for assessing errors associated with the estimation of the parameters but not for assessing errors associated with imperfections in the functional form (although such errors can sometimes be detected by testing whether the lack of fit of the calibration curve can be explained by the errors observed upon remeasurement of the calibration standards). Such errors are item dependent because they depend on the value being measured. Thus, remeasurement of process items even with new calibration data is inadequate. Remeasurement of working standards may indicate that there is a problem; but unless the standards properly cover the range, this remeasurement may not provide the data to correct the problem. These imperfections can be reduced by experimentation. However, material accounting often cannot wait until the experiments are complete.

The fourth example is the use of values derived in part from specifications. For example, consider a fuel element containing a measured quantity of nuclear material that is cut into sections. The material in each section is calculated from the geometry specified for the cutting. Such a method might be much more accurate than any alternative measurement method, in which case it should be used. The errors in the values obtained from such calculations depend on how the actual distribution of material differs from that specified. Thus, the errors are item dependent. In this example, remeasurement of process items has no meaning, and standards do not exist.

In each of these examples, the item-dependent errors can be modeled as random variables. Such modeling provides relations among measurement errors which can be the basis for inference. For example, the simple model that specifies independent, identically-distributed errors that are item independent is the basis for summarizing all errors by a single probability distribution and the basis for doing error assessment by remeasurement of working standards or process items. For item-dependent errors, this simple model can be generalized by modeling the selection of items for measurement as random selection from some population. As discussed by Lawton et al., the measurement error in this case can be thought of as the sum of two errors, an item-independent error and an item-dependent error.[4] In general, both of these errors have non-zero means (in other words, non-zero systematic components) and both have random components. In the last two examples above, the item-dependent errors depend on the "true" values, which are usually the quantities of material being measured. Unfortunately, with only a single measurement method described by this model, no technique for assessment of the total random error, equivalent to remeasurement of working standards or process items, exists. Thus, for example, the randomness of the sequence of errors cannot be tested as it could under the simple model. Thus, until a way for assessing the validity of this model is prescribed, the use of this model cannot be objectively justified.

How are item-dependent errors to be assessed? Section 2 argues that nuclear material accounting requires for each material type one measurement method with an upper bound established for any item-dependent errors. Sections 3 and 4 discuss the value of a second method for which this requirement may not be met. In Section 3, this second method is discussed as a substitute to reduce costs. In Section 4, it is discussed as an approach to improving precision.

2. BOUNDS FOR SYSTEMATIC ERROR

In nuclear material accounting, assessment of the systematic error, although it may be difficult, cannot be avoided. Since material balances are formed around processes that change the form of the nuclear material, measurements on receipts are made on different materials than measurements on shipments. Thus, the measurement methods differ, at least to some extent; and judging whether an inventory difference is attributable to measurement error must be based on not only the random errors but also the (long-term) systematic errors. Systematic errors may be difficult to assess both realistically, so that apparent inventory differences are properly attributed to measurement error, and objectively, so that the integrity of the accounting is maintained. This difficulty occurs in another measurement context, the reconciliation of different determinations of the fundamental constants.[5]

Consider some approaches to assessing the systematic error. If the item-dependent error can be ignored, then the following procedure discussed by Jaech[3] is a possibility: A standard is measured repeatedly, and the results are used to correct for the systematic error and, at the same time, to assess the error in this correction caused by the random measurement error. The assessment is then completed by establishing error bounds for the value assigned to the standard.

Assessing the systematic part of the item-dependent error seems more difficult. One approach is direct study of each source of item-dependent error. For each source, the error is bounded either experimentally using standards that vary over the range of the population or theoretically. One weakness of this approach is that some sources of item-dependent error may be missed. However, if such sources are important enough and are not detected by other means, they will eventually cause an inventory difference that cannot be explained by current understanding of the measurement error. This situation will impel a search for unassessed error sources. There are approaches to the assessment of item-dependent errors that apply independent measurement methods to the same items.[4] Such methods provide information on the random part of the item-dependent error but do not provide a bound for the systematic part.

When the systematic part (the mean) of the item-dependent error must be assessed through direct study of each error source, the resulting bounds will often be no tighter than bounds for the entire item-dependent error. Better bounds for the mean than for the entire error cannot be obtained if knowledge of the population of items is insufficient to show where the mean lies in the range of the items. Because better bounds for the mean will be provided only infrequently, the remainder of this paper will consider the case where one of the available measurement methods has established bounds for the entire item-dependent error. In other words, one available measurement method gives measurements satisfying the following model

$$x = \mu + \beta + \varepsilon_x, \tag{1}$$

where μ is the "true" value, β is an error for which a bound is available, and ε_x is an item-independent random error. The error β includes all systematic errors and the random part of the item-dependent error.

Say that another measurement method exists which satisfies the following model

$$y = \mu + \alpha + \varepsilon_y + \gamma + \delta, \tag{2}$$

where α and ε_y are the systematic and random parts of the item-independent error and where γ and δ are the systematic and random parts of the item-dependent error. The components δ and ε_y are assumed independent of the errors in x, and the item-dependent error $\gamma + \delta$ does not have established bounds that are tight enough to be useful. How can this method be used? We discuss two possibilities.

3. ASSESSMENT OF ONE METHOD WITH ANOTHER

Under some circumstances, measurement methods with unknown item-dependent errors can be used to achieve more cost-effective material accounting through the following procedure: The measurements with unknown item-dependent errors (denoted by y) are made on all items; the measurements with bounded item-dependent errors (denoted by x) are made on a representative sample of the items; and in the assessment, the x measurement is used in the role of a referee method. The cost effectiveness of this procedure depends on the y measurement being less expensive than the x measurement or on the y measurement being nondestructive whereas the x measurement involves destroying product. This procedure is discussed here, even though it is similar to the usual use of a referee method,[4] so that we can consider the effects of errors in the x measurements. Errors in the x measurements may be larger than those of the best referee methods because of the need for ongoing x measurements to assure control of the measurement process and the need for timely x measurements to update measurement procedures in response to changes, for example, in production methods.

Consider the measurement of N items to determine the total quantity present. For item i, i=1,...,N, the measurement y_i of the quantity in item i is obtained. For a sample of size n out of the N items, two measurements x_{1i} and x_{2i} of the quantity are also obtained. An estimate of the total quantity is

$$U = \Sigma y_i - (N/n)\Sigma'(y_i - m_i), \tag{3}$$

where

$$m_i = (x_{1i} + x_{2i})/2, \tag{4}$$

and where Σ denotes the sum over all items and Σ' denotes the sum over the sample of items. This measurement design and the corresponding estimate are perhaps the simplest version of the procedure being discussed.

Error assessment for U is based on the following assumptions: The measurements x_1 and x_2 are modeled as in equation 1 except that the values of β, although they vary from item to item, are treated as non-random. The two values of ε_x are assumed to be statistically independent. The measurements y are modeled as in equation 2. The random parts of the measurement errors are all independent and for each measurement method, they are identically distributed. Under these assumptions, the mean value of U is

$$\begin{aligned} E(U) &= \Sigma(\mu_i + \alpha + \gamma) - (N/n)\Sigma'(\alpha + \gamma - \beta_i) \\ &= \Sigma\mu_i + (N/n)\Sigma'\beta_i \end{aligned} \tag{5}$$

and the variance of U is

$$\begin{aligned} Var(U) &= Var(\Sigma y_i - (N/n)\Sigma' y_i) + (N/n)^2 Var(\Sigma' m_i) \\ &= N(N/n-1)\ Var(y) + N(N/n)Var(m) \\ &= N[(N/n-1)\ Var(y-m) + Var(d)], \end{aligned} \tag{6}$$

where

$$d = (x_1 - x_2)/2. \tag{7}$$

As discussed above, the second term in equation 5 can be assessed using the established bound for β. The two variances on the right side of equation 6 have the obvious estimates

$$s_{y-m}^2 = [1/(n-1)]\Sigma'[y_i - m_i - (1/n)\Sigma'(y_i - m_i)]^2 \tag{8}$$

$$s_d^2 = (1/n)\Sigma'(d_i)^2 \tag{9}$$

The estimate s_{y-m}^2 is biased because of item-to-item variation in the errors denoted by β. The direction of this bias is unknown if the errors β are related to the errors in y. Thus, such a relation must be avoided. In particular, if the item-dependent errors in y arise as in examples 3 and 4 above, care must be taken to assure that β does not depend on the "true" value being measured. If the errors β are unrelated to the errors in y, then s_{y-m}^2 has a positive bias, which can be ignored if the errors β are not too variable.

In material accounting, all assumptions must be checked. The assumptions about the x measurements can be checked as in the simpler case of no item-dependent error.[6] First, the errors denoted by β in equation 1 are checked through direct experiment. If the item-dependent errors in y arise as in the last two examples, the part of β due to calibration error must be checked carefully. Second, the assumption that the errors denoted by ε_x are independent and identically distributed can be checked by examining the values of d_i. The assumptions about the y measurements are checked by comparison with the x measurements. The assumption that the errors in y are independent and identically distributed can be checked by examining the values of $y_i - m_i$. Also, the scatter plot of $y_i - m_i$ versus m_i might show an unexpected relation that indicates a problem. What procedure is followed when violation of the assumptions is indicated is very important in material accounting since in this situation objective error assessment may be impossible.

Checking the assumptions that make the error assessment valid must be done regularly. This is the essence of a measurement assurance program.[6]

4. IMPROVEMENT OF PRECISION

If the precision of the x measurement is not sufficient for accounting purposes, improvement might be sought by measuring every item twice by the method with bounded item-dependent error (x) and once by the method with unknown item-dependent error (y). However, in this case, the y measurement does not contribute to the estimate in equation 3 (which is the classical linear estimate) as can be seen by letting n=N. Note that this is true even if the y measurement is much more precise than the x measurement. The reason is that the error in estimating the systematic error in the y measurement compensates for any increase in precision. Improvements on the linear estimate in equation 3 are possible, however, because measurement error is not exactly Gaussian.[7] Measurement error usually shows a higher probability of large errors than is predicted by the Gaussian distribution. Even though this property may rarely be detected in the usual samples, it still may be the basis for obtaining benefits worthwhile in comparison to the estimate in equation 3.

The principles involved in finding a better estimate than equation 3 can be seen by considering the following extreme case: Let the y measurement be perfectly precise so that its only error is the fixed systematic error. Let T_{y-m} be a robust location estimate computed from the values $y_i - m_i$, $i=1,\ldots,N$ [Ref. 8]. Consider the two estimates Σm_i and $\Sigma y_i - NT_{y-m}$. If the x measurement has an error distribution with longer tails than the Gaussian distribution, the second estimate will have higher precision for any of several choices of T_{y-m} [Ref. 8]. We see that when the distribution of the x measurements is not Gaussian, the error in estimating the systematic error in the y measurements may be smaller than the error in the estimate Σm_i.

Another improvement that is possible when Σm_i is replaced with a robust estimate is improvement of the variance estimate. The efficiency of the variance estimate for Σm_i is affected by non-Gaussian distributions even more than the efficiency of Σm_i itself. The efficiency of the variance estimate for a robust estimator, if chosen properly, should be affected less.

