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INMM

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On the Cover:
Nuclear material safeguards is of worldwide concern, with national as well as international implications. Sixteen nations with nuclear research and/or power facilities are represented by members in the Institute of Nuclear Materials Management, (INMM). The Institute is an international, professional safeguards organization. Flags, left row, top to bottom: Portugal, West Germany, United Kingdom, Peoples Republic of China, Canada, South Africa, Belgium, Luxembourg. Right row, top to bottom: Netherlands, Austria, Italy, United States, Japan, Australia, France, Lichtenstein. *Illustration/M. Thorpe*

Making Policy Pay

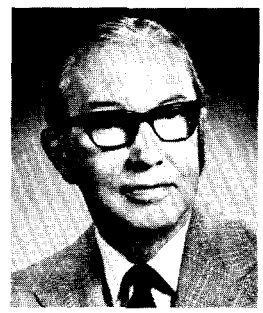
The summer issue of the Journal represents a new approach by the Institute in regard to design, content, and production. So far, comments have been favorable, even enthusiastic. To continue and extend these improvements will require the active participation by the membership as well as the officers and the Institute staff.

The summer issue contained five technical articles. One had been contributed previously. The other four were solicited on rather short notice. We are grateful to these authors for so promptly and generously responding and for the high quality of their interesting papers.

The program committee for this year's annual meeting was very successful as a result of a great deal of effort. As Charlie Pietri explained in the summer issue, only about 20 percent of the papers presented were unsolicited contributions. The committee was particularly successful in persuading five distinguished and busy individuals to present their views at the plenary session. These papers are reproduced here as well as in the Proceedings. The Journal committee feels that these papers are of sufficient interest and value to deserve such special attention.

This issue also contains the verbatim transcript of an interview, which took place on Monday afternoon with three of these speakers: James K. Asselstine, Commissioner of the U.S. Nuclear Regulatory Commission, Edward V. Badolato, Deputy Assistant Secretary of Security Affairs of the U.S. Department of Energy, and Peter M. Tempus, Deputy Director General for Safeguards of The International Atomic Energy Agency. We are most grateful to them for their participation.

The Institute is an international, professional safeguards organization. Nuclear material safeguards includes national safeguards systems and international safeguards systems, as In-



stitute members are well aware. Most of the papers presented at our meetings and published in our Journal are on safeguards instruments, techniques, and methodologies which are or may be employed to meet the goals defined by national governments or international agencies such as the IAEA. The definition of goals and the decisions as to how to achieve them are, to a large extent, matters of policy which evolve with time and experience. Available safeguards techniques constrain policies and policies influence the development and refinement of techniques. It is extremely important that policy makers understand what it is that they make policy about (nuclear energy) and the technical tools (safeguards measures) which they may employ. It is equally important for the technical community to understand what it is the policy makers are trying to do. A policy that can't be implemented is not a viable policy; and a technique which the policy does not need is a waste of effort, no matter how technically sweet it may be.

An important function of the Institute is to bring together the policy makers, the operators, and the designers. In this regard, it seems to me, that an active correspondence department would be a constructive feature for the Journal. There are five provocative papers and an interview on the following pages. At least two of the papers in the summer issue deserve constructive criticism. These submissions represent considerable effort on the part of the authors and those who have typed and retyped and edited the texts. Is it too much to ask a member to read these critically and to send comments to the Journal? For me, the letter columns in *Science* and other journals are as stimulating as any of the articles, especially as they attempt to bridge the gap between the political and technical fields. I hope that others share this view.

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

JNMM welcomes your letters and comments. Please send all correspondence to *JNMM*, 60 Revere Drive, Suite 500, Northbrook, IL 60062 USA.

Looking at INMM Milestones . . .

Greeting you, the INMM membership, sponsors and friends via this issue of the Journal is one of my last official acts as Chairman. As I remarked at the INMM annual banquet, I'm both pleased and sad as my term draws to a close. I'm pleased because of all the accomplishments achieved by the Executive Committee and the Committee Chairmen. I'm sad because now I'll have to start working again instead of being able to delegate everything.

I mentioned the achievements of the Executive Committee and the Committee Chairmen in the above paragraph. Following are just a few.

• We have had annual meetings which have surpassed all others in quantity and variety of papers. This follows a recommendation of the Long Range Planning Committee which I mentioned in one of my previous Chairman's Columns, namely, to expand the scope of the Institute to include the safeguards concerns of Waste Management and Transportation.

• We have formed the Public Awareness Committee. This committee has as its purpose production of information monographs on items of nuclear concern to the general public. It currently is looking for someone, or someones, to write these monographs. Funding is available to cover travel and a small stipend. If you are interested, please contact Dick Duda (818-440-2621) or Bob Keepin (505-667-6394).

• We have formed the Publication Committee. This committee is responsible for overseeing policy, design, content of the Journal and other technical publications of the Institute and implementing the publication of the Journal through preparation of reports, articles, other news, etc. The results of this committee are tangibly represented by the NEW Journal. It has been well received and I hope you will get your comments and contributions to Nancy Trahey or the INMM Headquarters Staff.

• The Long Range Committee activities were covered in a previous Journal, an article which I trust you read. The committee is reviewing our five year plan, updating it and preparing it for Executive Committee review. Watch for its future plans.

As my term draws to a close and as Charlie Vaughan's begins to blossom, I again wish to express my sincere thanks for your support, your suggestions and your hard work, all of which made my job so easy these past two years.

Yvonne M. Ferris
Rockwell International
Golden, Colorado

. . . and Charting a Course for the Future

The 27th Annual Meeting of INMM is now history, and this allows me as well as many hard-working members who contributed so much to this year's first class endeavor, to breathe a few sighs of rest and relaxation. While the INMM has always presented a strong annual meeting in the safeguards area, the past two programs have exhibited very comprehensive agendas. The meeting this year in New Orleans was the second largest in INMM's history. The preponderance of comments have been favorable and for those who missed being there in person or missed some of the papers of interest, I think the timely publication of the proceedings will afford an excellent opportunity to further individual professional expertise.

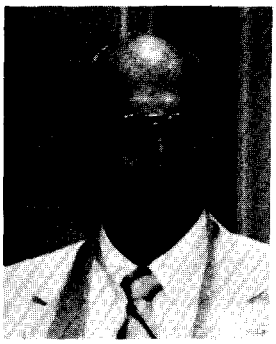
Complimenting people for a job well done is always difficult when such a large group of people is responsible for a success such as the annual meeting. Clearly those technical experts who presented papers, led sessions and provided exhibits made the meeting program a success. Not quite so visible is the group of people that I worked with to organize and coordinate all the happenings in New Orleans, and I can tell you that they are super people who did a super job. My personal thanks to Gary Carnival, Harry Leith (Wells Fargo), Dennis Mangan, INMM Headquarters Staff, and Charles Pietri as well as the more than fifty hard-working people who provided them with support.

I want to express thanks to the membership for their strong vote of confidence in electing me Chairman for the next year. Following Yvonne Ferris' lead will be difficult because of her extreme dedication to INMM over the past years, her leadership

ability and the grace and charm she has brought to the chairmanship. Clearly it has been two years of accomplishment, the INMM is currently in excellent shape, and Yvonne is a dream to work with.

The future is full of challenge and excitement for the INMM and those who participate as leaders, members and supporters. Our members number about 700, of which approximately one third reside out of the U.S., and represent an expansive scope of disciplines and interests. Truly we are a who's who chapter of the nuclear age. As a group we have the potential for significant contribution and quite frankly, because of our nuclear leadership, I think that we have an obligation to work vigorously in support of the nuclear community. I am convinced that with the leadership you have elected and with your support as members, INMM can continue to meet its charter commitments.

As we begin the new fiscal year in October, we will be in a period of transition; but this is nothing new since our environment is continuously changing. We have a number of programs which are just beginning and we must make sure they continue to make progress. We will also begin to take on new challenges. Some of the keys I see include the new Journal, training, waste management, an update to our long



range planning and an improved method of representation for foreign membership. As we work together, I will be stressing ownership, accountability, meeting commitments and budgets. A necessity of today's environment is finding new, creative and possibly non-traditional methods to deal with the future.

I am always available to listen and discuss ideas related to the INMM. I encourage and welcome input from our membership. In addition to the normal mail, my telephone number is (919) 343-5656 and I have an automatic telecopy number of (919) 343-5879. Please communicate freely with me and the members of the Executive Committee.

Charles M. Vaughan
General Electric Company
Wilmington, North Carolina

Physical Protection

The Technical Working Group on Physical Protection had a very well-attended and successful series of technical presentations at the 27th Annual INMM Meeting in New Orleans. A working group Steering Committee meeting was held at the close of one of the sessions. Items discussed were:

- Next year's Annual Meeting: Attendees were encouraged to start planning to present papers.
- Is the working group serving the needs of its members?
- More papers from the Technical Working Group members are needed for the new *Journal*. The Steering Committee was unaware at the time that the Winter 1986 Issue will focus on Physical Protection/Personnel Security. Papers must be submitted to headquarters by October 21, 1986. Because of the technical review process it is requested that they be submitted earlier if possible.
- Physical Security equipment vendors and their role in the working group's workshops.
- Future workshops.

It was suggested that the workshop on the use of computers in security, tentatively scheduled for spring 1987, be expanded to include artificial intelligence, modeling, information control and display, and automation in maintenance and training. The exact date and location of the workshop has not been determined. We welcome your suggestions and encourage you to call and volunteer to be overall workshop chairman or an individual session chairman.

James D. Williams
Chairman
The WLS Group
Albuquerque, New Mexico

Japan

The Japan Chapter of the Institute of Nuclear Materials Management held its 7th annual meeting in Tokyo in May of 1986. The program committee was chaired by T. Osabe, Japan Nuclear Fuel Company, Ltd., with the generous assistance of nine committee members and two secretariats. One hundred-thirty nonmembers and members participated in the meeting. The meeting program was as follows:

Opening Remarks, T. Osabe, Program Chairman.

Chapter Chairman's Welcome Remarks, R. Kiyose, Chairman.

Invited Lecture, Chairman: K. Nakano, Power Reactor & Nuclear Fuel Development Corp. (PNC); "Recent International Circumstances Relevant to Safeguards," *H. Kawamoto, PNC — Former Inspection General of STA*; "IAEA Office in Tokyo — Activities and Advantages," *S. Beach, Inspector, IAEA.*

Invited Special Session, Chairman: H. Kuroi, Japan Atomic Energy Research Institute, (JAERI); "Evaluation Criteria of Inspection Goal Attainment, *T. Haginoya, Nulcear Material Control Centre (NMCC).*

Session I, Chairman: M. Hirayama, Toshiba; "Design of Mini-Computer System for NRTA at Reprocessing Plant," *T. Ihara, JAERI*; "Field Test of NRTA at PNC Tokai Reprocessing Plant, *N. Miura, PNC.*

Session II, Chairman: T. Okamoto, University of Tokyo; "In-pipeline Uranium Enrichment Monitoring Test at Centrifuge Uranium Enriching Facility," *M. Hori, PNC*; "Development of Infrared Spectroscopy for Enrichment Monitoring System (1)," *T. Oda, JAERI.*

Session III, Chairman: H. Umezawa, JAERI; "Automatic Analysis System for Pu. Products at Reprocessing Plant," *Y. Juno, PNC*; "Experience on Application of HLNCC at Inspection," *K. Nidaira, NMCC.*

Session IV, Chairman: M. Kajiyoshi, PNC; "Development of the Ultrasonic Tamper Indicator," *M. Kikuchi, NMCC*; "Some Considerations on Applications of Safeguards for Automatic Powder Storage in Japan Nuclear Fuel Service Company," *M. Masuda, Chubu Electric Power Co., Inc.*

Session V, Chairman: K. Tsutumi, PNC; "Data Treatment at NMCC — Current and Future," *Y. Nakahara, NMCC*; "Design of Book Audit System for Item Facility and Study on Possibility of Extension for the Bulk Handling Facility," *H. Nishimura, JAERI*; "Some Considerations on Fuel Cycle Orientated Safeguards," *K. Ikawa, NMCC.*

Session VI, Chairman: H. Okashita; "Radiation Viewing Device — Test and Evaluation," *M. Kurihara, EPCI*; "Development of Reactivity Measurement Technique for Spent Fuel," *Y. Hirose, Hitachi.*

Paper Presentation, "In Congratulations of the 10th Anniversary of the INMM Japan Chapter," *Y. Kawashima, Honorary Chapter Chairman.*

The meeting also included a chapter business meeting, closing remarks by vice chairman M. Hirata, and a social gathering. It was judged a success by all present.

The chapter held its 15th Executive Committee meeting in October of 1985. Administrative issues discussed included the formulation of a sustaining membership system for the chapter, membership development, and an activities plan for the next fiscal year. The following new chapter officers were also elected at the meeting:

Chairman
Ryohei Kiyose
University of Tokyo
Tokyo, Japan

Vice Chairman
Mitsuho Hirata
Japan Atomic Energy Research Institute
Ibaraki, Japan

Secretary
Yohko Iwamatsu
Nuclear Material Control Centre
Tokyo, Japan

Treasurer
Reinosuke Hara
Nuclear Material Control Centre
Tokyo, Japan

Members at Large
Tohru Haginoya
Seiko
Tokyo, Japan

Kazuhisa Mori
Japan Atomic Industrial Forum
Tokyo, Japan

Masumichi Koizumi
Power Reactor & Nuclear Fuel Development Corp.
Ibaraki, Japan

The Japan chapter currently has 89 members from industry, nuclear energy organizations and universities. It is celebrating its 10-year anniversary in 1986.

N14 Committee

The following standards have been approved by ANSI and are now in the publication process.

ANSI — N14.1a — 1986. Packaging of Uranium Hexaflouride for Transport (addendum to ANSI N14.1 — 1982).

ANSI — N14.19 — 1986. Ancillary Features of Irradiated Fuel Shipping Casks.

ANSI — N14.27 — 1986. Carrier and Shipper Responsibilities and Emergency Procedures for Highway Transportation Accidents Involving Truckload Quantities of Radioactive Materials.

The ANSI N14 Standards Committee met on June 26, 1986 in New Orleans, following the INMM Annual Meeting. Items discussed included a review of each N14 standard and project, N14 Peer Review Panel Report, N14 Membership Interest Survey, and membership responsibilities. Also, Dick Haelsig was commended for his excellent ANSI N14 presentation at the PATRAM '86 Conference in Davos, Switzerland.

John W. Arendt, Chairman
JBF Associates
Knoxville, Tennessee

Speaker Systems

Your input is needed to help formulate speaker guidelines for meetings, workshops and seminars. The guidelines include presentation of talks, preparation of slides and transparencies and delineation of related criteria. Volunteers should contact Charles Pietri, U.S. Department of Energy, Chicago Operations Office, 9800 S. Cass Avenue, Argonne, Illinois 60439, U.S.A., or telephone (312) 972-2449, FTS: 972-2449.

N15 Committee

The N15 Standards Committee met in New Orleans, Louisiana, June 26, 1986 at the conclusion of the INMM Annual Meeting. Several N15 Subcommittees also conducted working sessions in New Orleans.

Several organization changes have recently occurred within N15. Ken Byers has assumed the Vice Chairmanship and Gary Kodman is the new Subcommittee Chairman of INMM-1, Accountability. The Subcommittee Chairman position for INMM-9, Nondestructive Assay, is currently vacant. After many years of dedicated service, Darryl Smith has resigned from the position. Darryl has been very active in a number of INMM functions, but I would like to recognize his effort and contributions to N15. Current members of the N15 Standards Committee are:

N15 Chairman
Obie P. Amacker, Jr.
Battelle, Pacific Northwest Laboratory
Richland, Washington

N15 Vice Chairman
Ken R. Byers
Battelle, Pacific Northwest Laboratory
Richland, Washington

N15 Secretary
D.J. Frank
Rockwell International,
Rocky Flats
Golden, Colorado

INMM-1, Accountability
Gary P. Kodman
Rockwell Hanford Operations
Richland, Washington

INMM-2, Material Classification
Nick J. Roberts
Los Alamos National Laboratory
Los Alamos, New Mexico

INMM-3, Statistics
Dick Mensing
Lawrence Livermore National Laboratory
Livermore, California

INMM-5, Measurement Control
Yvonne M. Ferris
Rockwell International,
Rocky Flats
Golden, Colordo

INMM-6, Inventory Techniques
Frank Roberts
Battelle, Pacific Northwest Laboratory
Richland, Washington

INMM-7, Audits, Records, and Reporting Techniques
Sheldon Kops
Sheldon Kops, CPA
Chicago, Illinois

INMM-8, Calibrations
Walter W. Rodenburg
Monsanto Research Corp.
Miamisburg, Ohio

INNM-9, Nondestructive Assay
VACANT

INMM-10, Physical Security
John W. Hockert
International Energy Associates Ltd.
Washington, D.C.

INMM-11, Training and Certification
Barbara M. Wilt
Westinghouse Electric Corporation
Columbia, South Carolina

INMM-14, International Safeguards
Thomas E. Shea
International Atomic Energy Agency
Vienna, Austria

In an attempt to increase the awareness of N15 activities and subcommittee efforts, an introduction to INMM-5 and a description of INMM 5.1 follows. The INMM-5, Measurement Control Subcommittee, Yvonne Ferris, Chairman, is currently comprised of four working groups: 5.1 — *Analytical Chemistry Laboratory Measurement Control,* Charles Pietri, Chairman; 5.2 — *Mass Measurement Control,* Vic Lowe, Chairman; 5.3 — *Mass Spectrometry Measurement Control,* Dick Perrin, Chairman; and 5.4 — *Calorimetry Measurement Control,* Don Jewell, Chairman.

INMM 5.1 — Analytical Chemistry Laboratory Measurement Control Committee

The purpose of this committee is to prepare a standard to provide guidance in designing and administering a measurement system, in establishing a means of obtaining statistics on measurments for standards purposes, and in developing the required expertise for measurement control and assessment in the analytical chemistry laboratory for the effective management of nuclear materials. Other measurements/measurement control activities for analytical chemistry laboratories are within the scope of this committee. The committee is concerned with measurements and measurement control as related to biases in process measurements, inventory differences, and shipper-receiver differences, and their prevention, detection, evaluation, and resolution. The present committee consists of the following members:

Clemens Auerbach
Brookhaven National Laboratory
Upton, New York

Hontas Bailey
Nuclear Fuel Services
Erwin, Tennessee

Jere T. Bracey
International Atomic Energy Agency
Vienna, Austria

Linda H. Collins
Babcock and Wilcox
Lynchburg, Virginia

Wayne L. Delvin
Westinghouse Hanford Company
Richland, Washington

Donald R. Joy
U.S. Nuclear Regulatory Commission
Washington, D.C.