The estimate $\Sigma y_i - NT_{y-m}$ is appropriate when the y measurement is perfectly precise, but, of course, it is not appropriate in general. Several robust estimates have been studied,[8] although none exactly fit the accounting situation discussed here. Thus, development of an appropriate estimate is needed. Also, a variance estimate must be developed.

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SAFEGUARDS APPLICATIONS OF FAR INFRARED RADIOMETRIC TECHNIQUES FOR THE DETECTION OF CONTRABAND

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ABSTRACT

A new safeguards system under development employs radiometers in the 100-300 GHz spectral band to detect contraband, including shielding materials (used to attenuate the gamma ray emissions from nuclear materials), weapons, or explosives covertly concealed on personnel. Clothing is highly transparent at these frequencies and imaging techniques can detect contraband by its emissivity and reflectivity differences relative to human tissues. Experimental data are presented and sample images are used as a basis to discuss system advantages and limitations.

SECTION I

Introduction

During the past decade, the need for new, versatile, personnel inspection techniques has arisen. Traditional systems employing magnetometers and x-ray imagers are now common in mass transportation centers, but because metal detectors are easily defeated and because x-ray imaging of personnel is prohibited by radiological health considerations, alternative or complementary approaches need to be developed. In this work, a new inspection technique is investigated which utilizes radiometric imaging in the so-called far infrared (FIR), or near-millimeter-wave (NMMW), spectral region extending roughly from 300-3000 μm.[1-5] This spectral region is ideally suited for personnel inspection because the attenuation of clothing is small and because the radiation does not present a health hazard. Although the same description can apply to the microwave spectrum (3-mm to 1-cm wavelength), both the resolution for a reasonable size imaging system collection aperture and contrast between the concealed object and human tissues is degraded.[6] The FIR can provide resolution on the order of 1 cm using modest antenna apertures of 10-100 cm. Human tissue can be characterized as a nearly ideal blackbody, thus providing a uniform backdrop against which radiometric imaging and detection can be accomplished. The FIR method provides a method of material (anomoly) detection not necessarily including identification. The new detection technique creates a visual display using a cathode ray tube driven by the output of a sensitive radiometer operating in the NMMW portion of the spectrum. An optical scanning system generates a two dimensional search matrix 1 m^2, or approximately 10^4 resolution elements. It is possible to distinguish between various objects at the same absolute temperature by measuring their apparent temperature (or emissivity) with a radiometer.

Because human tissue is characterized by an emissivity close to unity at FIR/NMMW frequencies of 100 GHz (3 mm) and higher, a radiometer at these wavelengths will measure body temperatures that are roughly 10-15°C above room ambient. Concealed metallic objects will

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reveal themselves as regions of moderate-to-low emissivity against the uniform high emissivity background of human body tissue. These concealed objects will also shadow the radiated signal from human tissue and reflect some ambient background into the radiometer.

At the present time, radiometric detection against a human tissue background has been investigated for metallic objects, special nuclear shielding materials, and some explosives. Careful measurement of attenuation for clothing and other common concealment materials indicates only a small loss at far infrared wavelengths. Metallic objects 2 cm^2 in area were easily detected against a human backdrop with several layers of intervening clothing. The detection of nuclear shielding materials is more difficult and strongly depends on the manufacturing details of the material and the placement and contact on the subject. Explosives are very difficult to detect; however, only a small effort has been dedicated to this subject.

This paper describes the details of an FIR radiometric imaging inspection technique. Images will be used as a basis for discussing present performance and ultimate system potential.

SECTION II

Radiometry Fundamentals

All objects at temperatures above absolute zero radiate energy in the form of electromagnetic waves and absorb and reflect energy that is incident upon them. A perfect absorber is called a blackbody which is a perfect radiator and has an emission spectrum completely governed by the absolute physical temperature T. The brightness of the radiation is given by Planck's radiation law as follows:

$$B = \frac{2h\nu^3}{c^2} \frac{1}{e^{h\nu/kT}-1} \qquad (1)$$

where

B = brightness (watts m^{-2} Hz^{-1} rad^{-2})

h = Planck's constant (6.63×10^{-34} joule-sec)

ν = frequency (Hz)

c = velocity of light (3×10^8 m sec^{-1})

k = Boltzmann's constant (1.38×10^{-23} joule$^{o}K^{-1}$)

T = temperature (^{o}K)

If Eq. (1) is integrated over all frequencies, the familiar Stefan-Boltzmann relation is obtained

$$B = \varepsilon \sigma T^4 \qquad (2)$$

ε = emissivity

σ = constant (1.80×10^{-8} watts m^{-2} $^{o}K^{-2}$)

In Fig. 1, several brightness curves are plotted as a function of frequency and temperature using Eq. (1). The spectral region of interest in this work includes frequencies of 100-300 GHz. In this region $h\nu << kT$ so that the exponential factor in Eq. (1) is given to a good approximation by $kT/h\nu$. Thus

$$B = \frac{2\varepsilon kT}{\lambda 2} \qquad (3)$$

where λ is the wavelength in meters, and the apparent brightness is a function of the absolute temperature T and emissivity ε. Two objects at the same temperature but with different emissivities, or two identical objects at different temperatures, will radiate different amounts of energy. By using very sensitive detectors of this incoherent thermal emission it is possible to discriminate between objects at different apparent temperature (εT). The apparent temperature difference arises from emissivity or real absolute temperature differences. State-of-the-art detectors in the NMMW portion of the spectrum (100-300 GHz) can differentiate apparent temperature differences of a fraction of 1 degree for a 1-second integration time.

In radiometric systems, detection can be accomplished with the use of either coherent (heterodyne) or incoherent (video) techniques. The incoherent approach at NMMW frequencies requires liquid-helium-cooled detectors with little performance advantage relative to heterodyne detection. In the coherent approach as used in this program, the radiometer incorporates a room-temperature Schottky barrier diode mixer. The intermediate frequency (IF) is amplified by a low-noise, gallium arsenide, field-effect transistor (GaAs FET) amplifier. For a heterodyne system the minimum detectable temperature difference is given by:

$$\Delta T = \frac{T_{sys}}{(B\tau)^{\frac{1}{2}}} \qquad (4)$$

where B is the IF bandwidth, τ is the post-detection integration time, and T_{sys} is the equivalent noise temperature of the receiver.

The range of minimum detectable temperature, as a function of IF bandwidth and receiver equivalent noise temperature, is illustrated in Fig. 2. Low noise IF amplifiers are now available with frequencies up to 10 GHz, and 3000°K is a reasonable system noise temperature for receivers of 100 to 300 GHz. Temperature differentials of a fraction of a degree should therefore be readily detectable.

Passive detection systems are the most desirable because the signal is derived totally from the self-emitted radiation. However, the inspection of large areas (1 m^2) at reasonable frame rates (i.e., a few seconds) may require illumination for increased contrast. This can be accomplished using incoherent sources such as mercury arc lamps with effective brightness temperatures of a few thousand degrees in the NMMW portion of the spectrum. The UV, visible, and near-infrared emissions are filtered out so that the subject is totally unaware of the illumination and, because the flux is much less than the normal level received from the sun, the radiation hazard is negligible.[7]

SECTION III

Transmission Characteristics of Clothing and Other Common Concealment Materials

The key idea in utilizing FIR/NMMW detection and imaging is that many materials, especially clothing, become transparent in this spectral region. Visual images and infrared thermal images (thermograms) will only indicate features of the outer layers of clothing or other concealment materials.

To assess the utility of FIR/NMMW imagery, it was first necessary to investigate the transmission characteristics of materials.[1-4] Absorption coefficients are available in the literature for many materials.[8] The intent was not to repeat these careful measurements, which are generally performed on pure materials, but rather to indicate the gross transmission features of common materials which include contributions of reflection and scattering.

The transmission data are summarized in Fig. 3. As the wavelength increases beyond 1000 µm (1 mm), the transmission of even dense materials, like leather and wood, is sufficiently high to permit inspection through these materials. The data should be used as trend indicators and not for absolute numbers. The optimum region for minimum loss and maximum resolution occurs between the wavelengths of 1 and 3 mm, and actual system operating wavelength will be dictated by these conditions, the status of components, and the achievable sensitivity of detectors and radiometers.

SECTION IV

Experimental Radiometric Imaging/Detection System

The NMMW, passive imaging system, Figure 4, consists of four major subsystems; an optical-type scanning system, a radiometer for signal detection, electronics for scanning system control and signal processing, and a visual display and recording system.

The scanning system has a fixed elliptical primary mirror with focii at 1 and 3 meters. Thermal energy emitted by a body at the focus in the object plane is reflected by the vertical scan mirror, the horizontal scan mirror, the elliptical primary mirror, and finally, into radiometer horn antenna at the image-plane focus. The scanning mirrors, therefore, sweep the 3-meter focus over the object plane while the 1-meter focus remains fixed at the radiometer.

A block diagram of the radiometer is shown in Figure 5. The thermal radiation emitted by a target is focused, through the chopper, into the radiometer horn. The radiometer is a Dicke receiver;[9] i.e., the chopper alternately blocks the signal from the target and reflects a reference signal from an ambient load into a horn antenna. The signal is squarewave-modulated at the chopper frequency, heterodyned in the mixer, amplified in the IF amplifier, and square-law detected by the diode detector. The amplitude-modulated video signal is then amplified and synchronously detected in the correlator. The resultant DC signal is integrated, amplified, and sent to the data collection system for proper display formatting. The 3-mm radiometer and imaging system has a double sideband system noise temperature of approximately 1700°K and a minimum detectable input temperature (ΔT) of approximately 0.1°K for 1-sec integration.

SECTION V

Experimental Results

The 3-mm radiometer was used to obtain single-line, horizontal scan data prior to implementation of the full scanning operation. Figure 6 shows a scan of a 2-cm-wide lead target (nuclear material shielding) against a human body with the view both unobstructed and through a 2.4-mm-thick leather jacket material. Also included is a similar scan using incoherent illumination from a mercury lamp. The detected signal is enhanced and now appears hotter than the ambient background. The results indicate that metallic objects will appear several degrees cooler in a passive detection scheme and will be detected through normal layers of clothing. As observed previously, metallic objects reflect the room ambient thermal radiation and this is compared to radiometric skin temperature. The emission temperature from the skin surface at 3 mm is approximately 205°K, and preliminary measurements at 1.4 mm indicate an emission temperature of approximately 307°K. These values vary by 2-3°K on a given subject, probably as a function of skin thickness, skin moisture, body fat layers, and other body characteristics. Typically, the emission temperature of the human body ranges from 7-10°C above ambient in the laboratory environment.

Typical passive radiometric signatures for a variety of composite shielding materials appear in Figure 7. The differential radiation, ΔT, is plotted versus real physical temperature because the latter value can vary depending on the location of the contraband sample on a human. For certain samples and physical temperatures, the differential radiance can be zero and thus the sample is radiometrically indistinguishable from the background. This ambiguity is unlikely and, in any event, can be resolved using active inspection or by comparing radiometric signatures at two wavelengths, e.g., 3 and 1.4 mm. These studies are now in progress.