Erwin Kuhn
International Atomic Energy Agency
Vienna, Austria

W.R. Laing
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Leroy C. Lewis
Westinghouse Idaho
Idaho Falls, Idaho

Eugene P. Shine
E.I. duPont, Savannah River
Aiken, South Carolina

C. Mike Smith
U.S. Nuclear Regulatory Commission
Washington, D.C.

Julia M. Smith
Richland, Washington

Louis J. Swallow
St. Louis, Missouri

Larry H. Taylor
Rockwell Hanford Operations
Richland, Washington

INMM 5.1 urgently needs additional members with professional background in applied statistics, accountability measurements, measurement control and quality assurance, and related disciplines, who are involved in analytical chemistry laboratory operations, directly or indirectly. Especially needed are potential participants representing commercial (NRC-licensee) and plutonium processing facilities. Interested parties should contact Charles Pietri, U.S. Department of Energy, Chicago Operations Office, 9800 S. Cass Avenue, Argonne, Illinois 60439; Telephone (312) 972-2449.

Obie P. Amacker, Jr.
Chairman
Battelle, Pacific Northwest Laboratory
Richland, Washington

Certification

The INMM Safeguards Certification Examination is offered semi-annually as shown in the chart below. One opportunity is in conjunction with the Safeguards Short Course (mid-February) and a second opportunity is in conjunction with the INMM Annual Meeting (summer). Locations vary to afford qualified applicants every possible advantage. Special provisions can be made for administering the examination to qualified applicants outside of the United States.

The Safeguards Short Course provides applicants with an excellent opportunity to review the various subject matter covered in the examination prior to taking the exam. The next course is scheduled the week of February 16-20, 1987 at the Garden Plaza Hotel in Oak Ridge, Tennesee.

Participation in the INMM Certification Program is voluntary; it constitutes a strong professional commitment to our industry. If you desire information on the education/experience requirements, examination types/fees, or have any questions or concerns please contact me at (803) 776-2610 (extension 313), or any member of the INMM Certification Board or the INMM Headquarters office for resolution.

In conjunction with the INMM Safeguards Certification Program, Activity on INMM-11/ANSI-N15.28 "Criteria and Standards for Qualification and Certification of Nuclear Materials Professionals" has begun. The target date for submittal of the standard for ANSI review and acceptance is December 31, 1988.

Barbara M. Wilt
Westinghouse Electric Corporation
Columbia, South Carolina

Safeguards

The Safeguards Committee met at the annual INMM meeting in New Orleans on June 6, 1986.

Topics of discussion included:

1) Category I Material Subcommittee Report
2) Physical Protection Subcommittee Report
3) Update Status on DOE MC&A Activities
4) Update Status on NRC Activities
5) The Need for a Computer Security Subcommittee

Tom Collopy, UNC Naval Products, presented a report on the Category I Material Subcommittee activities. The current status of the NRC MC&A reform amendment was presented. Industry has provided NRC with comments on their guidance package associated with the reform amendment. There is concern in the area of non-measurement errors associated with the reform amendment.

The Physical Protection Subcommittee Report covered the latest

Topic/Subject	1987	1988	1989	1990
Safeguards Short Course				
Date	February 16-20	February 15-19	February 13-17	February 19-23
Examination Registration Deadline	January 15	January 15	January 15	January 15
Location	Tennessee (Oak Ridge)	Colorado (Denver)	Florida (St. Petersburg)	Georgia (Atlanta)
Fee (*subject to change)	$500* (includes examination fees)	$550* (includes examination fees)	$550* (includes examination fees)	$550* (includes examination fees
Place	Garden Plaza	T.B.E.	T.B.E.	T.B.E.
Annual INMM Meeting				
Date	Summer (June/July)	Summer (June/July)	Summer (June/July)	Summer (June/July)
Examination Registration Deadline	May 15	May 15	May 15	May 15
Fee (*subject to change)	$100 (intern)* $250 (specialist)*	$100 (intern)* $250 (specialist)*	$100 (intern)* $250 (specialist)*	$100* (intern)* $250 (specialist)*
Place	T.B.E.	T.B.E.	T.B.E.	T.B.E.

T.B.E. = To Be Established

information on the INMM/FBI /Utility interfaces. If Congress passes the legislation, NRC will provide a proposed rule in the late fall for implementation of criminal history checks by the Utilities. Conceptually, the INMM might serve as the conduit between the Utilities and the FBI to obtain criminal history "Hit or No-Hit" information on potential employees. Concern was expressed by Samir Morsy of the Vienna INMM Chapter on the participation of INMM in this type of activity. Mr. Morsy requested the Vienna Chapter and other Chapters be kept informed of any activities in this area.

Don Emon and Glen Hammond from the DOE provided updates on current activities in MC&A areas and R&D activities. In the MC&A area, the DOE is reevaluating the limits and composition of material for DOE categories. A draft report is due in October. A graded safeguards approach which has significant new features is being proposed to provide various levels of protection for DOE facilities. Mr. Hammond discussed the Cerberus work in development of a 5-year plan for R&D programs. DOE is depending on more input and responsibility by individual DOE sites to determine future enhancements for DOE safeguards systems.

Mike Smith, NRC, provided an update on recent rules, current rules and future activities at the NRC. The status of the low Enriched Uranium and Category I materials was also presented. Current rules include the MC&A reform amendment, spent fuel shipments, insider rule package, reporting requirements under 10 CFR 73.71, non-power reactors, and the FBI/criminal file information. Future rules discussed deal with independent spent fuel storage (10 CFR 73.50) or dry cask storage and 10 CFR 73, Appendix B, which deals with security force exercise programs. Should NRC require force-on-force exercises? If so, who should do it and how will they be graded or evaluated? This is a potential topic for the INMM Physical Protection Subcommittee. Mr. Smith also discussed a study concerning NRC/DOE comparability.

A computer security subcommittee will be formed to address current topics. Industry personnel have requested information in this area.

A suggestion was made for a session at the next INMM annual meeting to deal with safeguards terminology, definitions, and the integration of MC&A and physical protection. The theme might be "How mature is Safeguards?".

Leon D. Chapman
BDM Corporation
Albuquerque, New Mexico

Membership

The Institute's membership has stabilized at around 700. Credit for this stability goes to the Executive Committee for expanding our efforts in waste and transportation, to the promotional efforts of Headquarters, and to the hard work of several members in organizing the greatly increased number of workshops which have served to introduce our technical society to many new friends.

We are still not enlisting the utilities people enough to reflect numbers that should be in INMM. Because of the relative size and importance of the utilities to the total nuclear industry, their people should make up a major part of our membership. If you are personally in or

associated with utilities organizations, please help us get the word to them that INMM can be of great benefit as a forum, both among themselves and with the government.

Senior Members in the INMM currently number 69, and individually prepared certificates have been forwarded to all but one or two. Certificate preparation and mailing is now being handled by INMM Headquarters. As a result, it should be more efficiently accomplished than has been possible by past procedures.

During the transition of Senior membership functions to INMM Headquarters, we have experienced a few problems. If you have applied for Senor membership and have not heard from us, received a certificate, or otherwise been overlooked, call or write Beth Perry or me and we will follow up on the problem.

Senior Members present in New Orleans were recognized as a group at the Annual Meeting dinner. We appreciate and thank all of you who have been associated with the nuclear industry and INMM for many years.

Sustaining Members of the Institute are those organizations who share our objectives and who contribute significantly to our programs, both through their financial support and through their support and encouragement of employees and associates who work in INMM activities. The Institute currently has eleven Sustaining Members: Battelle Memorial Institute; Brookhaven National Laboratory; EG&G Idaho; E.R. Johnson Associates; Los Alamos National Laboratory; Rockwell International, Rocky Flats Plant; E.I. duPont, Savannah River Laboratories; Atomic Energy Corporation of South Africa, Ltd.; International Atomic Energy Agency; UNC Nuclear Industries; and Euratom.

The present Sustaining Member cadre resulted from solicitations of several firms and associations over the past two years. We consider this program very successful and hope to proceed with another solicitation campaign in FY 1987.

Our Sustaining Members were individually honored at the Annual Meeting dinner in New Orleans this year, and we continue to be most appreciative of their support.

Emeritus Members currently number eight in the Institute. They are Henry J. Culbert, Louis W. Doher, Duane A. Dunn, Wayne B. Harbarger, William D. McCluen, Melbern S. Smedley, Edward J. Stimson, and Russell E. Weber.

Resolutions of Respect were passed unanimously in the annual business meeting for deceased Emeritus Members Livingston P. Ferris and Ella C. Werner. Certificates were presented to their families at the Annual Meeting Dinner.

Fellows of the INMM total 14 after this year's election of an additional four. They are: William A. Higinbotham, G. Robert Keepin, James E. Lovett, Ralph F. Lumb, Samuel T. McDowell, Richard A. Schneider, Carl A. Bennett, Glenn A. Hammond, Sheldon Kops, Fred H. Tingey, John L. Jaech, E.R. Johnson, James W. Lee, and Robert J. Sorenson. New Fellows Jaech, Johnson, Lee, and Sorenson received their plaques at the Annual Meeting awards dinner.

In closing, I feel that our membership program has been a stable success in rather hard nuclear times. The graded membership activities continue to be an active and important part of our Institute program. I see many new and active faces in our midst, and we continue to grow in stature if not in numbers. INMM continues to be the leading technical society for safeguards. And, as Bartles and James would say, "We thank you for your support!"

R.G. Cardwell
Membership Chairman
Martin Marietta Energy Systems
Oak Ridge, Tennessee

Software Exchange

Computers, and recently IBM PC-compatible desktop computers in particular, are among the most frequently-used tools in nuclear safeguards. They appear in nearly every part of a nuclear facility. Computers run the access control and alarm systems, monitor chemical processing, keep financial, personnel, material accounting and item accounting records, control laboratory instruments, and keep office records, among other things. As in every other industry, creative people in nuclear safeguards are continually developing new software and new applications of commercially-available software. In order to encourage interchange of information, ideas and (non-copyrighted) software, the editors of the Journal have asked me to investigate the possibility of starting an INMM software exchange, along the lines of the many specialized user groups now in existence.

The basic purpose of the INMM Software Exchange would be to provide people who have written software of specific interest for safeguards or have ideas for applying commerically-available software to safeguards problems with a way to share their work with other safeguards professionals, and to provide people who have specific problems with a place to air them for a large and expert audience. Future columns might also include reviews of new or particularly interesting commercial software or hardware. If there is enough interest, it would be possible to make software available for downloading via telephone lines; it would certainly be feasible to set up a library of software such that it could be made available by mail (on floppy disk) for the cost of postage.

I am willing to undertake the job of writing this column and of maintaining a software library in PC-compatible format if there is sufficient interest. If this seems like a good idea to you, or if you have any comments or suggestions to make about how INMM might serve as a better medium for dissemination of software of safeguards interest, please either telephone me (Bell 516-282-2928, FTS 666-2928) or write me at Bldg. 197C, Brookhaven National Laboratory, Upton, NY 11973. I will be looking forward to hearing from you.

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Bringing Safeguards to the Crescent City

New Orleans, Louisiana, is an evocative, history-laden city. In New Orleans one discovers a soft blend of social structures long ingrained, of Mardi Gras, provincialism, Worldliness, Dixieland and the French Quarter.

New Orleans' role as a trading center was ensured by its location on the banks of the Mississippi when Spanish explorers discovered the river in the 16th century. But New Orleans didn't become known as a world-class meeting place until the 19th century, when private social and eating clubs called "krewes" sponsored parades and balls for a Mardi Gras (literally Fat Tuesday) festival.

It was against this backdrop, cloaked in the city's mid-summer heat and humidity, that the Institute of Nuclear Materials Management held its 27th Annual Meeting, "Success in Integrated Safeguards." More than 550 safeguards professionals, educators, presenters and exhibitors filled the New Orleans Fairmont Hotel for the four-day meeting, June 22-25, 1986.

"Success in Integrated Safeguards" included 139 paper presentations, making the 1986 program the Institute's largest yet, nearly tripling in size in as many years. The meeting opened with a Plenary Session featuring presentations from representatives with varied perspectives on nuclear technology and safeguards implementation: Edward V. Badolato, Deputy Assistant Secretary of Energy for Security Affairs, U.S. Department of Energy; James K. Asselstine, Commissioner, U.S. Nuclear Regulatory Commission; Peter M. Tempus, Deputy Director General for Safeguards, International Atomic Energy Agency; John C. Devine Jr., Project Manger, Advanced Light Water Reactor Project, Electric Power Research Institute; and Alvine Weinberg, Distinguished Fellow, Institute for Energy Analysis. The text of the Plenary Session Presentations is included in this issue of *JNMM*, as well as a transcription of a round table discussion held after the Session.

The INMM Poster Session, chaired by Roy Cardwell, Martin-Marietta Energy Systems, featured graphic presentations of five technical papers.

Plenary Session speaker Alvin Weinberg proposes that states be paid large sums from a special fund to compensate for any presumed disadvantages of accepting a nuclear waste storage or disposal facility.

As one would expect, many speakers could not avoid mentioning the recent tragic accident at the Chernobyl plant in the Ukraine. The Soviet disaster has put nuclear safety back in the news, and the issue does not promise to fade soon.

Some other meeting highlights: a comprehensive yet focused transportation session developed by David Dawson, SAIC; an updated presentation of the "insider threat problem" by Rokaya Al-Ayat, Lawrence Livermore National Laboratory; two significant sessions on quality assurance (measurements and systems applications) headed by John Clark, E.I. duPont de Nemours &Co., Savannah River Plant, and Wayne Delvin, Westinghouse Hanford Company; sessions on physical protection developed by Dennis Mangan, Sandia National Laboratories and J.D. Williams, the WLS Group, which emphasized improved operations based on past experiences and some highly in-

novative technology and, at long last, a comprehensive overview of DOE inspection activities.

Following Monday afternoon's technical sessions, 450 attendees boarded the Riverboat Natchez for a three-hour cruise on the Mississippi that included dinner and a Dixieland band. The cool breezes on the Mississippi and the clear night sky made the trip something to remember.

The 27th Annual INMM Awards Banquet was held Tuesday evening. INMM Chairman Yvonne Ferris passed the gavel to Chairman-elect Charles Vaughan, and recounted the organization's numerous successes over the past two years. Four INMM members were advanced to the grade of Fellow: John Jaech, E.R. Johnson, James W. Lee, and Robert J. Sorensen. Jim Lee also received the distinguished service award for his singularly outstanding career in the transportation field and dedicated service to the Institute.

Corporate Sustaining Members were also recognized: Atomic Energy Corporation of South Africa, Ltd., Battelle Columbus Laboratories, Brookhaven National Laboratory, EG&G Idaho, E.I. duPont de Nemours/Savanna River PLant, E.R. Johnson Associates, Los Alamos National Laboratory, RCA Government Communications Systems, Rockwell International/Rocky Flats Plant, International Atomic Energy Agency, UNC Nuclear Industries, and Euratom.

Finally, new senior members were recognized and newly elected Executive Committee members were introduced: Chairman Charles Vaughan, Vice Chairman John F. Lemming, Secretary Vincent J. DeVito, Treasurer Robert U. Curl, and Members at Large Ralph E. Caudle, Yvonne Ferris, Joerg H. Menzel, Darryl B. Smith, and Nancy M. Trahey.

In addition to providing a forum for the exchange of technical information on all aspects of the fuel cycle, the meeting provided an opportunity for INMM Committee Meetings and non-INMM organizational meetings. The complete proceedings of the 27th Annual Meeting of the Institute are available from INMM headquarters.

Between sessions at the Fairmont

Sixteen organizations participated in the INMM Exhibit, presenting the latest in safeguards technology.

Speaker's table at Monday's Plenary Session, (l to r) Peter M. Tempus, IAEA; James K. Asselstine, NRC; Alvin Weinberg, Institute for Energy Analysis; Edward V. Badolato, DOE; Yvonne Ferris, INMM Chairman.

Nuclear Safety and Security in a Changing World

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ABSTRACT

Two major crises of 1986 — the Chernobyl nuclear accident and international terrorism have had the effect of making what we all do even more critically important for U.S. national security and for the security of the world. Chernobyl can be a starting point for efforts to make nuclear power systems safer and more benign. It also poses very basic questions for our nuclear arms control activities. A fundamental objective of the Administration's arms control policy is to achieve substantial and equitable reductions in U.S. and Soviet nuclear forces with effective verification. However, Chernobyl served to remind us once again of the obsessive secretiveness of the Soviet Union and the difficulties of obtaining information on Soviet nuclear weapon activities. All of this points to the importance of developing improved monitoring technologies and obtaining Soviet agreement on on-site inspection. Terrorism continues to pose a serious threat to the West. DOE of course plays a major role in securing nuclear facilities against terrorism and has a number of programs underway designed to further enhance the security of those facilities. Just as the arms control process has encouraged the Soviets to accept the use of national technical means for verification purposes, perhaps Chernobyl will encourage them to share information on non-military nuclear technology. Nuclear managers can and should play a significant role in encouraging such information sharing.

Secretary Herrington asked me to tell you how disappointed he is that he cannot be with you today. We have talked about your conference this week and I know Secretary Herrington has the highest regard for this organization and its activities.

He feels that we are participants — all of us — in one of the more critical enterprises in which mankind is engaged. We are entrusted with heavy responsibilities — to maintain peace and freedom through the application of the nuclear deterrent, to harness for all peoples' well being the benefits of peaceful nuclear technology, while safeguarding both kinds of nuclear efforts from threats that would mean harm to people or damage our progress. Today I want to talk about common threads that tie together our policies in all of these areas.

We come to focus on these goals — you and I — from diverse personal experiences. In my own case, my previous career in the Marine Corps has fixed in my mind the importance of military strength and nuclear deterrence for keeping the peace. I have also shared first hand the perils and mindless destruction of terrorism in various parts of the world such as Indochina, the Middle East and Central America. I come to my present responsibilities with a keen awareness of our own strengths and vulnerabilities. I also bring to my job, as I know all of you do, a determination to do my part in protecting our people from renegade elements who mean us all harm.