Preliminary signature data for three available explosive samples (C4, detasheet, and TNT) indicate that these bare materials are difficult to detect using only passive radiometry at the 3-mm wavelength. However, explosives appear very amenable to detection using active/passive, dual wavelength radiometry, or FIR/NMMW spectral line detection.

Imaging has also been accomplished using the system illustrated in Figure 5. The first image is designed to test spatial resolution as shown in Figure 8. The target is a variety of metallic geometric shapes, with the dimensions indicated, mounted in front of a 77°K cold surface. The 3-mm image clearly indicates the presence of the smallest object (1 cm^2), although squares and circles appear the same. This is acceptable because our present goal is to detect, not necessarily identify, contraband. The data presented were recorded photographically from the display monitor without the use of image processing.

The second image, Figure 9, is the 3-mm wavelength reproduction of a handgun. The shape is readily discernible. The presence of a heavy layer of cloth over the object does not degrade the image as shown in Figure 9d.

Both of the previous figures illustrate the potential of the imaging techniques; however, the target geometry is idealized by the presence of the 77°K background. Because the metal objects mask the 77°K background and reflect the room ambient background, $\Delta T \approx 230°K$. If an active imaging system were developed, the anticipated signal level would be comparable to 200°K. However, for passive detection, the ΔT is an order of magnitude lower and, thus, is less conclusive at this point.

Figure 10 demonstrates the present prototype passive system operation for a real human subject with a concealed weapon. The weapon is detectable, but not easily identifiable, and only relatively large objects would be seen. It will be necessary to improve the performance of the radiometer (a factor of 10 is within present capability) and to use illumination to insure large signals ($\Delta T \approx 200°K$) for the detection of small (2 to 4 cm^2) objects.

SECTION VI

Conclusions

It has been demonstrated that radiometric detection of metallic objects is feasible in the 100-220 GHz band. Data obtained with a prototype, passive radiometric imaging system operating at 100 GHz indicates that target signatures (5-10°K ΔT and 2 cm^2 resolution) are adequate to detect contraband covertly carried by personnel - especially SNM and weapons. Clothing and other common nonmetallic materials of concealment present only a small transmission loss.

The detection of composite nuclear shielding materials is more difficult than solid materials and presents a complex set of problems that is strongly dependent on the manufacturing details of the material and the placement and contact on the subject; however, a sensitive, high-resolution scanning system should detect the object. A preliminary evaluation of explosives (C4, TNT, detasheet) at 3-mm wavelength indicates low contrast relative to human tissue background.

Radiometric improvements and illumination schemes will be implemented to increase the signal-to-noise ratio and/or inspection rate. The results to date are encouraging and work is proceeding to improve performance and address real detection scenarios.

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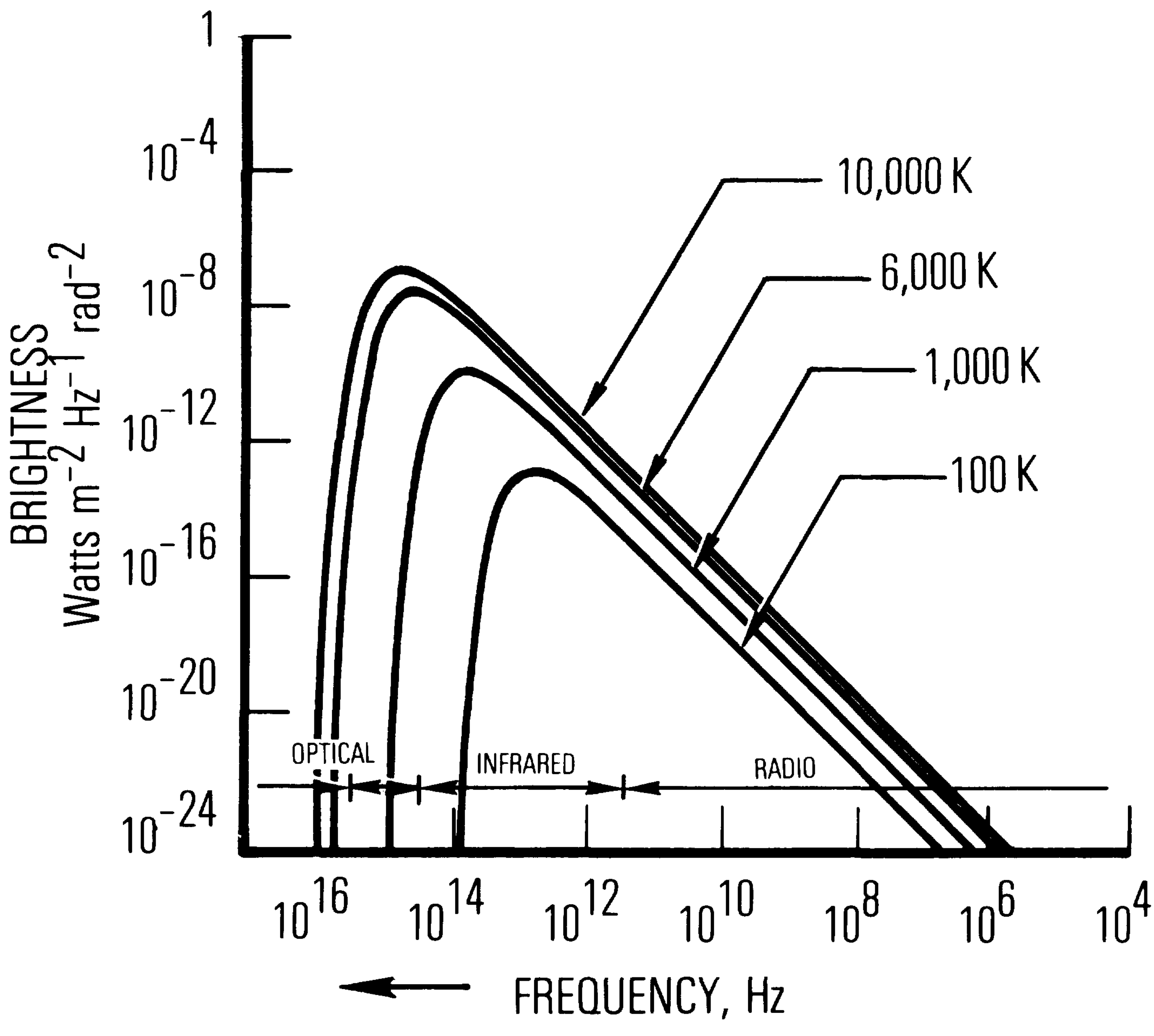

Fig. 1 — Spectral brightness curves showing radiated power from general blackbodies of the temperatures indicated.

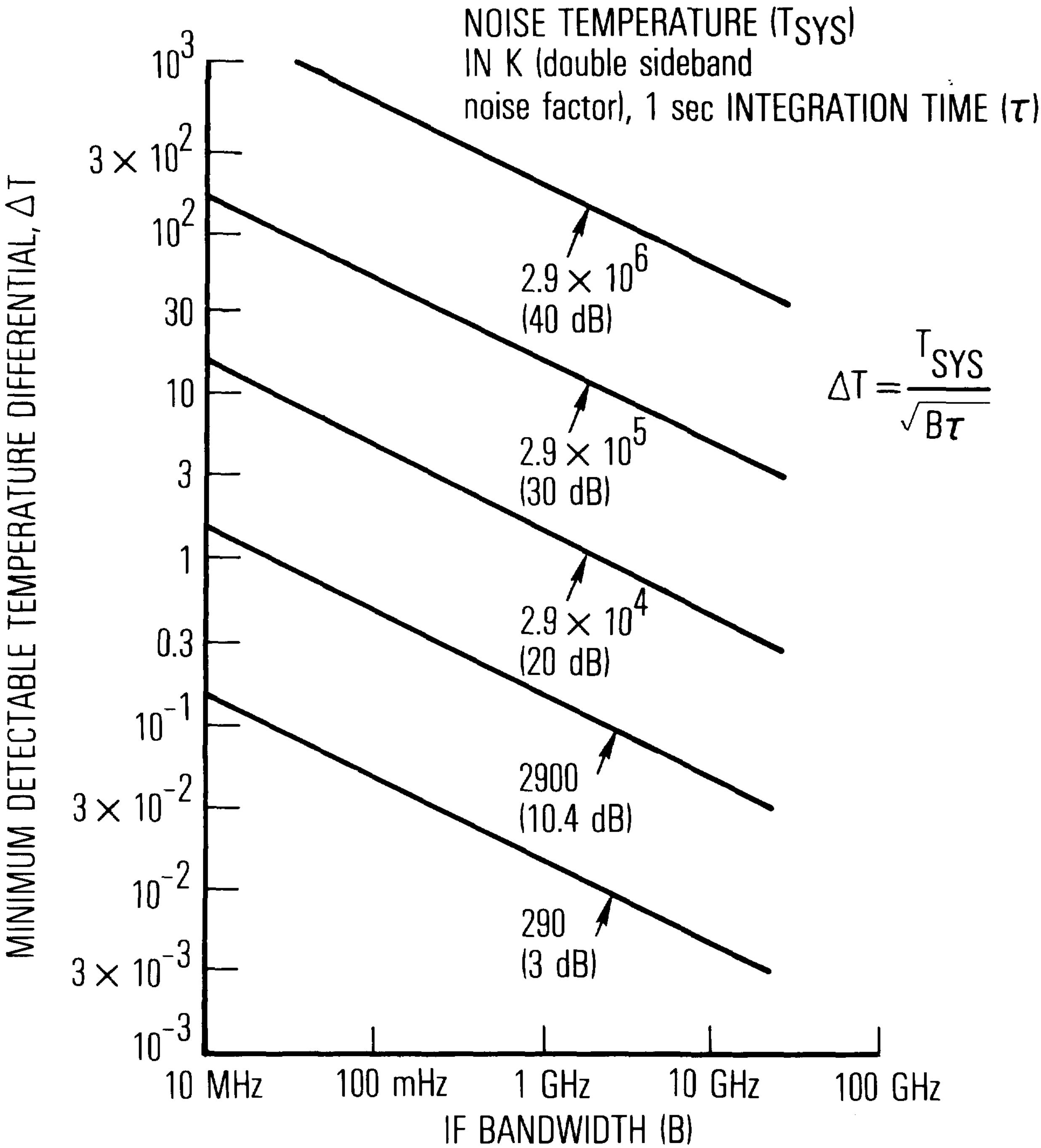

Fig. 2 — Theoretical performance of coherent radiometer, 1-second integration time. The parametric curves indicate system noise temperatures of the radiometer receiver.