I know all of us who deal with nuclear energy have the same interest in protecting humanity from its dangers while making the most of its great promise for enriching all of our lives. In this respect we have a close kinship with our ancestors who first discovered the harmful effects of fire and then harnessed it to peaceful uses. The fundamental difference of course, is the enormous amount of energy released by nuclear reactions as compared to fire.

The long standing policy of the U.S. — is no less than to manage the development of nuclear technologies for electricity, for medicine, for deterrence and for defense in ways that will make the entire world safer and more prosperous. These are not new goals we suddenly discovered after Chernobyl. These are policies the Reagan Administration has pursued steadfastly from its very beginnings.

We believe nuclear power is essential for the economic future and national security of the U.S. Its safe development and careful management are critical to our future. Moreover, we want to share our nuclear safety expertise with other nations. We have demonstrated our commitment to safe and secure nuclear development by improving safeguards and security systems to guarantee that U.S. nuclear facilities and materials never become victims of terrorism.

And finally it is our policy to maintain peace through our nuclear deterrent while at the same time pursuing

substantial, verifiable, and equitable reductions in nuclear arms by means of our arms control negotiations with the Soviets.

Above all, we seek to improve the safety and reliability of the world's nuclear power infrastructure, from raw uranium ore to reactors, and to reduce the dangers of nuclear war and the potential effects of that undeclared war, terrorism. We hope that Soviet nuclear technology managers and the nuclear technology managers of other countries share these same goals, and we must constantly do our best to persuade them that *we "have a better idea."*

We who are gathered here today, who operate in the real world of nuclear science and engineering, are the core of not just the American but the international community which must help the world find its way to nuclear safety and security.

In 1986 we have faced two major international *crises*: the accident at Chernobyl and the ravages of international terrorism. In its own way, each threatens our safety and security; each challenges our good will and our best technical skills. In Chinese the word *crisis* consists of two characters — one for "danger" and one for "opportunity." So it is with these two crises; I intend to devote my remarks to the Department of Energy's efforts to address those dangers and opportunities.

What I'll mainly be discussing today are some of the lessons to be learned from Chernobyl, especially regarding reactor safety and arms control verification. I also want to tell you about our intensified efforts to protect our nuclear complex against terrorism.

Chernobyl can be a starting point for new national and international efforts to make nuclear power systems — wherever they are installed — more benign. The Finns, the Swedes and the Poles would certainly agree that it is in the interests of all nations that nuclear power reactors be built and operated with safeguards for their normal workings, and in the unlikely event of an accident. Consider the fact that the containment of TMI was built to withstand three times the force of the Chernobyl explosion. The reactor at Chernobyl was one of the very few in the Soviet Union with any kind of containment — and it was obviously inadequate to prevent a disaster. The Poles speak with bitter irony about the "cloud of friendship" that descended on them from the Soviet Union. But in a very real sense, the Soviets' problem creates a problem for all of us since there is no public opinion in the Soviet Union to push for nuclear safety, however many people are affected as a result of Chernobyl. While in the West, public opinion is alive, active, and a powerful force in any democratic decision making process.

President Reagan has expressed our nation's sympathy for the Soviet people and made it clear that we stand ready to help the Soviets in coping with this disaster and in preventing future incidents. Whether the Soviets are capable of overcoming their typical reluctance to take advantage of that offer remains to be seen. Still, we are hard at work, as many of you know, perfecting the safety systems of our own nuclear power plants.

The Department of Energy and the nuclear power community of this country work continuously to improve the already impressive safety of nuclear rector designs. Our laboratories in Idaho and Illinois, among others, are working hard towards designing safer nuclear reactors, one that cannot fail to shut down completely before any runaway reaction is possible.

The Three Mile Island incident gave additional impetus to this quest. In the aftermath, some of the nation's finest minds and most knowledgeable and experienced experts — in and out of government — have focused on designing a nuclear power system that could be easily operated without danger of accident. We continue to make significant progress in that direction.

Effective policy also requires attention to implementation. More than a year ago Secretary Herrington established a new division under an Assistant Secretary within the Department of Energy to focus on environmental, health and safety aspects of nuclear power and weapons production. The budget for these activities has grown from $47 million in Fiscal Year 1986 to a request for $76 million for Fiscal Year 1987, an increase of more than 60 percent, clearly demonstrating our commitment to nuclear safety.

It is noteworthy that DOE has safely operated its own research and production reactors for over 40 years and many in this audience have contributed to that safety record. We have built that record by staying alert to possibilities for mishap. We were in the midst of a routine risk assessment of all of the DOE reactors when the Chernobyl accident occurred.

Last month Secretary Herrington received the report of a Special Review Team on the safety of DOE's N reactor an Hanford, Washington, the only one of the five DOE reactors that is graphite moderated and even remotely resembles the Chernobyl reactor. The eleven members of the team possessed more than 300 years of cumulative experience in reactor safety, graphite moderated reactors, reactor containment/confinement systems and graphite fire safety.

They concluded that the Hanford N reactor's graphite is well protected form the damaging effects of fires or explosions and that the confinement system provides an effective means for protecting the public.

But they didn't stop there and I think it's a healthy sign of the rigor of their work that they still offered recommendations for further precautions, such as additional verification testing of certain safety features under simulated accident conditions, improvements in monitoring hydrogen levels, reevaluation of the inert gas system and completion of the ongoing risk assessment of the reactor.

In thinking about Chernobyl it is most important to recognize that the Soviet approach to nuclear safety and environmental protection is very different from the United States'. Needless to say, the Soviet Union has no independent public opinion and no environmental movement that its nuclear officials and government policy must consider. While some might wish we were free of such public pressures, the fact is they are part of the strength of our democratic system and they help to

keep the system responsive to the American public.

Moreover, Soviet citizens are seen as servants of the State rather than the reverse as in the U.S. We know that the Soviets are willing to tolerate, and that they have accepted, far more environmental damage from all their industry than we would tolerate. Even worse, recent Helsinki Commission documents and numerous unofficial accounts refer to the Soviets' use of people in their gulags in nuclear work, including mining, with little or no protection from radiation.

History has shown that the Soviets are compulsively secretive, suspicious of the West and desperate to suppress any information that might reflect unfavorably on the Communist system. We saw this again in their reluctance to provide information on the Chernobyl accident to neighboring states and in the slowness with which information was made available by senior Soviet officials even after they realized the necessity to do so in the wake of outcry from other countries. We know that it took General Secretary Gorbachev 18 days to get around to saying anything about the accident.

As an outgrowth of this closed system, information on all manner of scientific and technological activity in the Soviet Union is strictly and rigidly compartmented. The Soviets do not share information even within their own nuclear establishment as widely as we do. Needless to say, we would very much like them to participate in this kind of information sharing. And while there are some signs of movement in this direction, we should be realistic in our expectations.

In the U.S., by contrast, new findings with safety implications are circulated widely within the U.S. nuclear community. This helps all our facility managers to improve their safety and operating records. This openness and sharing of information is yet another significant difference between the U.S. and the Soviet Union.

In the U.S., we have excellence in design, alert surveillance, strict oversight, independent public opinion and full spectrum exchanges of information about weaknesses or needed safety improvements, all at work to assure safe operation. We have taken measures to ensure that the Chernobyl accident will not be repeated in the U.S.

It is worth contrasting our recent experience with the People's Republic of China with our Soviet experience. While we have been able to conduct productive discussions with the Soviets on mutual nonproliferation concerns, they are most reluctant to share information, especially on reactors like Chernobyl which have the capacity to produce both electricity and plutonium for weapons. In contrast, the nuclear cooperation agreement that Secretary Herrington negotiated with the PRC allows the U.S. to assist the Chinese in developing a safe nuclear power industry. This agreement provides not only assurances of high safety standards but also compliance with the international nonproliferation regime. The Chinese have given us strong assurances on their nonproliferation policy. They have agreed to require IAEA safeguards on exports to non-nuclear states and have agreed to implement their policies in a manner consistent with basic nonproliferation practices we support.

Chernobyl also has important implications for U.S. arms control policy — especially verification. The Reagan Administration's fundamental arms control goal is to achieve deep reductions in nuclear weapons with effective verification. As I noted before, Chernobyl demonstrated the closed nature of Soviet society and the difficulty of obtaining information on virtually anything from the Soviet Union. Chancellor Helmut Kohl of the Federal Republic of German spoke for much of the world when he said recently, "The Soviet Leadership, in a completely inexplicable manner, elevated the mistrust of the entire world by its information blockade.

"The Soviet side, since Chernobyl, has not reduced the West's concerns about verification but rather increased them significantly."

In contrast, the Soviets are actively and extensively collecting information from the U.S. on military programs and scientific progress using both open and covert methods. Because of this fundamental asymmetry in our technical communities, the U.S. must insist that any arms control agreements we sign contain extensive and effective verifications provisions.

We have traditionally relied on remote verification technologies, known as national technical means, including satellite sensors and other intelligence collection techniques. But these remote means are not by themselves sufficient to create total confidence in compliance. Clearly we need to improve our remote verification technologies and this is an area in which DOE plays an active role. We also need to obtain Soviet agreement to on-site inspection — the right to have trained observers on the ground in particular locations to monitor arms control compliance. DOE developed the CORRTEX technology for measuring nuclear yield without revealing weapon test diagnostic information, a technique that the President offered last March to share with the Soviets. Recently the Soviets have expressed some willingness to agree to on-site inspection — at least in principle. But if past experience is any guide we will have a tough time translating "agreement in principle" into specific treaty language and into a verification system which we can be confident will prevent "cheating."

Arms control negotiations have been a learning experience for both U.S. and Soviet managers of nuclear technology. It hasn't turned the Soviets into an open society but it has institutionalized a process by which the two sides discuss on a regular basis some fundamental security concerns. Today the Soviets admit to a certain extent the necessity for verification and in practice accept the use of national technical means, whereas in the past they characterized such techniques as espionage. It has established the principle that it is useful to passively exchange basic information on military activities.

Early in the nuclear era the Soviets grasped the importance to their own security of preventing the proliferation of nuclear weapons around the world. In this area the two superpowers have quietly found and are continuing to cultivate common ground. Perhaps Chernobyl will teach the Soviets that sharing of information on

possible problems and their solutions is a good idea.

Let me turn now to the issue of terrorism and DOE's responsibilities in that area. Many of you have been involved in this program, and we sincerely appreciate your support and assistance. We all know that international terrorism poses a fundamental threat to the U.S. and its allies. Terrorism has become the weapon of choice of the weak against the strong and is encouraged, even facilitated, by enemies of the free world with the U.S. a prime target. Moreover, this problem is likely to be with us for a long time. The special nature of the facilities and materials that comprise the DOE nuclear complex make them potential targets of terrorists and necessitate special security arrangements to assure their safety.

In response to that threat, the Department of Energy has been improving its defenses against possible terrorist activities for many years. Shortly after taking over the Department of Energy, Secretary Herrington put together a team of experts to examine the status of safeguards and security at all of our nuclear sites.

This independent assessment of our safeguards and security systems reported to Secretary Herrington that: "Any adversary who attempts to gain control over or steal a nuclear weapon, or critical weapon component, or special nuclear material, would face a high probability of failure." After receiving this report, Secretary Herrington launched Operation Cerberus. Named for the three-headed dog of Greek mythology that guards the gates of Hades, Operation Cerberus is designed to improve safeguards and security at DOE nuclear weapon and special nuclear material facilities. Through Operation Cerberus we are directing and involving over 150 DOE and contract personnel — our "Best and Brightest" — to put together an implementation plan to improve the DOE system. These improvements are based on a systematic approach to corporate management, sound planning and programming and close cooperation with other government agencies.

DOE has spent nearly $3 billion in the last four years to upgrade personnel, equipment and facilities involved in providing safeguards and security. This is a good indicator of how seriously we view the threat. We are confident that these efforts will enhance our ability to protect sensitive installations and materials from sabotage or theft.

While we have made tremendous progress in protecting DOE facilities and nuclear materials, we must maintain our vigilance and stay in the forefront of technical developments to meet changing threats. Recent growing consciousness regarding insider threats has resulted in greater emphasis on providing protection against acts of sabotage or theft of nuclear material. For example, efforts are underway to address potential diversion hidden by nuclear material measurement uncertainties or falsification of data. New techniques are being developed to better protect and monitor the status of nuclear material. New techniques, such as nondestructive assay, allow us to monitor and categorize the "fingerprints" of nuclear materials.

In addition, recent national espionage cases have prompted us to tighten our controls over nuclear sites and sensitive classified operations and information therein. And we have reduced the vulnerability of nuclear weapons and materials to theft or sabotage by any employee who might be tempted to violate his trust and damage the national security.

We have expanded our coordination with other government departments and agencies. Better intelligence is critical if we are to be alert to the threat. We use not only historical data but the most current security information available from other government agencies. For example DOE chairs a Safeguard and Security Steering Group which includes representatives from the National Security Council, the Department of Defense, the Federal Bureau of Investigation, and the Nuclear Regulatory Commission.

Channels of communication and procedures have been established with other agencies as well as local law enforcement groups to provide assistance in the event of a domestic terrorist incident. I represent DOE as a member of Ambassador Bob Oakley's Interdepartmental Group on Terrorism that meets regularly to provide a forum to address current issues in combatting international terrorism.

Another recommendation in the report of the Special Project Team was to establish a single manager for nuclear safeguards and security R&D within DOE. A single manager approach provides both high level attention and coordination for common problems. Such an approach assures that informed decisions are made quickly with due consideration to DOE-wide policies, and priorities. The single manager approach, which is supported by Assistant Secretary Foley, is a critical element of Operation Cerberus. It is designed to provide key people, offices, and contractors with the right information at the right time.

Since Hiroshima and Nagasaki, we have passed the forty year mark in the nuclear era and sooner than we think will be successfully completing a half-century of the nuclear age. Our dialogue with the Soviets and others, as well as our determination to maintain our own nuclear strength, have been important factors in managing nuclear technology.

The United States has been the leader in that dialogue. It has been the Western, mostly American, technological community that conceived and shaped the arms control apparatus which the Soviet Union has for the most part accepted. The same is true of nuclear power as well as most other advanced technologies. The West shows the way and the Soviets follow. Of course, we do our best, as indeed we must, to deny the Soviets access to our most advanced technologies with military significance. But when it comes to nuclear safety and safeguards it is in everyone's interest that our technology and experience are widely shared.

For managers of the most sophisticated nuclear technology in the world, both in its peaceful and its military applications, this is not the time to ignore the rest of the world, to simply gloat over Soviet misfortune or to lose our perspective. We must follow a prudent strategy of patient persuasion. We must be steadfast in our goals.

Pointing out to the Soviet leadership its indifference to public welfare and international obligations is both justified and proper. However, criticism by itself is insufficient and our discussions with the Soviets should be coupled with continuing offers for joint actions to better manage all our nuclear assets and lead the world away from the risk of disaster and of nuclear war. We know what must be done to move closer to achieving these goals. The West can provide a better model and lead the way.

To briefly summarize:

- It is U.S. policy to continue to develop safe nuclear power systems and to share our expertise in safe, peaceful, nuclear technology with the entire world, and to include the Soviets and the Chinese.
- We are dedicated to the improvement of safeguards and security systems to guarantee that U.S. nuclear facilities and materials never become victims of terrorism.
- We will continue to modernize our nuclear deterrent to keep the peace while pursuing negotiations to achieve substantial and equitable reductions in nuclear arms with effective verification.

My message to you in the nuclear community is that we all have a solemn responsibility to manage safely and securely our nuclear resources and to use our knowledge and resources to improve the welfare of the world community. Part of that job is to bring the Soviets, and others, along with us, however reluctant they appear to be. You, the nuclear managers, provide the backbone of this vitally important mission.

Edward V. Badolato was appointed Deputy Assistant Secretary for Security Affairs, Office of Defense Programs, U.S. Department of Energy (DOE) on December 4, 1985. He is responsible for the protection, control, and accountability of special nuclear materials components and nuclear weapons at 59 DOE facilities throughout the United States. He is also responsible for verification of international arms agreements and control of sensitive technology information and equipment, as well as the control of classified information and the appropriate granting of security clearances. Prior to assuming his current duties, Mr. Badolato had served as a Special Assistant to the Secretary of Energy for several months. He was previously assigned to the Department of State's Bureau of Politico-Military Affairs. Until his recent retirement, Mr. Badolato had served in the U.S. Marine Corps as a career officer since 1960.

Reflections on Chernobyl

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ABSTRACT

The Chernobyl and Three Mile Island reactor accidents are revealing some of the social costs of such failures, widespread opposition to nuclear power. As far as mortality and morbidity go, Chernobyl was probably a smaller incident than the chemical disaster as Bhopal. But nuclear people must accept the idea that a nuclear hazard is perceived as somehow different. Since nuclear energy will be needed to replace oil eventually, and the environmental impacts of properly operating nuclear power plants are far less than those of fossil fuelled power plants, this appears to be an appropriate time for the United States and other interested countries to start developing inherently safe nuclear power plants which will be acceptable to the public.

Fifteen years have passed since I first alluded to nuclear energy as a Faustian bargain: mankind, in opting for nuclear energy must pay the price of extraordinary technical vigilance for the energy he derives from nuclear fission if he is to avoid serious trouble. At the time, I could not say exactly what degree of technical vigilance would be required, nor exactly what the consequences of a lapse in vigilance would be. As long as nuclear energy was small and unimportant, as it was in 1971, the likelihood of having to pay up on our bargain would be small; but as the number of reactors grew, as nuclear energy became large and very important, the likelihood, and therefore the frequency, of accidents would increase. Experience would then enable us to judge, rather than speculate on, the risk fission imposed on society.

Chernobyl has given us a second point on the risk versus benefit curve. The first point was Three Mile Island. Here, after about 400 reactor years of operation of pressurized water reactors, about 20 curies of I^{131} was released in a meltdown. No individual was exposed to more than 100 millirems of radiation, and very probably, no one suffered physical harm. Nevertheless, TMI profoundly affected the nuclear enterprise throughout the world. Perhaps most important, all members of the nuclear community — engineers, managers, reactor scientists — now realized that accidents described in Professor Rasmussen's famous probabilistic risk assessment could actually occur, and with a probability not grossly different from the theoretical probability he calculated in that study.

Chernobyl, which occurred after about 250 reactor years of operation with reactors of this type, has given us another point though on a somewhat different curve. The Chernobyl reactor, being graphite-moderated and with pressure tubes rather than water-regulated with a single pressure vessel, is not really comparable to the reactors that account for most of the world's nuclear power. No one in the West, as far as I know, has seen a Rasmussen type probabilistic risk analysis for Chernobyl nor do we know whether such as a priori analysis of accident in such reactors exists. In any case, had the sequence of events that precipitated Chernobyl been identified in probabilistic risk analysis as having a probability as high as 1 in 250 reactor years ($\sim 4 \times 10^{-3}$/reactor year), I should think the designer would have eliminated the sequences that were responsible for such high probability. But this is speculation. We in the West do not really know what happened at Chernobyl. We eagerly await the results of the Soviet investigation of the accident.

We do know that the consequences have been substantial. According to Dr. Gale, the American physician who helped with bone marrow transplants, some 300 people have received doses around 200 rads or more; and the roughly 100,000 reported to have been evacuated have received doses "large enough to warrant annual examination," say around 25 rads. Thus, assuming 10,000 man-rads per additional cancer, one can estimate about 6 additional cancers among the high dose group (compared to 60 spontaneous cancers), and 250 additional cancers (compared to 20,000 spontaneous cancers) among the 100,000 whom I assume to have been exposed to 25 rads. These figures must be viewed with great caution, especially since my estimate of 25 rads is speculation; moreover, at 25 rads, the linear hypothesis upon which I have based my estimate of health effects is on shaky grounds. As for the millions of people who received smaller doses, I cannot even attempt to estimate the medical consequences.

Perhaps of greater significance than the actual physical harm cause by Chernobyl is the near panic the incident precipitated in much of Europe. At the time the Rasmussen report was issued, we certainly did not anticipate that a reactor accident of the magnitude of Chernobyl would provoke the public concern that has occurred. Nor did we recognize the full social impact of land interdiction because of fallout. To be sure, at Missasauga in Canada some 240,000 people were evacuated when a chlorine tank car burst; but once the cloud passed, people returned to their homes. The interdiction of land at Chernobyl is rather more like the aftermath at Seveso, following dioxin contamination, or perhaps, the aftermath of a dam failure or even a volcanic eruption. In these cases land is interdicted for a long time. How long the land around Chernobyl will be interdicted remains to be seen.

THE COSTS OF CHERNOBYL

Chernobyl and Three Mile Island are revealing some of the social costs of nuclear accidents. These costs can hardly be estimated by probabilistic risk assessment, especially since they depend very much upon the cultural and political environment of the country in which the accident occurs.

An important social cost of Chernobyl is the possible abandonment of nuclear power in several Western European countries. Austria, Denmark and Norway had already rejected nuclear power even before Chernobyl; Sweden's phasing out of nuclear power by 2010, which had been regarded increasingly as being unlikely, is once again taken very seriously. In the United States, an ABC poll suggested that 58 percent of the public is not opposed to nuclear power. I would not be surprised if the Democratic Party platform in 1988 calls for a phase-out of nuclear power, even though 15 percent of our electricity now is generated from fission. At the very least, I would expect the 10-year moratorium in the U.S. on new nuclear plants to continue.

Of the many arguments against abandonment of nuclear power, I shall mention only two: first, the 285 gigawatts of electric capacity now represented by the world's reactors significantly reduce the world's requirement for oil. An oil-fired power plant that generates 1,000 megawatts at 60 percent lead factor burns about 25,000 barrels of residual oil each day; thus were all the nuclear electricity generated instead from oil, the world's demand for oil would be increased by 7 million barrels per day, or about 12 percent of today's demand for oil. Of course, many of the world's nuclear rectors displace coal and gas, not oil; but a saving of several million barrels per day seems justified.

Second, as long as the nuclear plant is operating properly, its impact on the environment is far less than the impact of fossil burning plants, and even dams. I would insist that we have the strongest incentive to continue to utilize nuclear energy, but we have an equal incentive to reduce both the frequency and consequences of malfunction.

Having stated this general criterion, we face the much more difficult question: how much safer must reactors be in order to restore public confidence in nuclear energy? One view, put forward only partly facetiously, is that some reactor accidents are necessary so that the public can place in proper context the real, as opposed to the imagined, hazard of nuclear energy. Thus as far as mortality and morbidity goes, Chernobyl is probably a smaller incident than was Bhopal, let alone the Vajont Dam failure. A case can be made for even the worst nuclear accident being no worse than the worst dam or chemical plant failure; since the latter are now "accepted" by the public, the former should be also — provided we actually experience some reactor disasters.

I do not accept this line of reasoning. Nuclear people must accept the idea that the nuclear hazard is somehow different, that the notion of interdicting land with an unseen agent is viewed by the public as particularly threatening. In short, Chernobyl demands that we reduce the frequency and consequences of accidents to the point where they do not evoke the near-panic we have just witnessed. Is this possible?

We must distinguish between reactors already on line, and new reactors, possibly of different design, that might be built in the future. A central question is the relevance of the experience at Chernobyl to the Western world's light water reactors — in particular, would the massive, and quite leak-tight, containment structures around Western LWRs, have mitigated the consequences of a Chernobyl-like accident. Though important arguments have been made that the Western containments are more substantial than the Chernobyl containment, I'm inclined to await a detailed comparison before answering this question. The Western containment certainly appears to be stouter, and a graphite fire is impossible in an LWR. On the other hand, it would be claiming too much to insist on the impossibility of an accident in an LWR that breaches a Western containment. All we can say is that the likelihood of such an accident appears to be extremely small, probably much smaller than in a Chernobyl-type reactor.

As for the safety of plants already on line in the United States and in many other countries, much has been done in the wake of Three Mile Island: operating procedures have been modified, the Institute for Nuclear Power Operation is in full gear, and various pieces of hardware have been improved. Minarick and Kukielka have analyzed precursor events in operating reactors that, had the events not been aborted by human or mechanical intervention, could have led to a core-melt. Their semi-empirical estimate of the core-melt probability in 1969 to 1979 was 10^{-3} per rector year (in good agreement with TMI-2 experience). This probability in 1980-81 fell to $.15 \times 10^{-3}$ per reactor year. Based on this analysis, the probability of a core-melt between now and 2000 in one of the 100 U.S. LWRs would be about 20 percent.

This number can be disputed. D. Phung suggests that on average the core-melt probability in U.S. reactors today is close to Rasmussen's $.05 \times 10^{-3}$ per reactor year or 3 times lower than the aforementioned estimate.

Newer modifications of LWRs, such as the

Westinghouse Advanced PWR and the General Electric BWR, designed jointly with Japanese reactor vendors, are estimated to be even safer. Their core-melt probabilities are estimated to lie in the range of 10^{-6} to 10^{-7} per reactor year.

No one can say whether these safety goals, if achieved, will be sufficient to restore the public's confidence in nuclear energy. If one accepts Phung's probability estimate, the chance of a meltdown in a U.S. reactor by 2000 is about 1 in 12. How much this has been lowered by better operating procedures is unknown. Should an LWR suffer a core-melt during the next 15 years, the public's reaction probably will depend upon how much radioactivity is released. Following TMI-2, where very little radioactive iodine, cesium, and strontium was released, many of us in the nuclear community were confident that such low release of fission products was a characteristic of water reaction. Chernobyl with its huge release raises questions about the validity of this belief. Clearly we cannot draw the full technical implications of Chernobyl until we have a complete investigation of the incident. What we do have is an impression of the social dislocation caused by the accident; and these social dislocations are large.

WHAT IS TO BE DONE?

The ultimate question is, can we accept a technology whose safety is measured probabilistically? We in the nuclear community had always assumed that, if the probability of a severe accident was sufficiently low, nuclear power would be accepted even if the consequences of unlikely accidents, especially the social dislocations, were very large. This has traditionally been society's attitude toward technological hazard. If the technology confers an important benefit, the society has accepted both the technology and the risk, the latter always being probabilistic. We accept chemical industry despite Bhopal; we accept dams despite Vajont; we accept fossil fuel despite the greenhouse effect. Why should we not accept nuclear energy despite Chernobyl?

In a participatory democracy such as ours, the answer to this cannot be given by any but the public. Though most nuclear technologist can point to the differences between Chernobyl and contained LWRs, and to the low estimated probabilities of serious accidents, one cannot say whether the public will ultimately be persuaded that nucler energy is acceptable.

The improvements promised by the advanced U.S.-Japanese LWRs are surely impressive. For example, were the 100 reactors now on line replaced by reactors with core-melt probability of 10^{-6}/reactor year, one could expect an accident no more frequently than every 100 years. Moreover most meltdowns, at least in contained reactors, ought to release little radioactivity to the public. Yet the safety of such a reactor is in final analysis a matter of probability; even though the probability is very low, an accident can happen.

Can reactors be designed for which the probability of a serious accident is zero — that is, a reactor whose safety depends not on active intervention of safety systems (which with some probability can fail), but rather depends on physical principles that ensure the reactor's safety without active intervention. Were such an inherently safe reactor actually demonstrated, could the public be convinced of its safety? And could such a reactor be the basis for a second nuclear era no longer tormented by profound public disaffection?

David Lilienthal, the first chairman of the Atomic Energy Commission, proposed exactly this in the wake of TMI-2. He called upon the nuclear technologists to develop an inherently safe reactor: one whose safety depended not on mechanical or human interventions, but rather upon immutable physical principles that even in an emergency would not be abrogated.

Though the nuclear community at first regarded this challenge as impossible to meet, our position has now changed. At least three different inherently safe reactors have now received considerable attention: The Swedish Process Inherent Ultimately Safe Reactor (PIUS) and the Modular High Temperature Gas-Cooled Reactor; and the Metal-Fueled, Sodium-Cooled Breeder. These reactors have been described elsewhere so I shall not repeat their description. Suffice to say that all of them introduce new inherent elements of safety that had not been incorporated in the current generation of reactors. The Swedish PIUS, in particular, appears to me to have as close to a zero probability of a disabling accident as I can imagine.

Since no new nuclear power reactor is likely to be built in the United States for, say the next 15 years at least, does it not make sense to use this time to develop a truly inherently safe reactor? Indeed I would go further: could not the development of inherently safe reactors be made an international project on which the United States and the Soviet Union would collaborate? I am suggesting that the world seize the opportunity offered by Chernobyl to take up David Lilienthal's challenge: to develop one or more inherently safe reactors — devices so transparently safe that both friend and foe of nuclear energy will regard them as adequately safe.

The Chernobyl incident has internationalized the peaceful atom in a way that the world had not anticipated. Secretary Gorbachev's suggestion to strengthen the International Atomic Energy Agency's activities in reactor safety, and particularly in exchange of detailed information on near misses, is most welcome. These steps are important in helping assure that the existing fleet of reactors will operate without incident. Even more striking is his suggestion that the IAEA sponsor international efforts to develop "a new generation of economical and reliable reactors with enhanced safety of operations compared to the existing reactors." I hope the United States takes up Secretary Gorbachev's challenge and develops, in collaboration with the Soviet Union, one or more inherently safe reactors. A precedent for such cooperation is the agreement reached at the summit to collaborate on fusion research. Indeed, could not development of inherently safe reactors be an agenda item at a future summit meeting?

For those who regard nuclear energy as an abomination that must be extirpated. such a course is unappealing. But

to those who insist that the proper response to nuclear energy's deficiencies is to fix the deficiencies, I should think serious development of inherently safe reactors is a sensible and perhaps overdue goal.

INTERNATIONAL IMPLICATIONS

Chernobyl has once more demonstrated, as had TMI-2, that a nuclear accident anywhere is a nuclear accident everywhere. We have yet to see all the impact of Chernobyl on the International Atomic Energy Agency; almost surely, IAEA will strength its programs on nuclear safety. Up to now the IAEA incident reporting system has been less thorough than the system sponsored by OECD, or by the U.S. NRC. Secretary Gorbachev's appeal to the United Nations to strengthen the international reactor safety regime, and particularly to confront the problem of terrorist threats against nuclear power plants, is surely a welcome move.

Another international aspect of Chernobyl has so far received little attention. Ever since the beginning of the nuclear era, many had speculated on the effect of conventional bombs on nuclear reactors. Could an accident of the magnitude of Chernobyl be precipitated by conventional bombing? Though controversy on this matter continues, most would concede that large precision-guided bombs could incapacitate a reactor, even a contained one, and might lead to a serious reactor accident. Chernobyl in a way reopens this issue: we now have a fuller appreciation of what might happen if the containment is breached, and a hydrogen explosion occurs in a high-powered reactor.

Bennet Ramberg has summarized the issue in several publications, most recently in the 1985 Annual Reviews of Energy. He points out that in a way, the presence of nuclear reactors in belligerent countries has the potential of converting non-radiological war into radiological war. Would this serve to deter war (in a miniature replaying of nuclear deterrence) or would this simply exacerbate the horrors of a war that such mininuclear deterence had not prevented? None can answer such questions. On the other hand, these issues would become irrelevant if we gradually switched to inherently safe reactors. PIUS, in particular, is all but immune from damage by conventional weapons. PIUS is contained in a 25-foot thick prestressed concrete structure not unlike an ICBM silo. The designers of PIUS claim it to be invulnerable to all but a direct nuclear hit.

CONCLUSIONS

Can Faust be exorcised? Can the world's nuclear technologists design reactors whose safety depends not upon mechanical interventions, but upon transparently inherent and immutable laws of nature? And would the development of such reactors restore the public's confidence in nuclear energy?

When a few nuclear technologists first took up David Lilienthal's challenge, most of the nuclear community was skeptical: first, whether inherently safe reactors were feasible; second, whether the deployment of inherently safe rectors would lead to demands to shut down existing reactors; and third, whether a technical fix would allay the pubic's opposition to nuclear energy. Today, the technical, if not the economic feasibility of inherently safe reactors is conceded. As for the coexistence of conventional and inherently safe reactors, one can only point to the many DC-3's that are still flying, and are accepted, alongside the much safer jet-propelled commercial aircraft. Whether inherently safe reactors will restore confidence in nuclear energy is hard to say.

That inherently safe reactors are possible is a powerful existence theorem. Should nuclear energy founder in the wake of Chernobyl, as it may in several countries, I cannot believe that the world will forever foreswear fission. The existence theorem, having been demonstrated theoretically, will tantalize future nuclear technologists. Eventually, some inherently safe reactors will be built and their inherent safety demonstrated. At that time we shall better know whether such devices can produce electricity economically, and whether their use will forever exorcise Faust from the minds of a skeptical public. In view of the uncertainties, and the risks associated with every source of energy, I would hope this generation takes up David Lilienthal's challenge and devotes the necessary resources to develop inherently safe nuclear reactors. Nuclear power could then be part of the solution to the problems of acid rain and the accumulation of carbon dioxide rather than a festering source of political conflict.

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An Immodest Proposal for Dealing with Radioactive Wastes

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ABSTRACT

The problem of disposal of nuclear wastes is more political than technical. Essentially all high-level waste accident scenarios involve at worst exposure to levels of radiation that are so low as to be in the range where health effects, if they exist, are miniscule. However, states and localities are refusing to be considered as locations for monitored and retrievable, or permanent geological, repository facilities. Such opposition is not on the basis of safety, but rather on the implications which such a "waste dump" would have for the area. It is proposed that a fund be established, for example $100 million per year, to be paid to a state to compensate for any presumed disadvantages of accepting a nuclear waste storage or disposal facility.

Chernobyl has pushed waste disposal into second place as the aspect of nuclear energy that most concerns the public. Nevertheless if there is to be a second nuclear era, the issue of waste disposal must be resolved.

Unlike reactor accidents, waste disposal has generally been regarded by the technical community as a second-order problem. The nuclear community has never denied that a serious reactor accident could happen; the issue has always been what frequency and what consequences would be acceptable to the public. By contrast, the nuclear community has never identified a plausible accident sequence involving solidified high-level wastes (short of a nuclear attack on a spent fuel storage pool) that could have anywhere near the consequences of an accident like Chernobyl. Essentially all high-level waste accident scenarios involve at worst exposure to levels of radiation that are so low as to be in the range where health effects, if they exist, are miniscule; indeed, they are in a range where there is some evidence for the exposures being beneficial.

I would insist therefore that the problem of high-level waste disposal, unlike the problem of reactor accident, has been greatly overdrawn. The fears expressed by the public in the former case are largely unjustified; the same cannot really be said of the fears evoked by the possibility of a reactor accident.

To allay the public's fear of wastes therefore we shall require a different approach than the one required to allay the fear of reactor accident. In the latter instance, since the fears are based on technical deficiencies of the technology, the approach must involved correction of the deficiencies: ultimately, the design of inherently safe reactors. Since in the case of high-level wastes, the fears are not based on technical deficiencies — i.e., since the existing technologies are good enough to guarantee that, even in the worst accident, no one will receive a high dose of radiation — further technical improvements are rather beside the point. Instead one must devise compensations for these fears. Though these fears may be irrational, they must nevertheless be mitigated if we are ever to dispose of radioactive wastes.

The experience of the Department of Energy in siting the Monitored Retrievable Storage Facility (MRS) illustrates the problem. The MRS is designed as an interim storage and repackaging facility for spent fuel. It is in no sense a "waste dump," but rather a carefully engineered and monitored nuclear "Fort Knox" where thousands of spent fuel assemblies would be stored and repackaged before being sent to the final geologic repository. Sweden has already built and is operating such a facility, the so-called CLAB, at its Oskarshamm reactor site. Though the city of Oak Ridge, which is the tentative site for MRS, has welcomed MRS, the State of Tennesseee has not. Governor Alexander, though conceding that MRS was safe, nevertheless opposed MRS because he believed the area surround MRS would be perceived to be a waste dump, and this would frighten away desirable industry. Governor Alexander was invoking the principle of NIMBY (Not In My Back Yard), not because of safety but because of social perceptions. As of this writing, I do not know how the DOE will respond to the State of Tennessee's disapproval.

The experience with MRS thus far is anything but reassuring for the fate of the permanent geologic repository. The Nuclear Waste Policy Act allows a state that has been chosen as the site of a geologic repository to veto the choice; Congress can then override the veto by simple majority of House and Senate. All three candidate states

— Washington, Nevada, and Texas, have indicated that they will veto. Should they veto, and Congress override, I believe we have the makings of a Constitutional crisis. Will it be Little Rock played over again, with federal marshals called out to enforce the will of Congress?