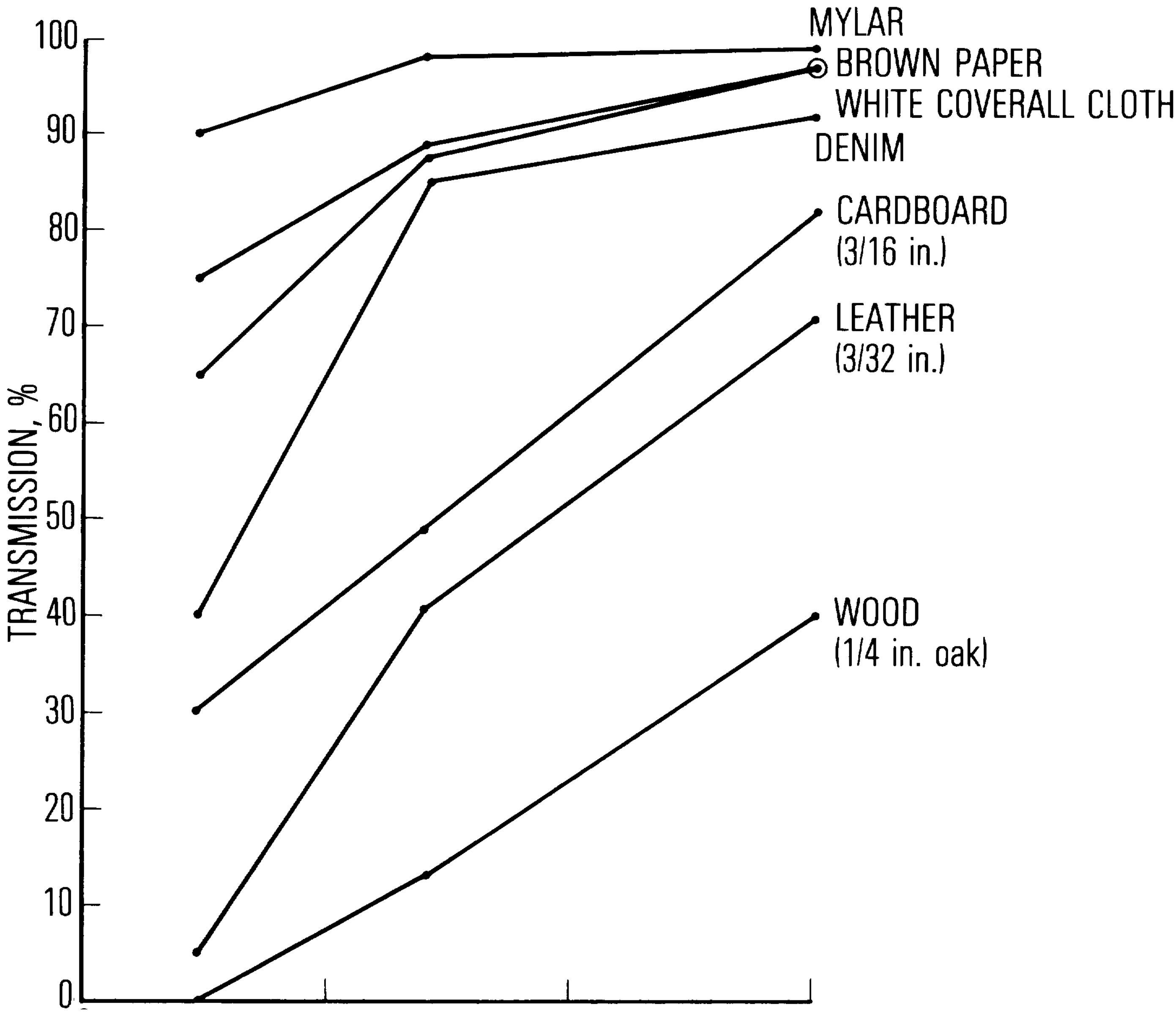

Fig. 3 — Transmission of representative concealment materials in the FIR-NMMW spectral region. Losses include the effects of absorption, reflection, and scattering.

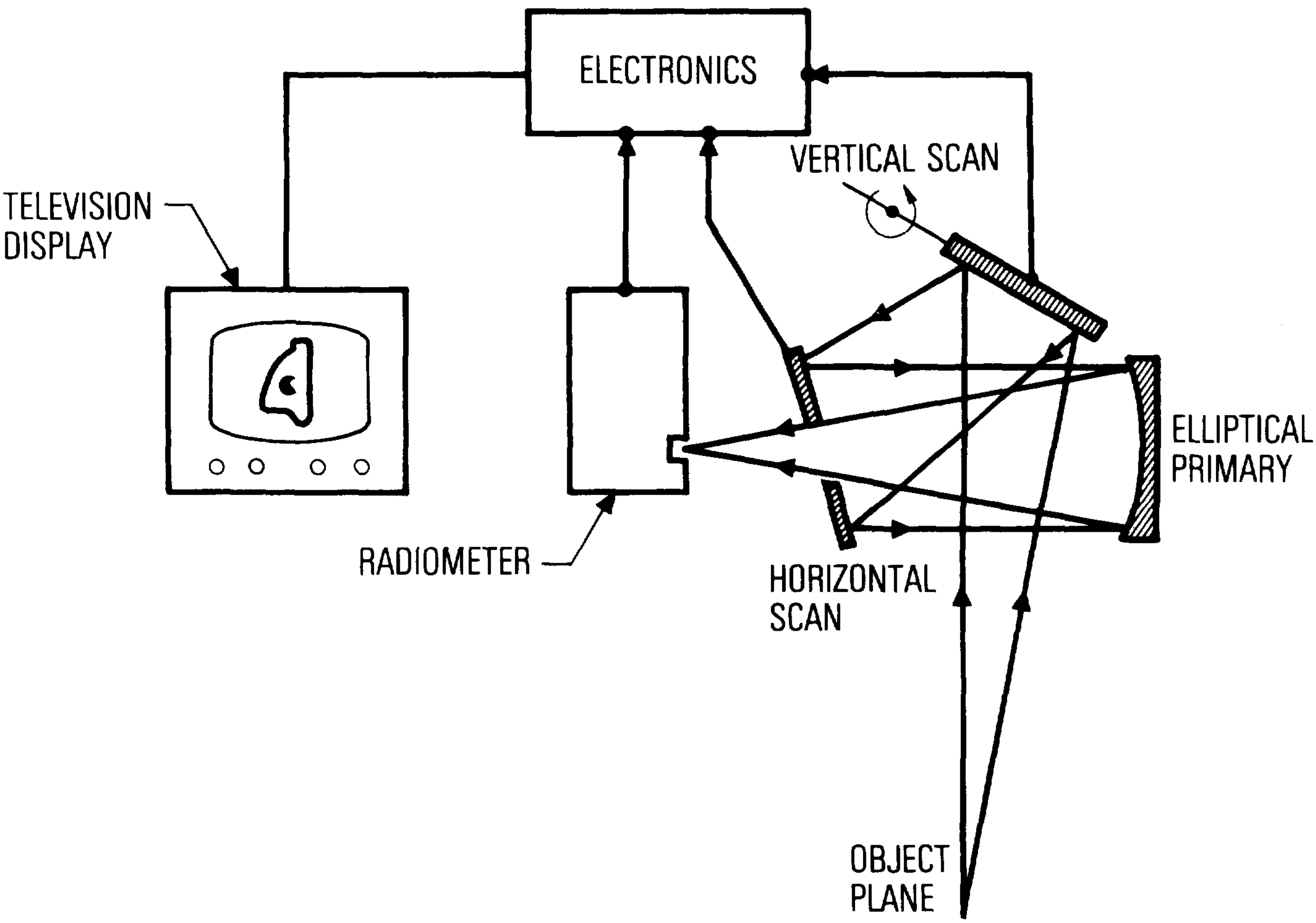

Fig. 4 — NMMW passive imaging system block diagram.

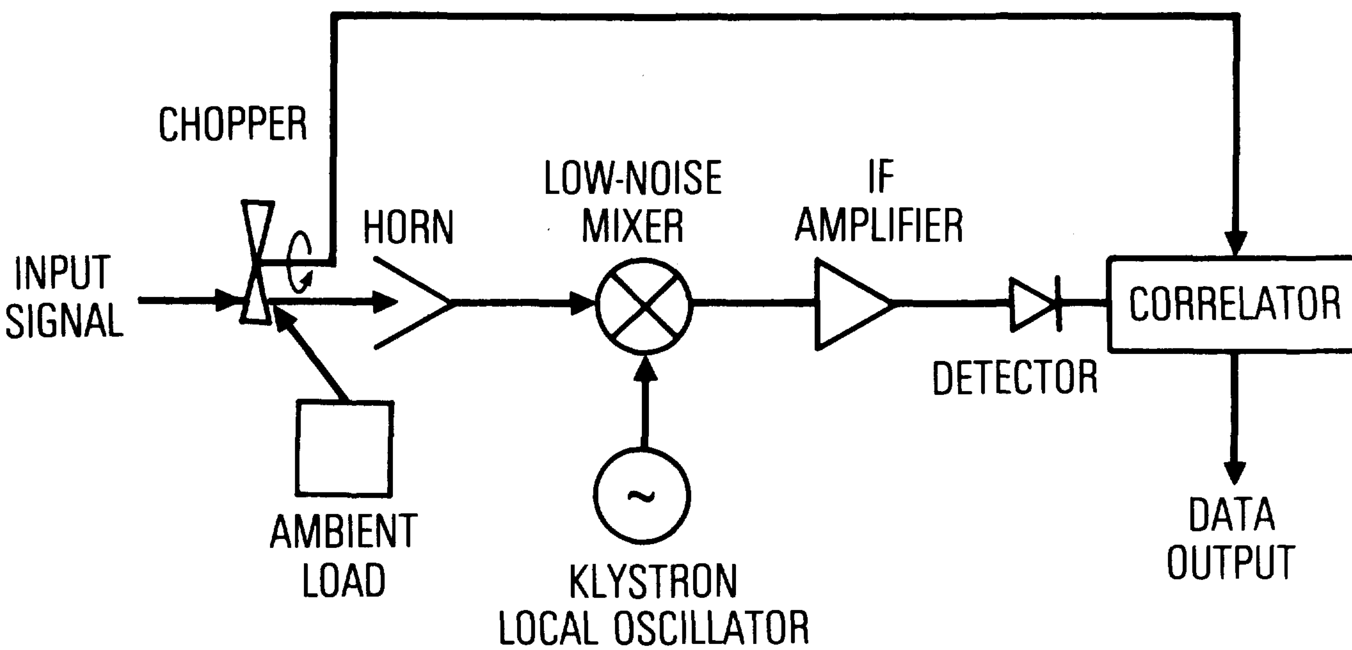

Fig. 5 — Radiometer block diagram.

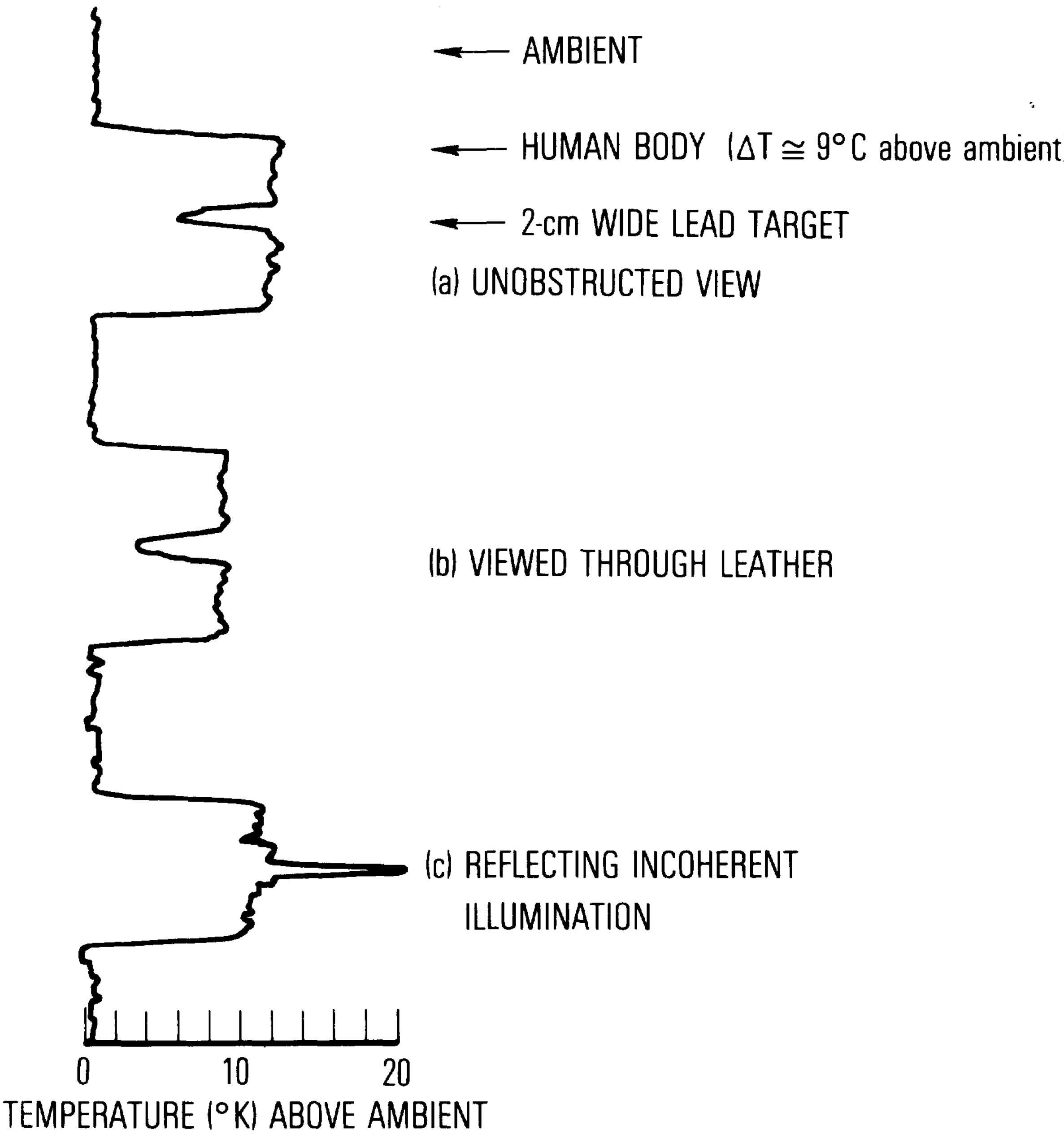

Fig. 6 — 3-mm radiometric scan of 2-cm wide lead target against a human body. (a) Unobstructed view of target. (b) Viewed through 3/32 inch of leather. (c) 2-cm wide lead target against human body, reflecting incoherent illumination.

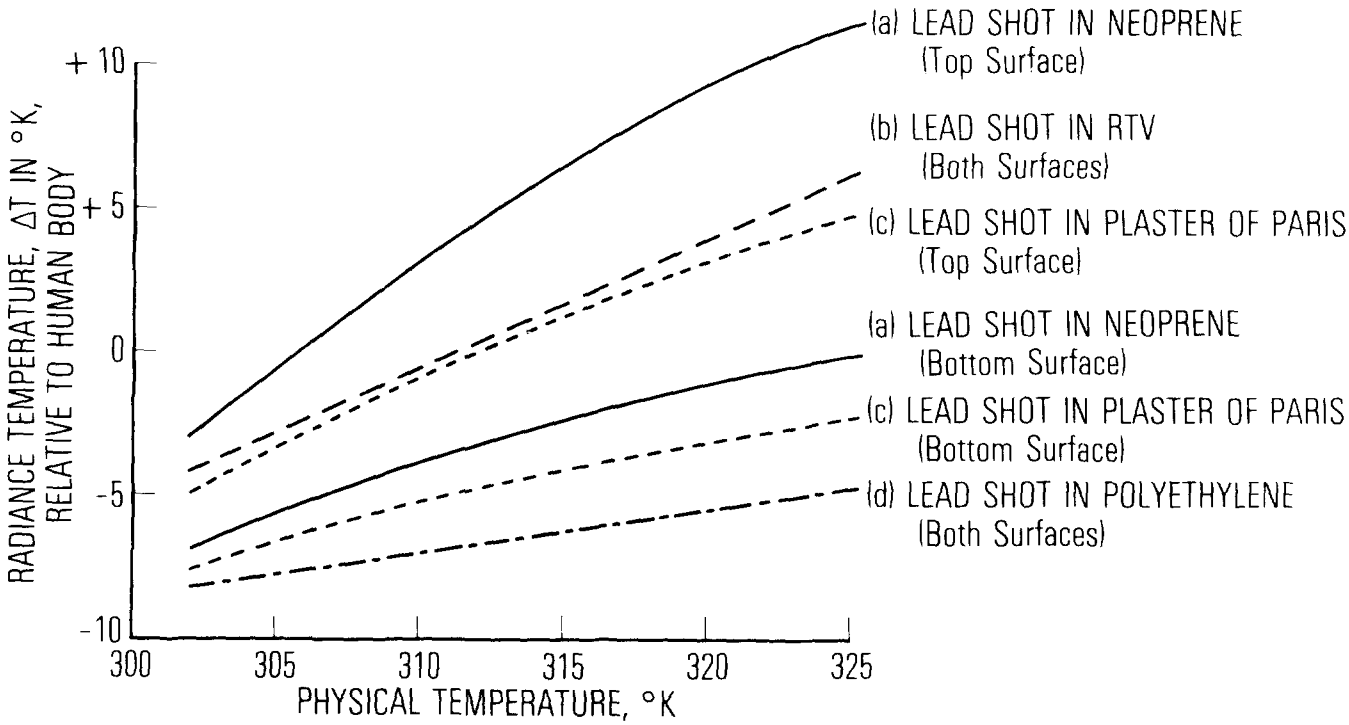

Fig. 7 — 3-mm Radiance temperature versus physical temperature of composite shielding materials.

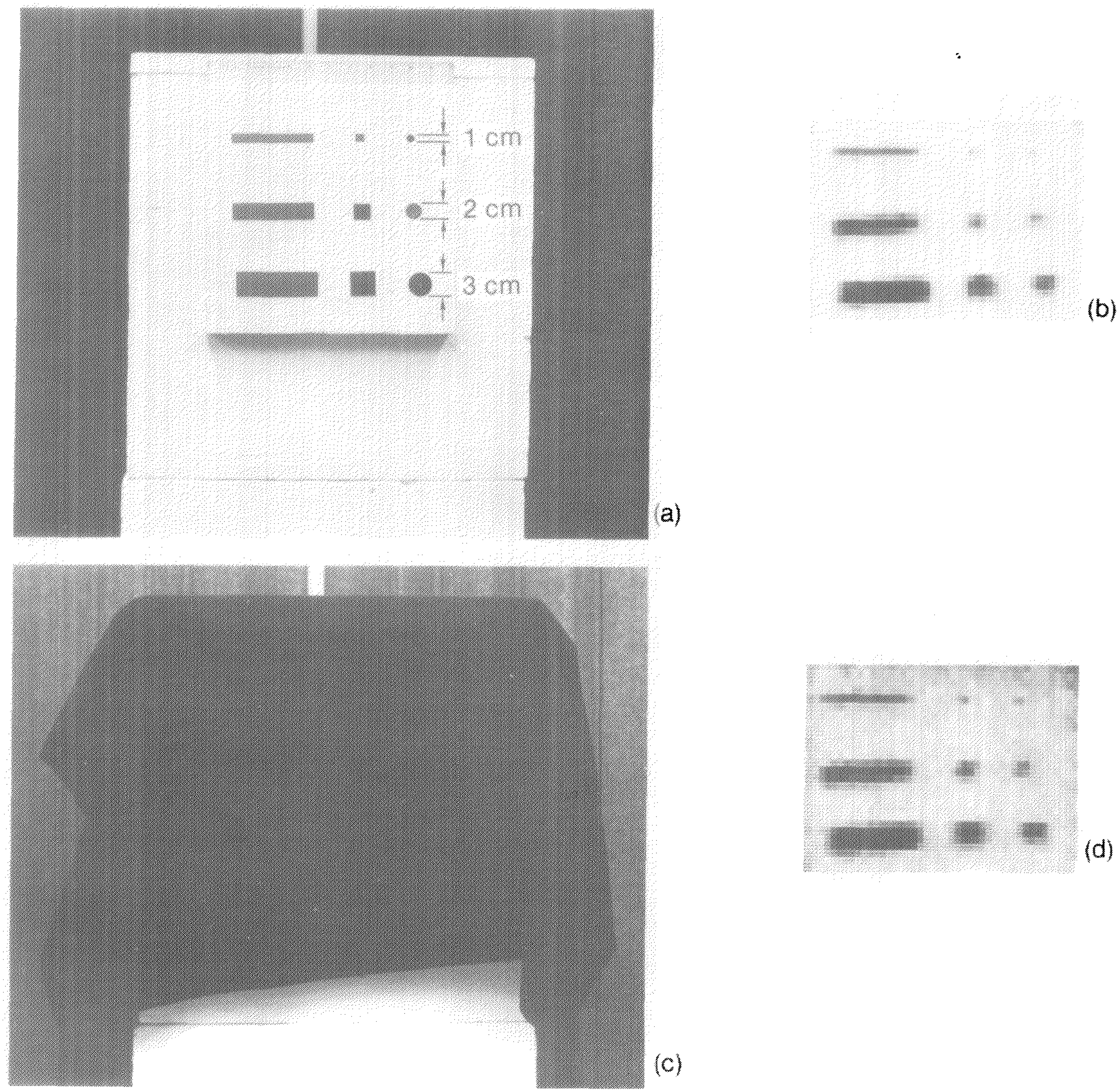

Fig. 8 — Images in the visible and at the 3-mm wavelength of 1-, 2-, and 3-cm metal objects. (a) Photograph of objects in front of liquid-nitrogen-cooled background (77°K). (b) 3-mm image. (c) Photograph of objects covered with heavy black cloth. (d) 3-mm image of covered objects.