Unless the waste problem is resolved, nuclear energy is dead, even without Chernobyl. Technology cannot solve the problem, since as I have argued, even the opponents cannot seriously challenge the safety of the existing technology; other approaches are therefore necessary. My own suggestion is massive compensation to the state, and the locale, for the "perceptual" damage imposed by the waste depository. As a beginning, I would suggest $100 million per year to be paid to the state that accepts MRS or the geologic depository. This amounts to 0.2 mills per kWhour on the nuclear electricity generated in the United States — or a levy of about .25 to .5 percent of the cost of this electricity. This compensation must be offered promptly and generously. The state would then have to decide whether such compensation is enough to mitigate the negative perceptions associated with nuclear wastes. Thus Governor Alexander, who worries about scaring off desirable industry, would have to consider whether this subsidy is enough to overcome the damage caused by perception of harm. He would consider, for example, that with this money the State of Tennessee could establish a venture capital fund which might attract, in a most powerful way, exactly the kind of industry he thinks might be scared off by the MRS. In short, I have come to believe that since the concerns over waste repository siting have little technical basis and therefore are not amenable to resolution by technical means, generous and open compensation must be the key to resolution of the waste disposal dilemma. To those who view such compensation as an unconscionable bribe, I can only say that a bribe becomes a golden opportunity if it is sufficiently generous! And $100 million per year is, I suggest, an offer that, as the Godfather says, cannot be refused, as well as being an amount that can be afforded by the nuclear industry.

For more suggestions on radioactive waste management see: N. Barkenbus, A.M. Weinberg, and M. Alonso, *Bulletin of the Atomic Scientists*, 41, Nov. 1985, pp. 34-37 and Alvin M. Weinberg, Marcelo Alonso, and Jack N. Barkenbus, editors, *The Nuclear Connection: A Reassessment of Nuclear Power and Nuclear Proliferation*, New York: Paragon, 1985.

Safeguards at NRC Licensed Facilities: Are We Doing Enough?

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ABSTRACT

The Nuclear Regulatory Commission is pursuing a number of initiatives in the safeguards area. The Commission is conducting a reassessment of its safeguards design basis threat statements to consider the possible implications of an explosive-laden vehicle for U.S. nuclear safeguards and to examine the comparability of safeguards features at NRC-licensed and DOE facilities. The Commission is also completing action on measures to protect against the sabotage threat from an insider at NRC-licensed facilities, and is examining the potential safety implications of safeguards measures. Finally, the NRC has developed measures to reduce the theft potential for high-enriched uranium.

It is a great pleasure to be here to participate in this 27th Annual Meeting of the Institute of Nuclear Materials Management. In keeping with the theme of this meeting, "Success in Integrated Safeguards," I want to spend the next few minutes discussing some of the more significant recent NRC activities in the safeguards area for NRC-licensed facilities, including the commercial power reactors, research reactors, and fuel cycle facilities. Among the safeguards activities which I intend to discuss are: the Commission's ongoing reassessment of the adequacy of the design basis threat statements for radiological sabotage and theft or diversion of formula quantities of strategic special nuclear material; factors that could indicate the need to revise these threat statements; the Commission's rulemaking proceeding and legislative proposal related to the insider safeguards threat at NRC-licensed facilities; additional design features for the commercial nuclear power plants which could mitigate the consequences of a sabotage attack; and finally, the Commission's efforts to reduce the potential for theft or diversion of high-enriched uranium, both here and abroad. In each of these areas, I think that the central question we should be asking ourselves is: Are we doing enough to assure that the public health and safety and the common defense and security are being protected?

Turning to the Commission's reevaluation of the design basis threat statements. I want to begin with a brief historical overview. In the early 1970's, the General Accounting Office issued a report to the Atomic Energy Commission which identified the need for guidance to the commercial nuclear industry on the design of physical security systems. When the Atomic Energy Commission was abolished and the Nuclear Regulatory Commission was established by the Energy Reorganization Act of 1974, the Congress directed that the NRC establish provisions for safeguards against threats, including sabotage of licensed facilities and theft of nuclear materials. This guidance to the industry took the form of design basis threat statements for radiological sabotage and for theft or diversion of formula quantities of strategic special nuclear material. These draft statements were developed in consultation and coordination with Federal law enforcement and intelligence agencies, and were supported by studies and analysis of the characteristics and capabilities of potential adversaries. These design basis threat statements have several key elements. First, they assume a determined, violent external assault, attack by stealth, or deceptive actions by the adversary. Second, they assume a variety of capabilities of the adversary, including; military training and skills; dedication; passive or active assistance by a knowledgeable insider who can be an employee in any position; sophisticated weaponry; and incapacitating or destructive tools to gain entry to a facility or to cause damage to the facility, the material container, or to the licensee's safeguards system. There are also two differences between the threat statement for radiological sabotage and the theft or diversion threat statement. First, the sabotage threat statement speaks of an adversary force composed of "several persons," whereas the theft threat statement speaks of "a small group" with the ability to operate as two or more teams. Second, the theft threat statement includes the possibility of a conspiracy between knowledgeable individuals in any positions, whereas the conspiracy element is not included in the sabotage threat statement. At least in these two respects, then, the theft threat statement assumes greater capabilities on the part of the adversary than does the sabotage threat statement.

The Commission announced its intention to review

the adequacy of these design basis threat statements on a periodic basis to ensure that they remained consistent with actual experience and with the best current understanding by the law enforcement and intelligence agencies of the potential threat to nuclear facilities. At the same time, the Commission added a further element of conservatism by noting that it was unwilling to rely entirely on law enforcement and intelligence projections. This added measure of conservatism was based upon the assumption that we might not always receive sufficient advance warning of a threat to take effective preventative action. Finally, the Commission announced its intention to provide levels of protection for NRC-licensed facilities which are comparable to the protection afforded for similar facilities and activities of the Department of Energy and the Department of Defense. Over the years, the NRC staff has monitored on a continuing basis the sabotage and theft experience at NRC-licensed facilities, the law enforcement and intelligence threat estimates, both within the United States and abroad, and the safeguards measures being applied to similar DOE facilities. In terms of actual experience, we have seen a number of events at NRC-licensed facilities over the past several years. However, most appear to fall in the category of vandalism, often by disgruntled employees.

Although several changes were made during the late 1970's and early 1980's to upgrade the Commission's more detailed safeguards requirements which were intended to help satisfy the design basis threat statements, no changes were made in the threat statements themselves. However, in the past few years, several events have occurred which have led the Commission to conclude that a reassessment of the threat statements was in order. The two most significant events were: the use of vehicle bombs as a terrorist tactic in the Middle East; and the substantial safeguards upgrade program undertaken in recent years by the Department of Energy for its defense nuclear facilities.

Following the use of vehicle bombs in the Middle East a few years ago, the NRC staff notified our licensees of the potential implications of an explosive-laden vehicle for U.S. nuclear safeguards, and undertook some limited studies both of the potential destructive capabilities of vehicle bombs for commercial power reactors and fuel cycle facilities, and of possible countermeasures that might be effective in dealing with vehicle bombs. Although I cannot discuss the details of these studies, it is sufficient to note that some potential vulnerabilities were identified, depending upon such variables as the type and size of the bomb, the distance from the facility, and the design of the facility. Facility design appears to be a significant variable, leading to the conclusion that vulnerability would have to be examined on a site-by-site basis. As for protective measures, the studies identified a range of potential countermeasures, including some relatively simple and inexpensive features to more costly and difficult options. It appears that the simple and inexpensive options would not provide complete protection, and their effectiveness would vary from site to site. The vulnerability of NRC-licensed facilities to attacks of this kind, and possible preventative measures, were also discussed by the Advisory Committee on Reactor Safeguards. On the basis of this information, the Commission decided to seek the advice of the National Security Council on the possibility of a domestic or foreign terrorist threat of such an attack on a U.S. nuclear facility. However, pending completion of this NSC review, it appears that a majority of the Commission does not favor the imposition at this time of additional measures to address this potential threat, either by requiring additional preventative measures and contingency planning, or by modifying the design basis threat statements.

As for the question of the comparability of protection for NRC-licensed and DOE facilities, the Commission proposed, and the Secretary of Energy accepted, a joint comparability review of the NRC and DOE safeguards protection programs. The focus of the effort will be on facilities that possess formula quantities of strategic special nuclear material. This joint comparability review will have as its objective the identification of DOE facilities that are comparable to NRC-licensed major fuel cycle facilities and the comparison of protection features. In my view, the more interesting comparisons are likely to include such areas as: the protection against vehicles of all types; the use of deadly force to repel or contain an adversary; and the use of design features to prevent intrusion or escape by an adversary. Although we recognize that the National Security Council review of the potential domestic and foreign threats against U.S. facilities is relevant to this comparability review, the Commission believes that we should now proceed with the comparability review with the objective of completing that review by the end of this year.

The Commission's reevaluation of the design basis threat statements, together with a recent event at one of the plants, also raises interesting questions in my own mind about the possible need for modifications to the radiological sabotage design basis threat, quite apart from the vehicular bomb and comparability questions. For example, a careful reading of the threat statement discloses that no mention is made of the use of vehicles of any type by the adversary. I question whether this assumption is realistic, and I doubt seriously that it is conservative. I also fail to understand why the theft statement is more conservative in its assumptions regarding the possibility of a conspiracy of knowledgeable insiders and the adversary's ability to function as two or more teams. It seems to me that these capabilities are just as likely to be present in the case of a sabotage attack as in the case of an attempted theft or diversion. Indeed, a recent suspected sabotage event at the Palo Verde plant reinforces these questions concerning the adequacy of the sabotage threat statement. During this event, three of the four offsite transmission lines leading into the plant were disabled within a few minutes of each other. The points at which the lines were disabled were far enough apart to require a coordinated effort by several individuals to accomplish the power loss within a few minutes. At a minimum, this experience raises questions about the

assumptions that sabotage adversaries will not use vehicles in their attack and that they cannot function as separate teams.

I believe that the time has come for the Commission to reassess several aspects of the sabotage design basis threat. I would assume the use of land-based vehicles in an attack, and I would require land-based perimeter protection to prevent vehicle intrusion. I would also proceed with contingency planning for vehicular bombs. In addition, I would take a critical fresh look at the potential for a conspiracy of knowledgeable insiders in a sabotage attack, and for the ability of the attackers to function as two or more teams. It seems to me that such a critical look is needed if we are to maintain a careful and conservative safeguards program. And finally, I would consider the addition of certain design features of the nuclear power plants which could provide an independent source of protection in the event of a sabotage attack that defeats the normal safety systems in the plant. Dedicated decay heat removal systems and added protective features to cope with station blackout events come to mind. Although I believe that such design features are worth considering on safety grounds, they would provide an added measure of protection against sabotage events as well. Indeed, I believe that such features have been added on some European plants based, at least in part, on their contribution to protection against sabotage. The consideration of such design features, coupled with a careful reevaluation of the sabotage design basis threat, would do much to enhance our protection against a terrorist attack.

I now want to turn to some of the other safeguards initiatives that the Commission has been pursuing in recent years. The first of these is the Insider Safeguards Rule. The Commission has had under development some of the elements of the Insider Rule since 1978, making this one of the longest-running rulemaking proceedings. There are three distinct elements to the rulemaking: an Access Authorization Rule, which would set screening requirements for nuclear power plant personnel, including background investigations, psychological assessments, and continuing behavioral observation; a Search Requirements Rule; and a set of miscellaneous safeguards-related amendments, including the vital islands concept.

By far the most controversial of these has been the Access Authorization Rule. The industry originally supported this rule, arguing that it was necessary to assure uniformity and consistency in an industry that relies on an often-transient work force. However, last year, the Nuclear Utility Management and Human Resource Committee (NUMARC) and the Edison Electric Institute (EEI) recommended that the proposed rule be withdrawn and replaced by an NRC policy statement with program guidelines developed by the industry. A majority of the commission has just acceded to this request. I continue to favor an NRC rule, although I would modify the NRC staff's proposal substantially. In particular, I am troubled by the lack of specificity in the staff's proposed rule and by the amount of prescriptive detail in the staff's proposed Regulatory Guide. I would have fleshed out the rule with some additional detail, but then I would have eliminated much of the questionable guidance in the Regulatory Guide, particularly on behavioral observation. I favored a federal regulation in this area for several reasons. First, a rule would better assure that the privacy rights of individuals are protected. Second, the appeal procedure in the rule, which is missing in the industry program, would protect the due process rights of individuals subject to the system. Third, a rule would provide a firm basis for NRC inspection and, in the case of security program deficiencies, enforcement. This is not available with a policy statement. Fourth, a rule would assure standardization and consistency of requirements throughout the industry on an important area affecting safety and security. For these reasons, I would have preferred an access authorization rule.

The Search Requirements Rule has proven to be noncontroversial, and this element of the package was approved last week. The same is true for the miscellaneous provisions, with the exception of the vital islands concept. The Commission introduced the vital islands concept in the proposed rule in an attempt to group one or more vital areas in the plant together into an area that could be protected as a single entity. This proposal generated considerable concern within the industry. In view of these concerns, the Commission decided to drop the vital islands concept from the rule and to study the matter further as part of continuing reviews of our vital areas policy.

In recent years, a principal area of interest for the Commission has been the potential adverse impact on safety of our safeguards requirements, and particularly those requirements which could restrict access to the plant and within the plant under emergency conditions. Indeed, the Commission's review of the reports on the June 9, 1985 operating event at the Davis-Besse plant provided some interesting examples of the potential averse safety impact of plant security provisions, including locked doors and access barriers. Although there were some limited attempts to address this problem in the Miscellaneous Rule Package, this is an area deserving of further careful study. I suspect that such a study will show the need to reexamine the licensees' *implementation* of our safeguards requirements more than the need to reevaluate the requirements themselves.

A further safeguards initiative by the Commission which is related to the access authorization issue is the Commission's legislative proposal to allow access by the nuclear industry to FBI criminal history information. The Commission's proposal would permit industry access to this information through a third party to be designated by the Commission for purposes of employee screening for access to a nuclear power plant. Safeguards have been built into the legislation to prevent abuse, to detect any errors in the information, and to assure fair treatment of employees. This legislation has been passed by the Senate and is pending in the House. The House Interior and Insular Affairs Committee held a hearing on the bill last month, and also seemed favorably disposed toward the proposal.

I want to end on a positive note with a few words on what I consider to be one of the Commission's most successful initiatives in the safeguards area: the control of high-enriched uranium. The Commission began this effort several years ago with a policy statement aimed at reducing the international trade in high-enriched uranium, principally as fuel for foreign research reactors. The focus of the policy was to encourage foreign research reactor operators to convert their reactors to low-enriched uranium fuel. New low-enriched fuels were then under development through the Reduced Enrichment for Research and Test Reactors (RERTR) Program being operated by the Department of Energy. However, it quickly became apparent that many foreign research reactors operators were unwilling to pursue conversion to LEU fuel unless the United States was willing to do the same. To solve this problem and to ease the difficulties in safeguarding HEU in this country, the Commission developed a rule requiring that NRC-licensed research reactors convert to LEU fuel. The Commission completed this rulemaking earlier this year by issuing a final rule requiring conversion. The Commission's rule provides that NRC-licensed university research reactors must convert to LEU fuel, subject only to three conditions. First, workable LEU fuel must be developed, and the RERTR Program is well on its way to completing this assignment. Second, federal funding must be available to cover the costs of conversion, including principally the cost of the new fuel. The Congress has already provided the initial funding for this effort. And third, conversion is required unless the licensee can show a unique purpose which cannot be met with LEU fuel. We expect very few of these unique purpose exemptions. With the adoption of the Commission's final rule, we can now proceed with the conversion process in this country, a move which should reduce substantially the potential for theft or diversion of HEU in the United States. In the interim, we have also taken steps to reduce the inventory of fresh HEU fuel supplies at our licensed reactors, and we are considering the need for further security upgrades at these facilities. I am also pleased to report that most foreign research reactor operators are making progress toward conversion, and I expect that our Domestic Conversion Rule will help assure continued progress by foreign reactor operators. I believe that the HEU conversion process is an example of what we can accomplish, both here and abroad, in reducing the safeguards risk and vulnerability at nuclear facilities. Thank you.

James K. Asselstine was sworn in as a member of the Nuclear Regulatory Commission on May 17, 1982 to serve a term ending June 30, 1987. Before his nomination by President Reagan and confirmation by the U.S. Senate, Mr. Asselstine served as Associate Counsel of the Senate Committee on Environment and Public Works since January 1981. Previously, he was Minority Counsel for that committee's Subcommittee on Nuclear Regulation from 1978 to 1981. He also served as Assistant Counsel for the former Congressional Joint Committee on Atomic Energy from 1975 to 1977. From 1977 to 1978, Mr. Asselstine was a staff attorney in the Regulations Division of the NRC's Office of Executive Legal Director, and from 1973 to 1975 was a legal intern and staff attorney for the NRC's Atomic Safety and Licensing Appeal Panel.

Problems and Progress in International Safeguards

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ABSTRACT

The paper discusses the following areas:

- *Conclusions and declarations with respect to IAEA safeguards of the Third NPT Review Conference and the US-USSR Geneva Summit*
- *Universality and credibility of IAEA safeguards*
- *The scope of IAEA safeguards: States, facilities, amounts of materials subject to safeguards*
- *The inspection workload and the new organization of the IAEA Department of Safeguards*
- *Safeguards implementation in 1985*
- *New developments in IAEA safeguards methodology*
- *New developments in supporting functions*
- *Problem areas and outlook.*

I am grateful for the invitation to address your Annual Meeting — an important event which brings together members of the small but vital species of professional safeguarders working in the national or international arena. I think it is a good practice that the head of the IAEA Department of Safeguards from time to time discusses with this audience basic problems and recent developments in international safeguards. In 1983 my predecessor presented to you a survey on basic concepts and methodology of IAEA safeguards. I intend to provide a general survey on its present status and prospects.

Let me begin with recent developments in international non-proliferation policy — the environment in which our profession thrives or suffers. You all will have learned that the Third NPT Review Conference held in autumn last year in Geneva — in contrast to the Second Conference in 1980 — was a success insofar as the States Party to the Treaty stressed their conviction that the Treaty is essential to international peace and security, reaffirmed solemnly their commitment to the purposes and provisions of the Treaty, and expressed their determination to enhance the implementation of the Treaty and to further strengthen its authority. The Conference inter alia noted with satisfaction that the IAEA has not detected any diversion of a significant amount of safeguarded material and commended the IAEA on its implementation of safeguards. It noted also with satisfaction the improvement of IAEA safeguards during a period of rapid growth of the number of safeguarded facilities.

The Review Conference, on the other hand, concluded that the nuclear weapon States should make greater efforts with respect to Article VI of the NPT — requiring a curb of vertical proliferation. Also, the summit meeting of President Reagan and Secretary General Gorbachev in November last year in Geneva dealt inter alia with this eminent problem area. The international non-proliferation regime and the strengthening of, and support for the IAEA safeguards activities also played a prominent role in their communique.