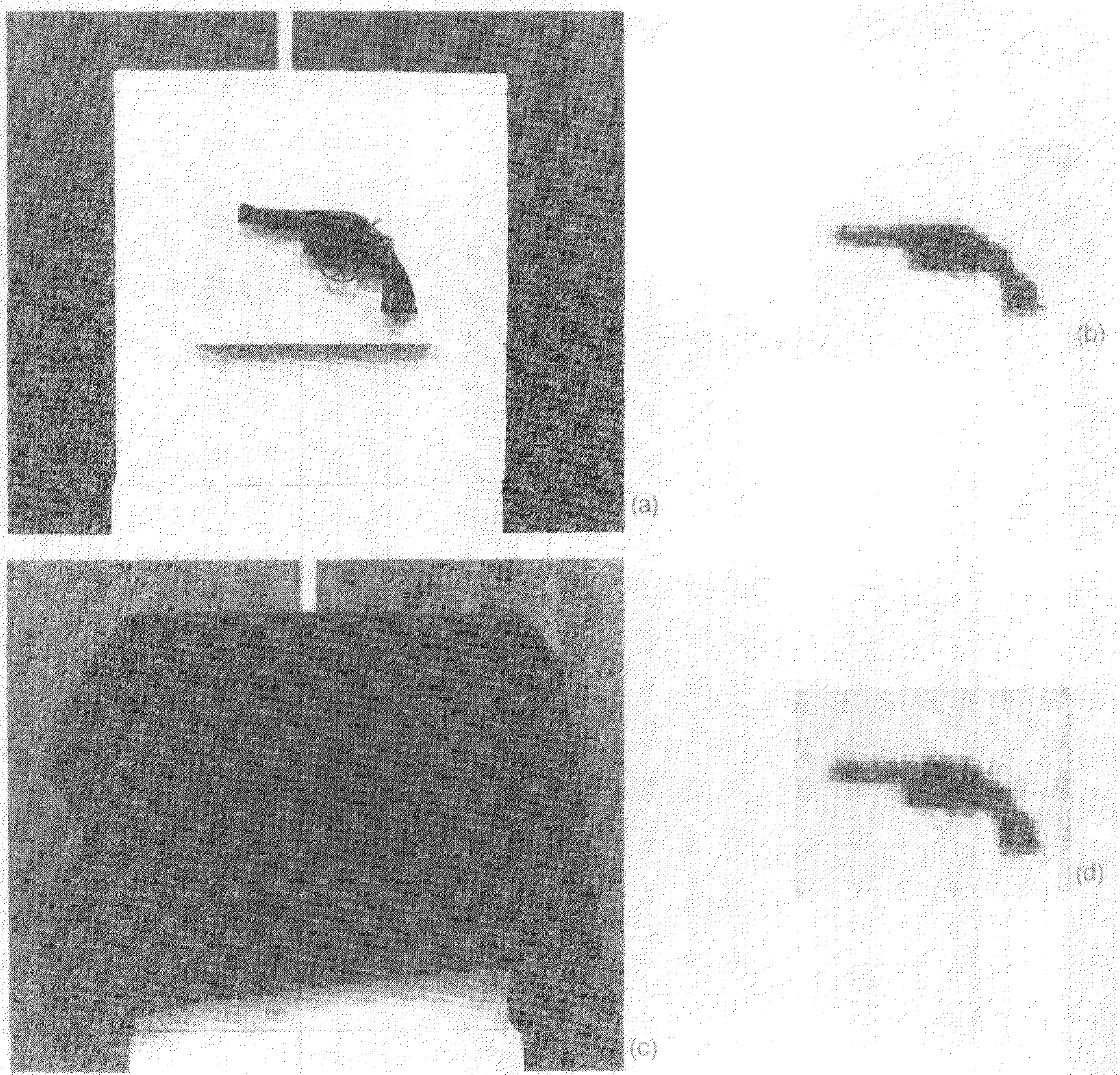

Fig. 9 — Images in the visible and at the 3-mm wavelength of a Smith & Wesson .38 special revolver. (a) Photograph of revolver in front of liquid-nitrogen-cooled background (77°K). (b) 3-mm image. (c) Photograph of revolver covered with heavy black cloth. (d) 3-mm image of covered revolver.

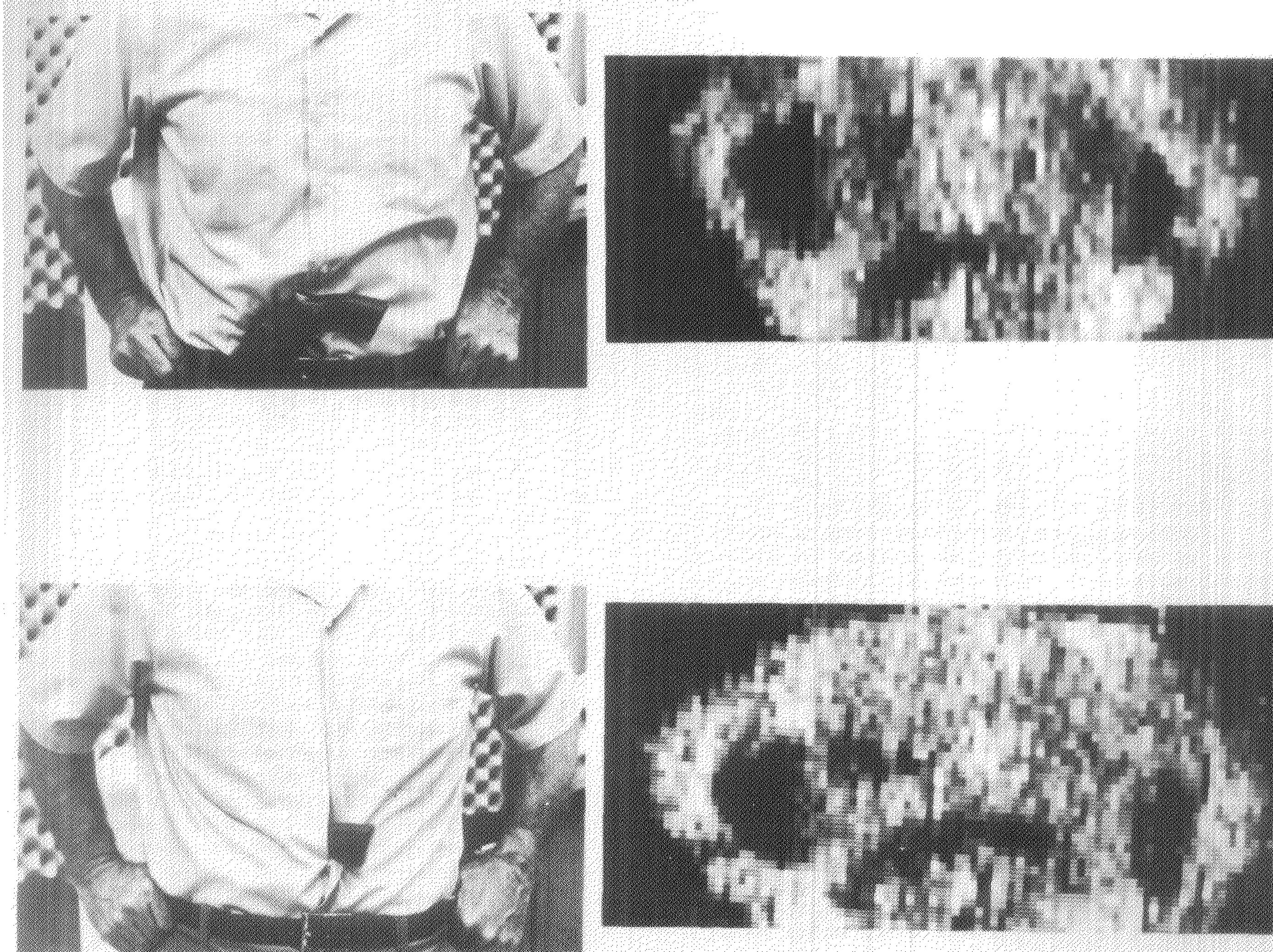

Fig. 10 — Images in the visible and at the 3-mm wavelength of a Smith & Wesson .38 special revolver on a human body. Photographs on left with corresponding 3-mm image on right.

A Weighted Hypergeometric Sampling Plan

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Abstract

Described is a method of obtaining a weighted sample from two or more populations so that a statistical statement can be made about the total population. The statistical statement desired defines RQL (rejectable quality level) and $\beta_0 = 1 - CL$ (confidence level). The subpopulations might consist of containers of nuclear material, the amount per container being essentially the same for a given subpopulation but different for the different subpopulations. Knowing the amount of material in each subpopulation, M_i, and the total amount of material, $M = \Sigma M_i$, the number of containers to be included in the sample from each subpopulation is computed from the equation for the hypergeometric distribution with zero acceptance number, with $\beta_i = \beta_0^{M_i/M}$ and the same RQL as was chosen for the total population.

There are frequent occasions when there is similar material stored in different ways, but when one would like to treat all material as belonging to the same population for sampling purposes. The problem is how to prorate the sample size to give proper representation to each of the subpopulations. For example, at some time a reactor vault might hold 3000 kg of fuel stored in 1300 canisters, and the reactor might hold 500 kg of the same type of fuel stored in 500 drawers. Then we question how many of these canisters and drawers must be examined to be 95% certain that less than 1% of the material has been misplaced or that the records are not in error. We intuitively feel that the vault canisters, which contain an average of about 2.3 kg, should be given more attention than the reactor drawers, which contain an average of 1 kg of fuel.

Let us first see what can be said about a portion of a population of similar items from which a random sample of items has been examined so that we are 95% certain that less than 1% of them are defective. For the purpose of this paper, we will define a defect to be an item or container which is either missing or has no material in it. In what follows, we will say that the population has been examined or tested at the 95:1 level. Let the population size be 10,000. The sample size is computed from the equation for the hypergeometric distribution with zero acceptance number. That is, if a single defective item appeared in the sample, the population would fail the test, and some more extensive action would be taken.

The sample size can be rigorously computed from the equation

$$\beta_0 = \frac{\binom{N - D}{n}}{\binom{N}{n}} \qquad (1)$$

where β_0 = 1 - CL (confidence level)
= 1 - 0.95 = 0.05
N = population size = 10,000
D = number of postulated defects = 100
n = sample size to be computed
$\binom{a}{b}$ = a!/b!(a - b)!

A well known (1) simplified equation which gives the same value for n and is easier to use is

$$n = [N - (D - 1)/2][1 - \beta_0^{1/D}] \qquad (2)$$

Substituting the values for N, D, and β_0, we compute n to be 293.67 or 294.

It is expected that the defective and sample items are randomly distributed throughout the population. That is, any fraction of the population will have that same fraction of defective and sample items. The question now is what statement can be made about a fraction of the population.

Equation 2 can be solved for β_0

$$\beta_0 = (1 - n/[N - (D - 1)/2])^D \qquad (3)$$

For one-half of the population N = 5000, D = 50, and n = 147. Substituting these values into Eq. 3, we compute $\beta = 0.22324$; this is very close to 0.22322, which is $\beta_0^{1/2}$, where β_0 is computed for the total population by using Eq. 3 and the integral value of n. This is slightly less than the value of 0.05 which was planned. In general, the β_i associated with any fraction of the population (1/x) is $\beta_0^{1/x}$; the hypothesized fraction of defectives (sometimes called RQL or rejectable quality level) is the same as for the total population.

Incidentally, the value of β_0 for the total population (taking N = 10,000, D = 100 and n = 294) computed from Eq. 3 differs from the value computed using the rigorous Eq. 1 by only 26 parts in 10^6. This is an empirical justification of the simplified Eqs. 2 and 3.

A more direct approach than the above empirical one is to examine Eq. 3. If the values of N, D, and n are all reduced by the same factor x, this factor is almost canceled in the second term within the parenthesis. We are then left with essentially the same value raised to the D/x, rather than D, power.

When there is a population of N items which can be thought of as made up of several subpopulations of N_i items each, the sample sizes for the subpopulations can be computed in either of two ways to obtain the same results. First, the sample size (n) for the total population can be computed by using Eq. 2, and this, then can be prorated over the subpopulations by using

$$n_i = nN_i/N$$

Alternatively, a β_i can be computed for each of the subpopulations from the β_0 chosen for the total population

$$\beta_i = \beta_0^{N_i/N}$$

The values for n_i can then be computed by using Eq. 2 and N_i, D_i, and this β_i. We have assumed that all items have the same weight; the ratios N_i/N and M_i/M are then equal.

The following table was computed with this alternate method for a population of 10,000 items having three subpopulations with N_i/N equal to 1/2, 1/3, and 1/6, respectively. The values for β_0 and D were taken as 0.05 and 0.01N, respectively.

TABLE I

N_i/N	N_i	β_i	n_i
1/2	5000	0.2236	146.8
1/3	3333	0.3684	97.9
1/6	1667	0.6069	48.9

The three values for sample sizes (n_i), when rounded, are identical to 1/2, 1/3, and 1/6 of the sample size of 294 computed for the total population. In addition, the product of the three values for β_i is equal to 0.05, the value selected for β_0 for the total population. This is as it should be. A β_i is the probability that no defects will be found among the sample items when 1% (in this case) of the items in the subpopulation are defective. The probability of this result of no defects in a sample happening simultaneously for the several subpopulations is the product of the probabilities for each one. This should be equal to the β_0 computed (from Eq. 3) for the same total sample drawn at random from the total population.

Return now to the original question of 3000 kg of fuel in 1300 canisters in the vault and 500 kg in 500 drawers in the reactor. The situation is similar to the example if weight of fuel, instead of number of items, is used in computing the β_i's for each of the two subpopulations. Assuming we wish to test this population at the 95:1 level, the β_0 for the total population is 0.05; for the vault, β_i is $(0.05)^{3000/3500} = 0.0767$, and for the reactor, β_i is $(0.05)^{500/3500} = 0.6518$. By using Eq. 2, with D_i equal to one percent of the containers in each case, the number of the 1300 canisters to be included in the sample is 232, and the number of the 500 drawers is 41.

Note that if the 1800 containers are treated as being equal, the sample size for a 95:1 test would be 275. If this is prorated between the vault canisters and the reactor drawers, the sample sizes would be 199 and 76, respectively. The reactor drawers, which contain about 1 kg each, would be over-sampled at the expense of the vault canisters which contain about 2.3 kg each, causing the net computed confidence level to be dependent on the distribution of the defects between the subpopulations. This effect is demonstrated by examing the effective β_0 for the population as the hypothesized total loss is distributed in different ways between the two subpopulations. At an RQL of 0.01, the loss is 35 kg for our example. If we use the subscripts v and r to refer to the vault and reactor, respectively, we have

$$D_r + (3000/1300)D_v = 35 \qquad (4)$$

where D_r and D_v are numbers of defective items.

The effective β_0 for the total population will be the product $\beta_v\beta_r$. By rewriting Eq. 3 for each of the two subpopulations, we have

$$\beta_0 = \{1 - n_v/[N_v - (D_v - 1)/2]\}^{D_v} \times \{1 - n_r/[N_r - (D_r - 1)/2]\}^{D_r} \qquad (5)$$

Then the effect of the two methods of weighting the n_i's is seen by comparing the overall β_0's shown in Tables II and III as the number of defective items is distributed between the two subpopulations according to Eq. 4. The appearance of nonintegral numbers of defects is no problem for these computations because they are only intermediate numbers used to illustrate the difference between the two procedures.

TABLE II

$n_v = 199 \quad n_r = 76$

D_v	D_r	β_v	β_r	β_0
0	35	1	.0025	.0025
5	23.46	.4351	.0190	.0082
10	11.92	.1887	.1368	.0258
13	5	.1141	.4369	.0498
15.17	0	.0793	1	.0793

TABLE III

$n_v = 232 \quad n_r = 41$

D_v	D_r	β_v	β_r	β_0
0	35	1	.0448	.0448
5	23.46	.3736	.1280	.0478
10	11.92	.1390	.3563	.0495
13	5	.0766	.6508	.0498
15.17	0	.0498	1	.0498

For the results of Table II, Eq. 5 has been used with the values of n_v and n_r as determined by prorating a total sample size of 275 between the two populations when the containers are treated equally. For the results of Table III, Eq. 5 has been used with n_v and n_r as determined by weighting the β_i's according to the mass in each population. We see from Table II that the effective confidence level varies from about 0.997, if the whole loss is postulated to be in the reactor, to about 0.92, if the whole loss is postulated to be in the vault. In Table III, on the other hand, the effective confidence level remains slightly better than the design level of 0.95 regardless of the manner in which the loss is postulated.

The reason can be understood by considering Eq. 5. If we set $d\ln\beta_0/dD_v$ equal to zero, while remembering Eq. 4, we will establish the criterion for β_0 to be independent of D_v or the distribution of defects. We find a first order approximation to be

$$n_v/M_v = n_r/M_r \qquad (6)$$

where M_v and M_r are the total masses in the vault and the reactor, respectively. The ratio n_i/M_i is very nearly the same for all subpopulations when the items in them all have the same weight. The difference in this ratio for the several subpopulations increases as the difference in weight of the subpopulation items increases. The small change in the value of the effective β_0 (.0448 to .0498 in Table III), when the hypothesized missing material is distributed disproportionately between the subpopulations, also increases as the difference between the item weights increases.

It is clear that the number of subpopulations need not be limited to two. The procedure, then, is ideally suited to the sampling of a stratified population. Once values have been selected for β_0 and RQL, the sample size for each stratum is computed separately, with no reference to the other strata. This sample size is computed with the hypergeometric distribution equation for zero acceptance number. The value to be used for RQL is the same as that selected for the total population, and the value to be used for β is $\beta_0^{Mi/M}$, where M_i and M are the total masses of the strata and the population, respectively. We submit that this procedure gives proper weighting of the sample to each of the strata.

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Our Common Commitment To Safeguarding Nuclear Power

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Address before ESARDA 2nd Annual Symposium

University of Edinburgh
Edinburgh, Scotland

March 27, 1980

It is a great pleasure for me to address the 2nd Annual ESARDA Symposium and this distinguished gathering of safeguards leaders from many countries of the world.

The title of my talk today is "Our Common Commitment to Safeguarding Nuclear Power," and I'd like to focus on the basic conviction and professional commitment that we all share in common. All too frequently, we tend to focus attention on our differences in viewpoint and approach to the specifics of how best to implement safeguards. But these differences are surely minor when compared with the overall professional challenge that we face together. We are convened here in Edinburgh at this 2nd ESARDA Symposium because all of us firmly believe that safe — and safeguarded — nuclear energy can make an essential contribution to the energy needs of our individual countries and to an increasingly energy-hungry world. And indeed it is difficult to underestimate the potential contribution from nuclear energy when we consider the energy supply problem from an overall global perspective.

Energy, very broadly interpreted, encompasses not only the fossil fuels that power machines, but also that marvelous and highly addictive energy form called food, which powers all living things on this planet of ours.

The basic energy equivalence of food and fuel is readily apparent: Synthetic fuels such as gasohol are derived from the fermentation of the basic food, wheat, or other vegetable matter. Conversely, many types of food-producing fertilizers and petrochemicals of all kinds are made from the basic fossil fuel, petroleum. And as we are all too well aware, the intimate linkage between food, fuel, and world power politics is repeatedly and ominously demonstrated in world events. Thus, it is not surprising that of all the problems mankind faces, the global energy problem, viewed in its broadest terms, has been called potentially the most dangerous and disruptive of civilization and the human condition as we have known it. In short, energy supply is crucial to world stability and indeed to peace.

In these terms, the potential contribution from nuclear energy to overall world energy supply becomes all the more important because, unlike most other energy forms in use today, nuclear energy provides a major new energy source that is completely independent of the strategic food-fuel resource that will be increasingly in demand, and short supply, throughout the world. And therein also lies the importance of our particular specalty in the nuclear energy enterprise — namely our commitment to the full realization of the great promise of nuclear power as a safe, safeguarded, and widely acceptable, energy source.

Now to focus down on our specific area of professional commitment, safeguards issues are admittedly often more political and economic than technical in nature; nevertheless, the technical understanding and input that we can provide is essential for prudent decision making at the highest levels. Our responsibility as technical leaders in safeguards and materials management is to inform — but certainly not to alarm — political leaders and others who influence opinion, and to inform and educate people generally. In principle, this clearly ought to be a straightforward matter of communications,but even there difficulties can arise; i.e., "the message received is not always the message given."

Now I'd like to tell you something about what the INMM, — sister organization to ESARDA — is doing to address some of the problem areas we all face in common. We, in the Institute, are determined to increase our effectiveness in communicating with government leaders and decision makers, with our colleagues in the technical community, and, of course, with the public — or at least that portion of the public who seek to be informed. In the INMM we have, for example, provided expert testimony to U.S. congressmen on nuclear issues such as the new US/Australia Agreement for Nuclear Cooperation. Similarly, in the INMM public information program, we are trying some innovative ideas designed to get more favorable nuclear coverage in the media. This has included the introduction of cartoons, notable quotes, and humorous pronuclear editorials in newspapers and magazines. We have also established an INMM Speakers Bureau, a Communication Bureau, and an INMM News Bureau consisting of Institute representatives in major cities to monitor press releases concerning safeguards and security issues and incidents, and to develop appropriate responses to inform and educate the public. We are also developing plans for favorable press tours at U.S. facilities to describe and demonstrate the effectiveness of in-place operating safeguards and security systems.

In response to developments of direct concern in the area of safeguards and materials management, I have recently appointed an INMM Public Information/Response Committee whose mandate is to develop an inventory and directory of INMM expertise and capabilities for (1) providing public information, education, consultation, and expert assistance when and as requested, and (2) for responding appropriately to new safeguards/security incidents — whether they be of an emergency or gradually evolving "chronic" nature. Such response might involve, for example, explaining in laymen's terms, physical protection or materials accountancy principles, or explaining the practical significance of an abnormally large inventory difference or MUF such as might occur at nuclear facilities within either the private or government sector.

Throughout the U.S. in the wake of Three-Mile Island, there has been marked increase in congressional and public interest not only in reactor safety, but also in the areas of nuclear waste and nuclear safeguards and security. The three main reactor safety "lessons learned" from Three-Mile Island — namely the need for (1) better professional training of reactor operators; (2) better measurement instrumentation; and (3) better emergency response — have had an inevitable impact in the safeguards and security area. In particular, the need for better professional training and upgraded safeguards performance has received markedly greater impetus since Three-Mile Island. In keeping with this overall thrust, the INMM has stepped up its training program in areas of statistics, accounting, and material control.