The NPT Review Conference expressed deep concern that the nuclear programmes of some States not party to the Treaty may lead them to obtain a nuclear weapon capability. They urged the States concerned to accept full scope IAEA safeguards and stated that any further detonation of a nuclear explosive device by any non-nuclear weapon State would constitute a most serious breach of the non-proliferation objective.

These declarations shed once again light on the essential role of IAEA safeguards — which has not always been properly understood, in particular on this side of the Atlantic. IAEA safeguards do not perform the function of a nuclear police but constitute a verification and warning system; it is the responsibility of the IAEA to implement this system in an effective and efficient manner. It is, on the other hand, the responsibility of the political world community to be concerned with the universality of IAEA safeguards and with the credibility of the sanctions to be expected by a wrongdoer in the case that the IAEA has to sound an alarm. I think the role of the IAEA is nowadays better understood than e.g. in the days of the Israeli attack on the Osirak reactor. Apart from some occasional sounds from Baron Munchhausen's frozen trumpet there is no doubt that the situation at Osirak was and is under control from the point of Agency safeguards. I can assure you that the famous fuel elements of Osirak which contain about 12 kg HEU are still there.

Reverting to the universality of IAEA safeguards it is

indeed disturbing to observe that there are five States, namely Argentina, India, Israel, Pakistan and South Africa, operating or having under construction unsafeguarded facilities capable of producing weapons-usable material. It is to be hoped that they will find it in their own security interest to follow the appeal of the Third NPT Review Conference and to submit all their nuclear activities to IAEA safeguards. On the other hand, four of the five nuclear-weapons States have concluded voluntary offer agreements with the IAEA covering nuclear material in some of their civilian nuclear installations. Discussions on the implementation of IAEA safeguards at certain facilities in the Peoples Republic of China are expected to start soon.

Agency inspectors are well received in all States which have concluded safeguards agreements. However, in spite of certain improvements, the efficient use of the inspector manpower available to the IAEA is still hampered by restrictions by States in respect of designation of inspectors. Improvement is also desirable in the timeliness, standardization and completeness of reports to be submitted by States to the IAEA. Finally, better State cooperation is needed in supporting the introduction of improved procedures, instruments and equipment into the field work. Here the question of liability in case of damages or losses of operator property, and operators' reluctance to invest more staff effort are playing an increasing role.

At the end of 1985 there were 130 States Party to the NPT, or the Tlatelolco Treaty, or States which submitted their nuclear activities to de facto full scope safeguards. A total of 163 safeguards agreements have been concluded with these States. IAEA safeguards thus cover about 98% of the nuclear facilities in non-nuclear weapons States. In addition 28 safeguards agreements are in force with the already mentioned five States, covering individual items which in most cases were imported from abroad.

The increase in the workload of IAEA safeguards which had been dramatic at the beginning of the decade has recently levelled off to a certain extent as a result of the decrease in nuclear energy growth rate. From the end of 1980 to the end of 1985 the number of facilities under IAEA safeguards rose from 416 to 486, ranging from small research reactors to reprocessing and enrichment plants. The amount of separated plutonium and high enriched uranium subject to safeguards grew rather slowly and reached about 9 to 12 t respectively. In contrast, the operation of many power reactors combined with a certain bottleneck in reprocessing led during this period to a considerable accumulation of plutonium contained in spent fuel from 79 t to 155 t. The amounts of low enriched uranium and source material reached about 24 600 t and 43 000 t respectively at the end of 1985.

The increase in inspection workload to which the IAEA is committed was accompanied by a certain increase of manpower. The Divisions of Operation at present include 161 inspectors and 19 inspection assistants. The total staff of the Department including non-professionals amounts to 489. The increase in staff members led to a reorganization of the Department which, after some teething troubles, resulted in increased efficiency. We have now three Divisions of Operation, the heads of which are relieved from day-to-day routine by Co-ordinators and Procedures- and Support Sections.

Operations Divisions in the last few years increased substantially the number of inspections in which NDA measurements played an increasing role; the number of facilities at which inspection goals were fully attained for the whole facility also increased. Simultaneous inspections were introduced for some facilities handling the same kind of nuclear material in order to account for the possibility of "borrowing" fuel elements from some facilities as a means of concealing diversion. The concept of unannounced inspection — the effectiveness of which is hedged by legal constraints and operational circumstances — is under active consideration; a few tests have been performed. The utilization of inspector manpower was improved through the establishment of field offices. The IAEA field office in Toronto was opened in September 1980 and the IAEA office in Tokyo was opened in July 1984. Problems to be resolved in Operations relate mainly to the improved organization of inspections such as better planning particularly of inventory verification and NDA measurements; rotation of staff among Operations Sections; and utilization of inspection assistants.

The "output" of the reorganized Department is already considerable. In 1985 a total of 7750 inspection man-days were "produced." These came from 1981 inspections carried out at about 300 nuclear installations in 53 non-nuclear weapons States and 4 nuclear weapons States. In 32% of the inspections carried out nuclear material was verified by NDA. More than 280 automatic photo and TV surveillance systems operated in the field, and 9000 seals applied to nuclear material were detached and subsequently verified at Headquarters. More than 1270 plutonium and uranium samples were analyzed. Accounting and other safeguards data comprising 561,000 data entries were processed and stored in the Agency's computers.

The sensitivity of inspection and evaluation activities may be illustrated by the fact that about 150, mostly minor, discrepancies or anomalies were found. All were satisfactorily resolved upon subsequent appraisal or investigation. The IAEA could thus state for 1985 as for previous years that no anomaly was detected which would indicate the diversion of a significant amount of safeguarded nuclear material — or the misuse of facilities or equipment subject to safeguards.

Let us turn now to a few observations on basic safeguards concepts and methodology. Governments submit their nuclear facilities to IAEA safeguards to provide assurance to other nations that they were abiding by their non-proliferation or other safeguards commitments. To give this assurance IAEA safeguards must be considered to be credible. Credibility must not only be assured under normal political conditions but also in periods of increased political tensions or in the case of special events. Credible IAEA safeguards provide the essential framework for the peaceful and viable international com-

merce in nuclear material, plant and equipment. The additional costs of an impeded nuclear commerce outweigh by far the cost of IAEA safeguards inclusive of costs to the States and operators. I think that it has been made completely clear and it seems to be generally accepted that the main objective of IAEA safeguards is the *verification* of the compliance of States with their safeguards agreements commitments. In the present political situation assurance of compliance is the normal result of verification. The specifications of goal quantities which were adopted by the IAEA following the advice of external experts proved to be viable in practice. Inspections are in general capable of attaining the inspection goals which are derived from the basic goal quantities. With respect to timeliness goals experience enabled the Agency to improve attainability by adopting the following guidelines: detection of an anomaly which may be caused by diversion of a significant quantity of nuclear material or more within.

- 1 month for HEU, MOX and separated plutonium
- 3 months for irradiated fuel containing HEU or plutonium, and
- 12 months for fresh LEU or natural uranium.

These guidelines remain in agreement with the recommendations of expert groups. The question as to which level of assurance should be guaranteed by IAEA safeguards has not yet been fully clarified. Therefore we are preparing a definition of long-term inspection criteria which we would like to implement within about ten years time, by gradually upgrading the short-term criteria now used to evaluate our inspection activities.

Effective safeguards approaches are now available for all kinds of nuclear plants presently subject to safeguards. In this connection the "Limited-Frequency Unannounced Access" model to be applied at ultracentrifuge enrichment plants is of interest. This approach, which aims at the effective inspection of sensitive parts of such plants and at the same time at the protection of confidential information, has been developed in cooperation with several technology holders. The first inspections following this concept inside the sensitive cascade areas have been performed.

Further, the development and implementation of a safeguards approach for Candu-type on-load refuelled reactors, making use of advanced automated instrumentation, is to be mentioned. This equipment is undergoing a rigorous test and performance monitoring programme. Bundle counters for spent fuel are the most important element involved.

For the first time, a heavy water production plant came under IAEA safeguards in a State in which all nuclear material are not necessarily under safeguards. A safeguards approach has been developed for this facility and it is expected that a test and demonstration programme will be implemented at the time the plant is scheduled to come into operation in 1988. This plant will not contain any radioactive material. The high sensitivity of radioactivity measurement equipment is of no use in it. Other physical and chemical methods must be used for control of the process and of the output. They are much more expensive and manpower consuming than nuclear material control measures.

In spite of the fact that no large reprocessing plant is due to come under IAEA safeguards in the near future, the IAEA has to prepare effective verification concepts and procedures for such facilities. In this respect, international cooperation continues in order to meet this challenging problem. Near-real-time accountancy is one of the promising methods in this case. We would be glad to receive further suggestions on how to safeguard properly such installations containing huge amounts of strategic material.

The development of instruments and equipment specifically designed for safeguards has been based on a very detailed analysis of the needs of the Operations Divisions and a medium and longterm implementation programme. In the field of non-destructive analysis (NDA) high resolution gamma-spectroscopy was further refined through the use of 8000 channel multichannel analyzers and improved through the use of miniaturized and highly computerized multichannel analyzers. The utilization of neutron measurement technique was extended through the development of more reliable and more specifically designed equipment.

The reliability and performance of surveillance film cameras was significantly improved. However, the production of optical film cameras — our work horse in surveillance — is fading out in the industry and we have to provide for a replacement by television cameras of at least the same reliability within the next few years. Advanced close circuit television systems are undergoing extensive testing and performance monitoring. The techniques for evaluation of surveillance films and tapes and the associated equipment have been further improved and standardized. However, the picture quality of film and television cameras still does not fully satisfy our needs especially under less than optimal light conditions. More tamper-resistant seals have been introduced and the procedures for controlling their use have been upgraded. The procedures for the speedy and problem-free shipment of samples taken by IAEA inspectors in the field to our Safeguards Analytical Laboratory (SAL) near Vienna are continuously being reviewed and improved. You will understand, for instance, that the transport of plutonium creates acceptability problems in many countries. Therefore, special containers for the air transport (PAT-2) have been developed.

Permit me to mention a few problems of international safeguards and of the general development of nuclear technology for which we seek to develop solutions. We could not solve these problems alone since sufficient expertise for the numerous tasks is not available to us from our own staff. Therefore the existing eleven support programmes which help us in developing new methods and instruments are of vital importance for the continuation and strengthening of credible safeguards. The US Support Programme is the most extensive. The Department of Safeguards, however, must ensure that the required development work or training is proposed to the support programmes in an operational and com-

prehensive manner and that the effective coordination of the several programmes is guaranteed. The IAEA has made significant progress in this respect.

The proper balance between safeguards confidentiality on the one hand and more transparency of Agency safeguards on the other continues to be under discussion. We plan to tackle this problem by means of improved statements (90(a) and 90(b) in terms of INFCIRC/153) by which we would inform the inspected States in greater detail on the results of the inspection activities which were performed. The combination of improvements to be introduced should make it easier for each State receiving 90(a) statements to predict the expected conclusions of the 90(b) statement and to evaluate goal attainment for the whole State as recorded in the SIR on the basis of the 90(b) statements. In this respect it would be a great help if States were to classify as "safeguards confidential" as few as possible of the data and information submitted to the Agency. The security efforts for ensuring confidentiality are considerable and grow with the increased use of electronic data processing.

Many new possibilities of rationalization and improved quality assurance arise for safeguards from the rapid development in electronic data processing, but management is faced with a corresponding number of problems such as the monitoring and quality control of data files, the quality of the software used, the tamper proofing of transmission cables, tapes and disks, etc. Furthermore, very safeguards-sensitive bulk-handling facilities are beginning to become fully automated and equipped with remote control for reasons of radiation protection and safety. Such facilities need new safeguards approaches, increased installation of safeguards instrumentation in process lines — which poses liability questions — and increased reliance on operators' data.

The surveillance of rapidly growing quantities of spent fuel in underwater storage ponds and recently in long-term storages, especially their long-term sealing or reverification in case of surveillance failure, require new methods and increased human resources which can hardly be found under financial zero-growth conditions. This also applies to the increased use of fresh fuel elements containing recycled plutonium and to fuel assemblies which can be dismantled to permit the exchange of defective fuel pins and later a compact storage of pins in long-term storages.

It is evident that this rapid and comprehensive change in inspection activities requires an intensified training not only of new but of all inspectors. It is not always easy for older inspectors to follow these developments since some of the subjects which are important today had not even been taught during their studies.

The safeguards activities of the IAEA are presently confined to verification in the area of horizontal proliferation and the IAEA is the only organization which has experience in establishing and operating an international inspection system covering sensitive materials and facilities. The time is near when the question should be asked whether this experience could be profitably utilized within the framework of disarmament related agreements hopefully to be concluded in the not too distant future. Let us consider e.g. an agreement for the "cut-off" of the production of weapon grade material. The scope of such an agreement could extend to the verification of existing stocks and the verification of compliance with agreed limitations in the operation of production facilities including the verification that facilities which are shut down pursuant to the agreement remain shut down. Technically speaking, this task lies within the framework of the present IAEA safeguards concept. There are, of course, certain difficult technical issues, e.g. the size of stocks or the throughput of huge bulk-handling facilities, but they do not seem insurmountable. The IAEA could transfer its experience to any bi-or multilateral verification system or it could itself be entrusted with this task. A possible first step could be the extension of the present voluntary safeguards agreements concluded with nuclear weapon States to their whole peaceful nuclear fuel cycle; a second step would be the extension to all nuclear facilities.

Verification at specific facilities should not be confused with ensuring that all the facilities and nuclear material as defined in the respective agreements actually have been submitted to safeguards. It is difficult to imagine how an international (or a bilateral) inspectorate could cope with the latter task. This problem would have to be dealt with by special arrangements between the parties. A concept which has been provided for in the Tlatelolco Treaty, namely "challenge inspections" to be carried out by the inspectorate upon request by one party, could be of interest in this respect.

The experience gained through IAEA safeguards is not limited to applications in the nuclear field. Containment and surveillance techniques, perhaps combined with the "RECOVER technique", could prove useful in various kinds of verification situations where assurance must be obtained that any change in a given set of conditions would be observed, recorded and reported.

Returning to more immediate issues I hope that I provided you with some information of interest on the status and prospects of IAEA safeguards. After a period of vigorous development and growth we have entered a more quiet period of consolidation and overall step by step improvement of the quality of our work and its efficiency as well as a period of preparation for the tasks which will face us in the future. Your continuing support is both needed and welcome and will be matched by the Agency's gratitude and continuing service to the international community.

Peter M. Tempus has been Deputy Director General for Safeguards for the International Atomic Energy Agency since 1983. Prior to his appointment to that post he was Scientific Advisor to the Board of the Swiss Federal Institutes of Technology in Zurich, and prior to that he was Deputy Director for the Swiss Federal Institute for Reactor Research, where he began as a Group Leader. He holds a Ph.D. in chemistry from the University of Berne, Switzerland.

Nuclear Energy — Moving Ahead with Confidence

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ABSTRACT

This presentation is a synopsis of action underway today to revive the nuclear power generation option in the United States. The Electric Power Research Institute (EPRI) working with U.S. utilities, the nuclear industry, and the U.S. Department of Energy is developing Advanced Light Water Reactor (ALWR) concepts which can become a truly viable candidate for the 1990's and beyond. Both the development program and the design concepts will be addressed.

As envisioned by EPRI, the Advanced Light Water Reactor will effect even further improvements on the safety performance of current plants. It will be significantly simpler in all respects, and of robust design with inherent capability to accommodate adverse situations. Its design will be based on proven technology, building on the successful experience of the past quarter century.

To be viable, the ALWR must be demonstrably safe, reliable, and economically attractive in comparison to its competitors. It is the objective of the ALWR program to produce a design basis on which all involved — including utilities, regulators and public — can proceed with confidence.

My task is to present a perspective on the future of nuclear generated electrical power in this country, from the viewpoint of the electric utility industry.

Certainly, today's picture is not encouraging. There have been no new nuclear plant orders in the past ten years. A number of plants planned or under construction have been cancelled, and others have been plagued by construction delays, licensing difficulties, and resultant cost overruns. The accidents at Three Mile Island and, more recently, at Chernobyl, have aggravated public uneasiness about nuclear plant safety.

Just as clearly, however, there is another side to the issue. Without question, there will be a continuing and growing need for electrical power in the nation and worldwide. Our available electricity generation alternatives are limited and imperfect. But among those imperfect alternatives nuclear energy stands out as one which has served us very well indeed for over a quarter of a century. In fact, it has been an outstanding electricity producer, by all objective measures of public health and safety, environmental compatibility and cost. The challenge then is clear: we must build on our successes and learn from our mistakes, and make available an even better nuclear generation option for the next decade and beyond.

Toward that end, the Electric Power Research Institute (EPRI) has established an Advanced Light Water Reactor (ALWR) Program to provide leadership to utility industry efforts to revive the nuclear power option in the United States. Let me describe to you the scope and structure of the EPRI program, our vision of the main design characteristics of the ALWR, and our thoughts about how the conceptual work now in progress can lead to the construction of an actual power plant.

As a first step, in 1983 EPRI embarked on a major program of regulatory stabilization, working with the Nuclear Regulatory Commission to identify and resolve key issues related to the licensing of light water reactors. In 1985, two additional major program phases were added: the development of a comprehensive set of requirements applicable to the advanced light water reactor design, and the assessment of small plant options. This three-pronged effort is being managed as a single major EPRI program involving extensive U.S. utility input and guidance, and incorporating the efforts of a broad spectrum of industry contractors. The EPRI ALWR Program is planned as a five-year effort with completion in mid-1989.

In EPRI's view, if the advanced light water reactor is to achieve its overall goal — that is, to be a viable candidate for selection by U.S. utilities to meet their capacity addition needs in the next decade — it must meet the following tests:

- *Technical Excellence* — The ALWR must be an outstanding power generation system in all respects, including safety, technical performance and environmental capability.
- *Economic Advantage* — The ALWR must be economically attractive in comparison to its competitors on a life-cycle cost basis.
- *Investment Protection* — The ALWR must provide very high protection of the utility investment, par-

ticularly in terms of:

- extremely low risk of severe accident
- assured licensability
- predictable construction cost and schedule
- predictable operating cost and plant availability

Based on those top-tier objectives, and taking into account extensive input from U.S. nuclear utility companies, the following set of fundamental philosophies have been established to guide the development of the ALWR requirements and conceptual design:

• *Safety*

Nuclear safety is of paramount importance and must play a dominant role in the development of ALWR requirements. While the safety record of existing U.S. nuclear plants has been outstanding, ambitious safety targets have been established for the ALWR to achieve an even higher level of safety. All aspects of ALWR development are being pursued with highest emphasis on safety.