As you are probably already aware, international training courses are offered periodically by the U.S. Department of Energy, in cooperation with IAEA, in the complementary area of physical protection and materials accounting and control. At the same time, ongoing Department of Energy and Nuclear Regulatory Commission programs in NDA training are being expanded and updated to reflect changing needs and increased requirements of plant operators and inspectors alike. Also, in the academic community, there are indications of growing interest on the part of some universities in establishing formal curricula and elective courses in the safeguards and materials management field.

Indeed, it appears that lessons, and the admonitions, of Three-Mile Island have had their repercussions throughout the entire nuclear community. And nuclear materials managers and safeguarders are certainly not excluded from the new focus on better professional training, greater appreciation of and sensitivity to human factors, and man-machine interface, etc. By analogy, with the recommendations of the Report of the Presidential Commission on the Accident at Three-Mile Island (the Kemeny Report), many safeguards experts have, in one way or another, expressed the basic conviction that there cannot be acceptable safety, or acceptable safeguards, without adequately trained, motivated, and qualified (i.e., certified or licensed) operators, managers, and inspectors.

The thrust of all this has translated into a rather widely perceived need to establish an objective means for formal certification of the professional qualifications of safeguards practitioners. The INMM certification program is one response to this perceived need. Toward the goal of an objective means for certification, two specially-commissioned INMM certification subcommittees have formulated a test library of over 500 examination questions covering the overall "safeguards" field. This test library has undergone an intensive process of validation, involving testing of three selected groups of practicing professionals and a control group to evaluate, screen, and modify the questions in order to ensure an effective and objective examination regime.

The INMM certification process consists of two levels of qualification. At the first level, the process is initiated with an entry-level general examination covering five basic areas:

1. General (physics, chem., fuel cycle, safeguards principles).
2. Nuclear Materials Accountability.
3. Measurement and Statistics.
4. Materials Control.
5. Physical Protection.

The basic prerequisite for an entry-level candidate is a bachelor's degree in an appropriate discipline (generally some area of the physical sciences) or a minimum of five-years experience in the field, or an appropriate combination of these. Upon successful completion of the entry-level examination, the candidate is designated a Qualified Safeguards Intern.

After some two years of experience in the Safeguards field and upon peer recommendation, the Safeguards Intern will be eligible to take a written certification examination covering the five basic areas, but with emphasis on his designated area(s) of speciality. In addition, an oral appearance before the INMM Certification Board is required. Upon successful completion of the Certification examination and recommendation by the Certification Board, the candidate will receive full accreditation as a Certified Safeguards specialist. A Certification Board, consisting of ten members (all of whom have successfully completed the new Certification Examination) has been established in accordance with INMM Bylaws, to implement, administer, and maintain strict control over the entire certification process.

In order to give credibility to the broad range of safeguards training and certification functions, safeguards education and training should clearly be coordinated (or at least not inconsistent) with professional qualification and certification programs. In this regard, some in the INMM have begun advocating the general concept of the professional association as a learning community. In any case, it should be noted here that the upcoming series of INMM-sponsored courses (i.e., Accounting and Audit Techniques in May, 1980, and two statistics courses — Fundamentals and Advanced — in September, 1980) are indeed being coordinated with the Institute's Certification Program. I should also note that the Entry-Level Examination under the new INMM Certification Program will be offered at the Institute's 1980 Annual Meeting in Palm Beach, Florida (June 30-July 2).

I want to turn now to a subject of vital importance to both ESARDA and INMM, namely safeguards standards including both physical and procedural standards. As any researcher knows full well, it's always important to have a mandate for one's R&D effort, preferably from a well-heeled sponsor — but in the calibration and standards area, we've surely got the best of all mandates! From the holy scriptures, I quote Proverbs Chapter 20, verse 23: "A false balance is an abomination unto the Lord." There's one for you to remember. Who knows, it just might come in handy the next time you get static from management about the high cost of calibration standards, measurement control programs, and the like!

At this point, I want to cite an excellent example of international cooperation in the area of physical standards. I refer to the U_3O_8 NDA standard reference material project jointly undertaken by the CBNM (Central Bureau of Nuclear Measurement) at Geel, the U.S. National Bureau of Standards, and the various member laboratories of ESARDA. This leadership project was initiated by the NDA Working Group of ESARDA, and when completed, will provide the first internationally certified reference materials produced specifically for a nondestructive analysis technique (specifically, for gamma-ray spectrometric measurement of uranium enrichment). ESARDA is indeed to be applauded for its leadership in the standards area and I hope your example will set a precedent that will be emulated by many.

The INMM N-15 Standards Committee, under the leadership of **Dennis Bishop**, has placed increased emphasis on periodic reassessment and refocusing of resources to keep abreast of new developments and changing requirements in safeguards and materials management. In his paper presented in this morning's session on Measurement Techniques and Standards, Bishop discussed possible channels for the development of consensus physical and procedural standards for more uniform implementation of safeguards both internationally and among different national safeguards systems. Also, as reported in this morning's session, many in the INMM N-15 standards program see a potential synergistic role that professional organizations such as ESARDA and INMM can play in promoting international cooperation and exchange in the vital area of safeguards standards and performance guidelines.

To achieve more effective INMM interactions on technical matters, and to better represent the professional interests and specialty areas of Institute members, we have recently begun the formation of INMM Technical Groups. The first such group, covering the area of physical protection, was established last summer, and by December the group had already organized and conducted a special Workshop on Intrusion Detection Systems. Based on the success of the Physical Protection Group, other INMM Technical Groups are foreseen in the areas of Accountability and Materials Management; Measurement and Statistics; System Studies; and International Safeguards.

All of these and other efforts, both within INMM and similar programs within ESARDA, should help foster a greater degree of professionalism in safeguards and materials management. They should also lead to increased recognition and respect for our professional role as seen by top management in the nuclear industry. Associations such as INMM and ESARDA clearly can provide a unique type of forum for consideration of safeguards and materials management problems in an objective professional atmosphere, largely independent of the inevitable professional biases that arise in the normal course of inspector-inspectee interactions. In contrast to the defensive, even adversary, roles that can develop between "safeguarders" and the "safeguarded" in the course of an inspection or plant inventory campaign, the professional society forum (such as this one here in Edinburgh) can focus objectively on the techniques and methods of accomplishing safeguards goals with minimum interference on plant operations and production.

Recognizing the inherently global nature of nonproliferation and safeguards issues, the Institute is expanding its scope, its activities, and its overseas membership to reflect the steadily increasing importance of International Safeguards in the 1980's. There is, I believe, a general feeling in the safeguards community that the beginning of the new decade marks a turning point toward greatly increased emphasis on the practical implementation of effective, workable international safeguards, and closing of the gap between technical and operational expectations on the one hand and actual performance on the other.

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 U.S. Safeguards Agreement with the International Atomic Energy Agency, which is currently pending consideration by the U.S. Senate. Following anticipated Senate ratification of the US/IAEA Agreement, a second INMM Workshop on the Impact of IAEA Safeguards in the U.S. will be held later in 1980 as a timely follow-on to the very successful INMM Workshop on IAEA/NPT safeguards that was held in Washington, DC in December 1978.

With regard to the very important matter of expanding cooperation between ESARDA and INMM, I believe the high level of technical representation at each other's annual meetings is but one of many clear indications of our mutual desire for increased cooperation and closer technical interactions. An excellent example of such international cooperation is the IAEA-sponsored International Working Group on Reprocessing Plant Safeguards, which has scheduled 1980 subcommittee meetings both here at the ESARDA Annual Symposium and at the INMM Annual meeting in Palm Beach, Florida in July. The full implementation of such cooperation can provide important benefits not only to our two professional organizations, but to the entire field of safeguards and security, on both the national and international levels.

In closing, I want to thank both the ESARDA Chairman and the 1980 Organizing Committee for their very kind invitation and this opportunity to address you at this 2nd Annual ESARDA Symposium. With the obvious success of last year's meeting in Brussels and this year's in Edinburgh, the ESARDA Annual Symposium series has already established a standard of excellence of which the entire safeguards community can be proud. As we enter the challenging decade of the 80's, it is my sincere hope that we can work together even more closely in our common commitment, and our unique professional contribution, to safe — and safeguarded — nuclear energy for the benefit of mankind.

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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.

Institute Of Nuclear Materials Management

Treasurer's Report for Period October 1, 1978 Through September 30, 1979

Cash Balance September 10, 1978	**$ 29,899.96**
Receipts:	
Dues	11,204.50
Journal Income	
Subscriptions	4,636.78
Advertising	1,397.00
Page Charges	7,294.00
Reprints	1,011.50
Proceedings Income	
Annual Report	10,571.00
Page Charges	4,124.09
Advertising	675.75
Miscellaneous Income	42.50
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Annual Meeting	
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Special Activities	1,371.00
Guest Tickets	1,315.00
Refreshment Sponsors	2,100.00
Interest Income	1,489.18
IAEA Workshop	8,470.00
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Expenditures:	
Journal Editor	11,851.90
Journal Editor—Travel	2,439.45
Editor—Moving Expense	500.00
Proceedings	
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Postage	1,150.02
Clerical	267.17
Miscellaneous	163.60
Journal	
Printing	16,265.51
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Clerical	2,051.77
Miscellaneous	653.83
Office Supplies	186.49
Typing Service	405.50
Telephone	223.73
Photography	196.07
Publication Support	374.80
Annual Meeting	
Chairman and Committee Expense	134.62
Registration Refunds	920.00
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Ladies Program	2,737.77
Luncheons	5,822.10
Speakers Breakfast	510.70
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Equipment	72.00
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Committee	177.86
Statistics	9,838.63
Material Control	120.83
Physical Security	100.00
N-15 Standards	406.81
Certification	425.82
Membership	1,372.90
Safeguards	226.07
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Student Awards	1,158.16
Chapter Expense	323.79
General Miscellaneous	344.41
IAEA Workshop	5,949.16
ANS-INMM Meeting	864.75
Membership Directory	
Printing	10.00
Postage	30.00
Total Expenditures	**$ 94,812.64**
Cash Balance September 30, 1979	**$ 58,545.80**
Net Gain or Loss:	
Total Receipts	$123,458.48
Less Transfer of Funds	17,493.72
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Total Expenditures	94,812.64
Net Gain	$ 11,152.12


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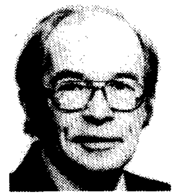
Harkness


Higuchi


Hodges

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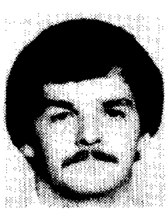
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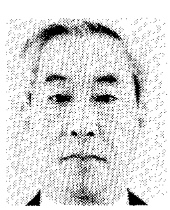
Hurt


Jaech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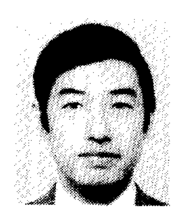
Naito


Reber


Schellenbaum


Wachter


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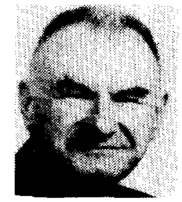
Winslow

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