Safety considerations in the ALWR Program extend well beyond hardware-oriented "lessons learned" from existing plants. Thorough attention is given to man-machine interface, plant simplification, design margins, and appropriate risk assessments as means of achieving meaningful and measurable improvement in nuclear plant safety.

• *Simplicity*

There is consensus that the growing complexity in U.S. nuclear plants is adversely impacting those plants in virtually all respects, including safety, initial capital cost, operating cost, availability, operability, and maintainability. For that reason, a very high premium is being placed on simplification as a fundamental means of achieving ALWR Program Requirements.

The development of ALWR requirements presents numerous opportunities for nuclear plant simplification compared to current vintage plants. Among these are the development of systems which are more straightforward (and therefore understandable and predictable) in operation, more reliance on passive safety characteristics, improved accessibility for maintenance and operation, and less complex piping and valve configuration (made possible by reduction of required modes of operation of a given system).

• *Design Margin*

As a design philosophy related to simplicity, it is intended that the ALWR be a "robust" plant with substantial built-in margin to provide inherent capability to deal with adverse situations. This approach is reflected in requirements such as those for improved core thermal margin and larger reactor coolant system inventories, compared to current vintage nuclear plant designs. Such features provide direct benefits in terms of reduced demands on man and machine under off-normal conditions.

• *Reliance on Experience*

The ALWR design is to be based on proven technology; its success must not depend upon yet untested technological advances. This concept is a reflection of the extraordinary data base available from many years of successful operation of light water nuclear power plants in the United States and worldwide. Design concepts, analytical methods, and hardware specifics have been refined to the point that there now is a demonstrated success path in virtually every aspect of plant design. While continuing development of new concepts is important over the long term, departures from proven technology are not considered to be necessary to support ALWR deployment in the 1990s time frame.

To the extent possible, judgments regarding plant experience, and resultant ALWR design choices, will be based on evaluation of statistical data from the Institute of Nuclear Power Operations (INPO), utility owners' groups, the Federal Government, and other recognized sources.

It should be noted that reliance on proven nuclear plant technology does not preclude application of available technological improvements from other sources. Where existing power plant experience warrants consideration of such improvements, this will be done. Incorporation of design features proven in comparable but not identical applications as the ALWR may be appropriate in some cases. These cases will be evaluated based on factors such as potential benefit, available experience base and similarity to ALWR application, consequences of failure, and available alternatives.

• *Utility Focus*

The Requirements Document is written by and for utility companies which own and operate U.S. nuclear stations. Theirs is the bulk of experience on which to base ALWR design requirements, and they must make the selection of future electricity generation systems. Most importantly, plant owner/operators bear ultimate responsibility for the safety and performance of their plants to the public, their customers and their stockholders. For these reasons, EPRI is working very closely with utility companies in the planning, preparation, and approval of the Requirements Document. A Utility Steering Committee of experienced utility company executives has been established to guide actively the Requirements Document effort and to serve as an interface between EPRI and the utility industry.

As I noted earlier, elimination of regulatory uncertainty is one key element in ALWR acceptance. The U.S. Nuclear Regulatory Commission (NRC) is directly involved in the ALWR Program, primarily through the regulatory stabilization effort wherein the utilities are working with NRC to identify and resolve outstanding ALWR licensing issues. This effort is closely linked with the Requirements Document preparation, and the results are being incorporated in each Requirements Document Chapter. Also, it is planned that NRC will review the Requirements Document and will prepare and issue a formal Safety Evaluation Report (SER) upon its completion.

Based on the approach and design philosophy I have just summarized, EPRI, the utilities, and ALWR contractors are now beginning to develop specific requirements for the ALWR.

In our view, the ALWR plant can be either a pressurized water reactor (PWR) or a boiling water reactor (BWR). Use of either of these proven technologies is consistent with the design philosophy of reliance on experience.

The ALWR plant can be of any size up to 1350 MWe, again consistent with existing experience. Depending on circumstances, plants at either end of the size spectrum may be attractive to utility investors. For utilities with a need for large capacity additions, a single large (900-1350 MWe) unit offers significant potential benefit in terms of economy of scale. For other utility systems, smaller plants may be preferable because of lower capital cost and better matching with capacity requirements.

The ALWR Requirements Document covers an entire standard plant including all interfaces with its environment and with the utility electrical grid. This is based on utility experience that many existing problems stem from inadequate integration of nuclear and non-nuclear portions of the plant.

Specific, quantitative target requirements have been established for ALWR safety, availability, plant life, radwaste production, radiation exposure to personnel, and life cycle cost. Additional guidelines have been established with respect to ALWR constructibility, operability, and maintainability. The ALWR Requirements Document preparation has been structured into thirteen separate sections or chapters, each of which will address specific system and component requirements and other plant features necessary to achieve the overall ALWR goals.

Preparation of the ALWR Requirements Document is an early step in the development of a new generation of nuclear plants for the 1990s and beyond. While the exact chronology of events leading to commercial operation of the first ALWR cannot be predicted, an overall sequence is envisioned which would lead from generic ALWR requirements (the Requirements Document), through NRC certification of several NSSS designs and the subsequent development of at least one detailed standard plant design and finally to the design, construction, and operation of the first ALWR.

We envision that a design team would be established including utilities, plant designers, and constructors to develop a standard ALWR design conforming to the Requirements Document and the NRC certification. The design must be taken to a very high level of completion to ensure confidence in cost and schedule projections. It is estimated that at the completion of the standard plant design, 70% of all the engineering documents will have been completed, so that the ALWR plant procurement, construction, and site-specific engineering could proceed unimpeded.

A major element in this detailed design effort is the specification and selection of plant equipment, including the production of vendor engineering information by the equipment suppliers and incorporation of that information into the design.

The exact genesis and structure of the standard plant design team cannot be foreseen. It is clear, however, that with the very high level of design completion and the extensive utility interaction required, such a standard plant development will demand a major commitment of time, talent, and money by the utilities, architect/engineers and constructors alike. It may well be that a group of utilities with the necessary interest in and experience with LWRs will band together to fund and direct the effort.

Based on the standard design, the site specific engineering and licensing would proceed, leading to the commencement of site preparation and actual plant construction. For the first ALWR, the construction and start-up phases are estimated to require 54 months (from first structural concrete to commercial operation). While such a schedule represents major improvement over recent U.S. nuclear construction experience, it is considered achievable and realistic in light of nuclear construction accomplishments in other countries, along with the ALWR requirements (e.g. constructability, simplicity, high degree of design completion) which will facilitate its construction.

In summary, the development of an advanced light water reactor is an ambitious undertaking, yet one which is firmly rooted in technical reality. The ALWR Program is defining a credible nuclear plant design basis on which all involved — including suppliers, investors, regulators, and the general public — can proceed with confidence.

Jack DeVine is the Program Manager for the Electric Power Research Institute's (EPRI) Advanced Light Water Reactor Program. In that position he manages the development of utility requirements and design concepts for advanced, simplified nuclear power plants for the 1990s and beyond. Mr. DeVine graduated from the U.S. Naval Academy in 1965 and, as a naval officer, served in construction and operation of nuclear submarines. In 1970 he joined the General Public Utilities Corporation, Parsippany, New Jersey, and held a variety of technical and managerial positions involving nuclear plant design and construction. In March 1979, following the accident at GPU's Three Mile Island Unit 2, he was sent to TMI-2 to assist in the emergency response work at the plant. He continued to have a major role in the TMI-2 recovery work, serving as Recovery Engineering Director and later as Technical Planning Director. In these positions he directed engineering and planning activities related to waste management, decontamination and defuelling of the damaged plant. He was assigned to the EPRI ALWR Program in January 1986.

Nuclear Safeguards: Maintaining the Balance

The following forum was conducted during the 27th Annual Meeting of the Institute of Nuclear Materials Management in New Orleans, Louisiana, U.S.A. Three Plenary Session speakers agreed to further discuss and elaborate on their presentations, the texts of which are included in this journal. It is the sincere hope of the Institute that an annual round table discussion on the technological and political environment for nuclear materials management and safeguards, with national and international leaders as well as representatives from the scientific community, might open the door to improved understanding, cooperation and further dialogue.

James K. Asselstine
Commissioner, U.S. Nuclear Regulatory Commission

Edward V. Badolato
Deputy Assistant Secretary for Security Affairs, U.S. Department of Energy

Peter M. Tempus
Deputy Director General for Safeguards, International Atomic Energy Agency, Vienna, Austria

William A. Higinbotham
Brookhaven National Laboratory, Upton, New York; JNMM *Technical Editor*

Eugene V. Weinstock
Brookhaven National Laboratory, Upton, New York; JNMM *Book Review Editor*

Nancy Trahey
New Brunswick Laboratory, Argonne, Illinois; INMM Publications Committee Chairman

Charles Pietri
U.S. Department of Energy, Argonne, Illinois; INMM Meeting Technical Papers Committee Chairman

William A.Higinbotham: Mr. Badolato, you talked this morning about the Cerberus effort which is going on at the present time. I thought that in addition to what you said this morning it might be of interest to say a few words about how the Department of Energy came to take this on, and in what respect does this differ from previous reviews which have happened at the department, and just what do you hope to accomplish by November of this year — when Cerberus is supposed to terminate formally?

Edward V. Badolato: Last year Secretary Herrington, as he was coming on board, was concerned about the overall status of safeguards and security. He put together a team of outside experts, which I headed. At the time I was an active duty Marine Colonel. It was a pleasure to have his confidence in me to do a comprehensive study of DOE's safeguards and security situation.

We went everywhere, lived out of a suitcase for a few months, and came back and reported to him that the

overall status throughout the department was satisfactory; that any adversary that attempted to gain control of or steal any weapon or special nuclear material would have a high probability of failure. However, there were some strong management actions which were required and we wrote the Special Project Team Report which we submitted to [Secretary Herrington] on 1 September. He approved that report and its 94 recommendations and directed that a plan of implementation be done.

The plan of implementation for those 94 recommendations is Operation Cerberus. Operation Cerberus, as many people know — especially from your organization, it seems like half the people in the room during the Plenary Session are working on it — is divided into nine major functional areas of safeguards and security, training and planning and R&D and MC&A and so on. In putting this project together we have really, literally, taken hundreds of scientists, engineers and contractors from the department, supporting laboratories and our contractors to support this effort. It is a large, massive operation that differs significantly from other efforts in that it has the personal interest of the Secretary, who is briefed quarterly on its progress, and the Undersecretary is briefed on it as well. Each of the committees has really firm milestones and we have a specific agenda. Unlike other committees, we had a mission. We have a clear directive from the Secretary, and we have set a deadline of November 1986 for all these programs to come to fruition. So, in sum, it is a large, department-wide effort taking place throughout the country — a large horizontal effort; it has high "viz" at the top leadership of the department, as well as a deadline when the actions and implementation plan are to be completed. We're not waiting for 1 November to implement these actions. Many of them are far along right now, such as our human reliability program, security awareness, physical security and so forth.

WH: Let me jump to an entirely different subject. One area you only touched on lightly was the United States support for the International Atomic Energy Agency. The main program of course is the POTAS program which the Department of Energy operates. In addition to that, the Department of Energy, Office of Safeguards and Security in particular has a supplemental program. I would like you to describe what the distinction is, and to what extent that's considered important at your level.

EB: We are the manager of the POTAS program of international safeguards, R&D and training. That program runs roughly $5.7 million right now. In addition, we have our own program that we manage for ourselves, and that runs an additional $5 million. In nonproliferation and our duties in international safeguards, we have not only statutory but also some regulatory responsibilities which get into tech transfer and things of that nature. These activities come together under me in security affairs in an effort to look at and support nonproliferation. As such, we feel that it is a very synergistic operation to support IAEA in this area as well as to work very closely with the IAEA in other areas of nonproliferation.

WH: I want to ask a question of both you and Mr. Asselstine that goes back to when the Atomic Energy Commission was broken up and two different agencies were set up. The arrangement was for domestic safeguards and safety, but in this case I'm more interested in the safeguards than the safety point. The basic R&D would be done by what's now the Department of Energy, confirmatory research by the Nuclear Regulatory Commission. I just wondered how this is working out. I think it's kind of a difficult arrangement to work effectively.

James K. Asselstine: I guess my own perception is that the arrangement has not worked out badly. The line is somewhat fuzzy, and how you define confirmatory research has always been a difficult job for the NRC. But my sense in the safeguards area is that the level of cooperation and exchange of information has been quite high and there has been a close working relationship between the NRC and the Department of Energy. By and large the program has worked well. I have not seen evidence of major disputes or overlaps in terms of research efforts that we have to support the safeguards program. I would say that the comparability study that we've now embarked on as a joint effort is an example of how the two agencies have worked fairly closely together in the past several years, and certainly since the NRC and the Energy Research and Development Administraiton, DOE's predecessor, was established, we have been able to maintain a program that has some coherence and consistency to it. I suspect that if anything, the one agency that both of us should concentrate on working somewhat more closely with is the Department of Defense. They're key players in all of this too. They have some expertise and some knowledge that I think perhaps we ought to work together on to draw more benefit for both our safeguards efforts. But I'd say that between DOE and NRC the working relationship in the safeguards area has been good and effective.

Eugene V. Weinstock

Eugene V. Weinstock: Mr. Tempus, the IAEA has often been criticized in the U.S. for what is regarded as excessive secrecy about inspection procedures and findings. Do you think that this preoccupation with confidentiality conflicts with the goal of providing assurance?

Peter M. Tempus: To some extent no doubt, it does. But the Agency is an assembly of member States, and the Secretariat is that part of the Agency which has to do what the States wish to have done. So it is not up to the Secretariat to define what is confidential, what is not confidential. We are told relatively clearly by the member

States what we have to consider and what we have to handle as safeguards confidential. No doubt there is a certain range of flexibility we can use. But in the most important parts — information which could help to increase credibility of Agency safeguards — our hands are tied. The main piece is the Safeguards Implementation Report, and here, as you know, the Board of Governors has decided that it should not be an external working document. Recent discussions, not at the last Board meeting but before, clearly indicated that the majority of Governors did not wish to have any changes. I know that the United States is a society that is very interested in having everything open and accessible, but decisions affecting the Agency must rest with the member States.

EW: The Chernobyl accident came up a number of times this morning. Since that accident there has been considerable pressure on the Agency to expand its safety activities. Will this draw resources away from the safeguards activities?

PT: No it will not. The resources will be additional ones. The safeguards budget in fact is in a way a separate budget. It does not show up that way in the budget documents of the Agency, but the scale of assessment is different from the rest of the Agency's budget and there are yearlong discussions on a new scale of assessment for financing safeguards. We are working by consensus in the Board, and though the developing countries are contributing not more than about 2.5 percent to the total safeguards budget, agreement could not yet be reached with them on proposals so far considered.

EW: You mentioned unannounced inspections in your talk. Under what circumstances could and would they be carried out, as a practical matter?

PT: Well, as a practical matter they are carried out in centrifuge enrichment cascade areas. Here there is a very clear procedure of how such unannounced inspections are completed, announced at the last moment, and how they are conducted. For the rest you must be aware that unannounced inspections are a difficult issue. Many countries issue visas only for one visit for an inspector. So to make an unannounced inspection in such a country is an impossibility. And even if a country gives visas for a certain time, if an inspector arrives with a passport clearly telling the airport and customs authorities that he is an inspector, by the time he arrives at the plant the effect of a real unannounced inspection would be nullified. I do not see any real hope to change this very much. In addition, an international inspector is not allowed to travel around a country or to visit a facility without being accompanied by a representative of the national authority. Another element is that even if the inspector would just show up one morning at a facility and say, "Well, now I wish to see you books," the operator will tell him, "Well that is fine, you can see my books, but the books are not closed. I did not know that you were coming. Come back tomorrow or in two days when I have [closed them]"

EW: This may be interpreted as a very combative question. It comes to mind in connection with the improvement in physical security in DOE facilities and because I work at Brookhaven where we have very little in the way of national security research going on. We do mainly basic and applied research — civilian research. Yet we see an enormous increase in the number of guards — I think there are about 70 or 80 — walking around in black SWAT uniforms and carrying automatic weapons. Frankly, some of us find that a little scary. Mr. Badolato mentioned this morning that DOE has already spent several billion dollars over the last few years improving physical protection at DOE facilities, and will spend more. If NRC adopts Mr. Asselstine's suggestions for similar improvements, the cost in the licensed sector will probably be far greater because there are many more power reactors than there are production reactors.

The interesting thing about all of this is that there is not a shred of evidence that the kind of terrorist threat to nuclear facilities against which these measures are designed to protect us actually exists in the U.S. And then we have the safety impact. As Mr. Asselstine has pointed out, it may be high. There are for example, rumors that two people have already been accidentally killed at DOE facilities by guards. Since no one at DOE or NRC facilities has been killed by terrorists so far, it can be argued that some of these security measures and procedures are a greater threat to safety than the terrorists they are designed to protect against. Someone characterized U.S. response to a virtually non-existent domestic terrorist threat as bordering on paranoia. Would you care to comment on this?

Edward V. Badolato

EB: I would love to comment. First I should make very clear that when you talk about a non-existent terrorist threat in the United States the FBI is well aware of various groups — groups which run the entire gamut from Hispanic groups such as the Machateros of Puerto Rico to the M-19 organization in the New York area — that have committed cold-blooded murders and terrorism against Brinks trucks. Also, authorities just recently found a garage in the East that a terrorist group had rented where hundreds of pounds of explosives were stored. When we say there's not a shred of evidence of terrorism I point to the recent situation where a school was firebombed by members of a fundamentalist group in Arizona — a group who by any definition of terrorism was a terrorist group. We have these groups spread all over the country, some of which are not really thought of as terrorist groups by the public, but they are terrorist groups.

We have had 148 bomb incidents in the New York greater metropolitan area, which doesn't reach quite to Brookhaven Lab, but it's close enough. Terrorism in New

York is so bad that the NYPD has formed a counter-terrorism outfit with 140 men. The FBI is really doing a good job with the assets and the people that they have. But please be aware that there are dozens of dangerous groups in the country, and that we should knock on wood that they haven't started coming over from Europe yet. The first time we bomb a Shi'ite Temple in Lebanon or we hit Iran or something like that, it's going to be "Katie bar the door!" regarding a rise in foreign-inspired domestic terrorism.

We know that in many areas of the U.S. these domestic terrorist groups have anti-government inclinations. And, it should be considered that the most significant demonstration of our government in various areas are the nuclear facilities. So consequently when we talk about Brookhaven and its campus-like atmosphere and the desire to maintain the ambiance of a campus, we certainly are for that; but ambiance should be appropriate with appropriate security. We have taken steps to ensure that laboratories that do not have a significant defense mission, such as Brookhaven or Argonne, are looked at very closely to ensure that the protective measures we have are adequate for the threat — which may be a lesser threat than we have at very specific, highly visible defense-oriented facilities.

Your comment about the number of guards is interesting. We have done some very, very thorough analysis on the particular threats involved, such as what we have to protect and the vulnerabilities of what we have to protect. We have arrived at the numbers that we feel are adequate and we have tested and run systematic field tactical operations to ensure the right numbers of guards are properly equipped and have the right training. The black suits that you see are suits which are used by law enforcement tactical teams around the country. They're fire proof and they have a particular reason for being that way. We wish that they were less alarming to the scientists, and we're working on that.

Which brings me to the other point: We have to understand why we have to have the level of security; to gain the cooperation and understanding of the professional laboratory workforce, have an education program, a security awareness program so that people understand, and to squelch rumors that allegedly guards killed several people. We have not had guards kill several people or anybody for that matter. The last fatality that we had involving any of our guards was over two years ago when anaccidental [gun] discharge resulted in the fatality of one of our guards at a Western facility. We are proud of our safety record and the professional training of our protection force.

Additionally, I feel it's important to understand that we set the level of security through agreements with each of our facility managers and contractors or labs. In fact, we have recently signed a security agreement with the people out at Brookhaven. This master safeguards/security agreement is an agreement between the laboratory and the Chicago operations office and the Department of Energy saying how much security is enough, and it describes what is an adequate standard of security for the lab so that we don't have overkill, yet we have the proper types of security for a nondefense-oriented lab.

JA: I'd like to add just a couple of comments to that. I agree with what Mr. Badolato said about the risk and potential threat that we face. I think there is another element that you can add in that can't be discounted entirely. That's the potential for state-sponsored terrorism from overseas. Whether that is an imminent threat or not, I think it is something for the longer term that we simply can't ignore. Having said all of that, you have to give the FBI and law enforcement authorities credit in this country. Terrorism does seem to be on the decline. The FBI does seem to be quite effective in dealing with it. But an important consideration is that we have to recognize or should recognize that these systems may not be perfect and if a threat does arise in the future we may not have advance warning or at least much advance warning.

Some of the areas of concern that I identified this morning and that the Commission has been focusing on are areas where it might take a while to develop some effective preventative measures. Do we want to wait until we have a clearly identified threat or do we want some reasonable improvement and relatively inexpensive steps early on, just to be in a position of being prepared? Some caution and some conservatism are worthwhile. I agree very much with your concern. I think we ought to focus in very careful detail on how our licensees have gone about meeting security requirements because I think in some respects they do have an adverse impact on safety. I think that that's fine tuning the system. By taking a careful look at what is there and identifying safety concerns and correcting them, we can minimize the potential adverse safety impact of meeting security requirements.

As I visit plants around the country I see a wide variation in the manner in which our licensees have chosen to meet our security requirements. Some are much more effective and much less intrusive on the day-to-day operations of the plant than others are. It's time to take a hard look at those that were very successful and find out what the lessons are, and then spread that word to those that have been less successful. There are ways to meet the security requirements in a manner that will not have a negative impact on safety. Prudence and care in identifying potential areas of weakness, followed through

James K. Asselstine

with reasonable, prudent, preventative measures to avoid potential problems, coupled with careful attention to the potential adverse effect on safety would do a great deal both to improve our safeguards preparedness and prevent any negative impact in the case of an emergency at one of

the plants. We ought to pursue both together.

WH: This suggests something to me regarding our focus entirely on protection against the insider and the outsider: The fact is that if a facility is designed in such a way that it's very difficult to commit sabotage, or it's very difficult to steal material because it's not in a form that's easily stealable, then there is plenty of time to interrupt the operation. In addition to that, it seems to me that it's very important to consider the contribution that can be made in the case of an emergency by the non-safeguards people. That is, by the operators themselves. It reminds me of the old question: Which way do your guards run when the fence is breached? If you say, "They head for the breach in the fence," well, you shouldn't do that. You should head them for the vault where the stuff is, and also get the guys in the vault to lock it up. I just wondered if your people are thinking about that broad issue. How do you integrate all of these things?

William A. Higinbotham

EB: We are thinking of the integration of both safeguards and security, and we naturally have to work very closely with our safety people. As a matter of fact, a large component in Operation Cerberus is our insider program. That involves us in being sure we have proper security measures taken regarding the insider threat. An interesting aspect of our recent tactical exercises considering the insider is just the question that you asked, Willie. It's very important to think in terms of initial exercises in this area. It is difficult for some of the security forces to actually comprehend that people are inside trying to fight their way out. They're so used to the counter-offensive with people fighting their way in. The other tactical maneuver that we have found is that whenever something starts to happen and it looks unusual we go into immediate and complete lockdown procedure in our most sensitive areas.

EW: Could you explain that?

EB: Vaults, access rooms, doors, passageways leading in and out and so forth are all put under very, very, very heavy surveillance and security with various types of access going on in there. Lockdown procedures are a very, very effective way to deny any type of an insider movement in or around the sensitive areas in the time of crisis. He may get locked in or be refused access to a vault, but it's a very, very effective way for us to protect our facilities when we're really not sure what's going on and we're trying to sort out the tactical situation. By comparison, the prior strategy of protecting peoplefrom coming in from outside was very simple. Now, with lockdown, we can sort the situation out. It has been very effective in our tactical exercises.

JA: From the commercial side, I suspect that this may be one of the areas where we have some lessons to learn by looking at what DOE has done in recent years. I'm not sure that the NRC has done enough in this area. How does one respond to a terrorist event or a sabotage event? How does one deal with the insider problem, particularly in the major fuel cycle facilities? I think that's an important aspect. Even on the previous question, I think that training is an area that probably deserves a fresh look on the commercial side. Are the guard forces being trained so that they do respond in an appropriate manner? I share some of the same concerns, Gene, that you expressed earlier. That is, to make sure that the guard forces respond properly and that the use of guard forces doesn't lead to an improper use of deadly force. In the commercial side, because such heavy reliance has to be placed on commercial guard companies, that is an area that deserves some effort and attention.

EW: Has an effort been made by NRC to explain the shoot-to-kill issue to the guards? I imagine that's one of the most difficult areas for the NRC to deal with.

JA: It's a very difficult area and I would have to say that at the present time it is somewhat unsettled. That's why I identified in my speech this morning a look at comparability. This question of use of deadly force is one that we in particular need to pay attention to. The guard forces in the commercial plants are in a difficult position. They are largely or often contract forces and this question of appropriateness and use of deadly force has to be looked at carefully. Right now there is some real uncertainty and inconsistency within the commercial program.

EB: We feel very confident about our program. We have a policy, we have a rule clarifying that our contractors have the same authority as the former Federal Guards under the Atomic Energy Act. We have sent mobile teams from our central training academy to train every guard force in the country. We question our guards on it, we constantly look at our training for it. We test guards on our inspections and we feel that everyone understands the policy on using deadly force. It has been a very, very contentious issue within the staff legal community, but the issue has driven us to be very professional in our approach. We feel that the uncertainty and inconsistency is well behind us.

Nancy Trahey: To what extent are you utilizing the developing police department counter-terrorist organizations that you mentioned earlier? That would seem to be an important back-up force for facility security.

EB: Whenever it's possible we do. For example, at Brookhaven the Suffolk Police Department is a backup response force. But out west sometimes you have three deputy sheriffs to cover 100 square miles. That's not much of a response force. We have certain laws against using the military that grew out of the post Civil War period which prohibit military use unless we have an emergency and it's approved by the President. But we try to use any outside assets that we can. It makes sense, it saves us money, and it also provides a better coordinated

operation.

We're making our facilities very, very strong at DOE in a security sense. However, we are not doing this to try to push [terrorists] over to the NRC regulated facilities. But, it is a fact of terrorism that they will go after the softer target. This is why we are getting together to talk about comparability: so that the nation's nuclear facilities have a common dialogue. If we are both guarding essentially the same type of facility, even though one is defense and one is civilian, there should be some commonality in the way we look at the problem. We must search and work together for commonality and common ground in training and operations and security for the good of our national security.

EW: I have another question for Mr. Tempus.

PT: The U.S. issues are of much more interest to you *(a wry laugh).*

EW: Not necessarily. *(General laughter).* You also mentioned this morning the possibility of the agency getting involved in the verification of a freeze on the production of fissile materials for weapons. Are there not possible risks to the Agency from being injected into an area of contention between the superpowers?

Peter M. Tempus

PT: Yes, no doubt there is a certain danger. The message I wished to convey was more that we are willing to offer our experience. Frankly, I do not expect that the big powers would come to the conclusion that an international organization should oversee any cutoff agreement. But we do not exclude it. We are offering our services, we are offering our experience. We are aware that there is, especially in the United States, much more experience already on the national level. In this respect we cannot add very much. International safeguards have some special aspects which quite often are not seen by national bodies. But the main point is that the national authorities and the big powers know that we, an international organization, wish to help where we are asked to help. That's all.

EW: In a recent book on IAEA safeguards by David Fischer and Paul Szasz [*Safeguarding the Atom: A Critical Appraisal*], the designation and accreditation of inspectors is identified as a serious problem: delays, limitation of choices and so on. Do you agree that this is a problem, and if so what steps are being taken to solve it?

PT: As you know, an international organization can do something only through negotiation. We have no power to impose our will, and what we have done over the years is to inform the Board of Governors that designation is a problem and that we are losing quite a bit of efficiency and effectiveness by this fact. Now, in addition, the Director General has recently sent an urgent letter to all member States in which safeguards problems resulting out of this are explained once more. The letter is asking for help and understanding.

The first reaction in the last June Board meeting was positive. We also see *de facto* actions taken by some States. Now I do not wish to overemphasize these first signs of better understanding and better cooperation. On the other hand, as I said this morning, there has been some improvement in the understanding of international safeguards in non-weapon States over the years. They have now much more a feeling that it is in their own interest that there should be no horizontal proliferation and that it is in their own interest that there should be unhampered nuclear commerce and provision of fuel and nuclear material and components.

WH: I think that what makes it so difficult domestically and internationally is that although the probability of a successful event is pretty small, the consequences could be whoppers. It's a difficult subject to deal with, and it's always going to be politically contentious.

JA: There has been a certain change in terrorist activity over the past several years. There is a much greater willingness to use innocent victims in recent years. Before, there was often an effort to strike at a symbol or to create some kind of public sympathy or notoriety. But increasingly there is a trend to using innocent victims and I think that one has to recognize that nuclear facilities offer an attractive target. We rely very heavily on local support and local response. The guard forces at our facilities by and large are there to provide some interim protection until additional assistance can be provided. Some [plants] do tend to rely on those kinds of local counter-terrorist organizations, and they will become increasingly important on the civilian side.

Charles Pietri: Since Argonne and Brookhaven are my direct responsibilities, suppose Brookhaven, for example, was unwilling to meet its security commitment. What happens?

EB: Let's use the reactor at BNL as an example. Last fall we found some problems. I think you're well aware of the fact that after some soul-searching between the Lab Director and DOE that the reactor was shut down until those fixes were effected. We reinspected and certified the fixes, some of which were physical security upgrades and others were additional guards, and the reactor was put back into operation.

WH: I think I'd like to close this off formally by saying that we're very happy that you're here and I hope you're finding out a little bit about the Institute. I'm sure I speak on behalf of all the members and all the officers in saying that we'd like very much for you to take advantage of us in any way we can be helpful to you.

Discussion participants were given the opportunity to edit their remarks.

Statistical Analysis of Measurement Error
By J.L. Jaech
John Wiley & Sons

This monograph addresses the statistical analysis of data obtained under the experimental situation where a number of items (n) are each measured once for the same characteristic by each of N measurement methods. The value of the characteristic for a given item does not change during the experiment. The analysis results in equations and procedures for estimating the parameters of the model, obtaining both point and interval estimates and testing hypotheses about the parameters.

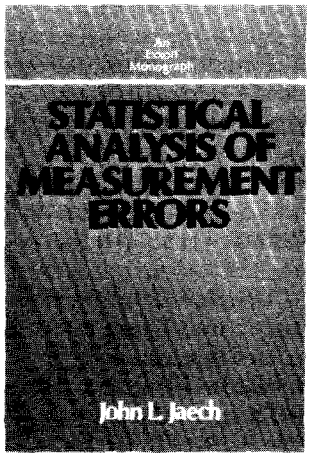
The first 49 pages consist of a basic introduction to statistics. Following the introductory material the measurement model addressed in the remaining chapters is defined as

$$X_{ik}=\alpha_i+\beta_i\mu_k+\epsilon_{ik}$$

where

X_{ik}=observed measurement value for item K, method i where
$k=1,2,\ldots n$; $i=1,2,\ldots N$,
μ_k=true but unknown value for item k,

and where α_i and β_i are parameters that jointly describe the measurement bias for method i, and where ϵ_{ik} is the random error committed in measuring item k with method i. It is assumed throughout that ϵ_{ik} is normally distri-



buted with zero mean and variance σ_i^2. It is further assumed that the ϵ_{ik}'s are uncorrelated between methods for a given item and between items for a given method.

With reference to the model, the following cases are treated in the text:

1. $N=2$; $\sigma_1^2=\sigma_2^2=\sigma_0^2$; $\beta_1=\beta_2$; $\alpha_1\neq\alpha_2$
2. $N=3$; $\sigma_1^2=\sigma_0^2$ for all i; $\beta_1=\beta_2=\beta_3$; $\alpha_1\neq\alpha_2\neq\alpha_3$
3. $N=2$; $\sigma_1^2\neq\sigma_2^2$; $\beta_1=\beta_2$; $\alpha_1\neq\alpha_2$
4. $N=3$; $\beta_1=\beta_2=\beta_3$; $\alpha_1\neq\alpha_2\neq\alpha_3$; $\sigma_1^2\neq\sigma_2^2\neq\sigma_3^2$
5. $N\geq4$; $\beta_1=\beta_2\ldots=\beta_N$; $\alpha_1\neq\alpha_2\neq\ldots\neq\alpha_N$; $\sigma_1^2\neq\sigma_2^2\neq\ldots\sigma_N^2$
6. $N\geq3$; $\beta_i\neq1$ for some or all i; $\alpha_1\neq\alpha_2\neq\ldots\neq\alpha_N$; $\sigma_1^2\neq\sigma_2^2\neq\ldots\sigma_N^2$

The methods used in the estimation of the parameters of the model under the various assumptions are: (1) maximum likelihood, (2) constrained maxiumum likelihood, (3) moments, and (4) generalized least squares.

A chapter is devoted to providing a comparison of the estimates resulting from the application of several of the methods to varius selected cases treated in the text. This was included for the reader interested in reconciling the different estimation procedures.

It is to be noted that this is a complete text on the experimental problem defined. The introductory material is adequate for the casual practitioner to understand the methods sufficiently for application and the derivations, included as appendices, of the methods and procedures along with an extensive bibliography should satisfy those interested in statistical rigor in the development of the procedures.

The statistical procedures are illustrated with numerous examples, primarily from the nuclear industry, and as such are of particular interest to those in the industry. However, since the problems treated in the text are generic to any situation in which measurements are performed, the book will be a valuable asset to anyone interested in the improvement of the accuracy and precision of measurements, whatever the arena.

Reviewed by
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Idaho Falls, Idaho

New IAEA Reports Produced Jointly by IAEA and POTAS

A series of IAEA Safeguards Technical Reports for various components of a State System of Accounting for and Control of nuclear materials (SSAC) were recently completed as a joint effort with IAEA under the U.S. Program for Technical Support to IAEA Safeguards (POTAS). These reports, listed below, should be of interest to those concerned with the interaction between IAEA and the National Safeguards System when safeguards are applied. There is no intention that the reports would serve as rules or standards but rather they are meant to be illustrations of what is believed to be representative of good practice. The general introduction to each report states, "This report is intended to provide the technical details of an effective SSAC which member states may use, if they want, to establish and maintain their SSACs."

STR-150 — Detailed Description of an SSAC at the Facility Level for Low-Enriched Uranium Conversion and Fuel Fabrication Facility, September 1984.

STR-159 — Detailed Description of an SSAC at the Facility Level for Research Reactors, September 1984.

STR-160 — Detailed Description of an SSAC at the Facility Level for Critical Facilities, October 1984.

STR-165 — Detailed Description of an SSAC at the Facility Level for Light Water Moderated (off-load refueled) Power Reactor Facilities, March 1985.

STR-166 — Detailed Description of an SSAC for and Control of Nuclear Material at the State Level, February 1985.

STR-180 — Detailed Description of an SSAC at the Facility Level for Research Laboratory Facilities, August 1986.

STR-185 — Detailed Description of an SSAC at the Facility Level for Mixed Oxide Fuel Fabrication Facilities, September 1986.

STR-193 — Detailed Description of an SSAC at the Facility Level for

Irradiated Fuel Reprocessing Facilities, April 1986.

STR-194 — Detailed Description of an SSAC at the Facility Level for On-Load Refueled Power Reactor Facilities, November 1985.

STR-198 — Detailed Description of an SSAC at the Facility Level for Centrifuge Type Enrichment Facilities, May 1986.

The reports should not only assist those interested in establishing a national safeguards system but provide a better understanding of what the IAEA needs to conduct its safeguards activities more efficiently, effectively, and with minimum burden on the national system and the facility operator. It is also intended that the documents be useful as a training tool for people who are responsible for operating an SSAC at the national or facility level.

All of these reports were prepared under the direction of Ralph Jones, a U.S. cost-free expert, working in the system study section of the Department of Safeguards and the Technical Support Organization (TSO) at Brookhaven National Laboratory. The co-authors from Brookhaven were E. Weinstock, M.S. Lu and W. Kane. In preparing the reports, Ralph worked closely with IAEA staff, and through long distance communication with his colleagues at Brookhaven. Many safeguards experts throughout the world were asked to review the reports and provided useful comments. Ralph also used the reports as a basis for lectures he gave at regional IAEA courses given in Russia, Japan and Australia.

On a personal note, Ralph completed his four year assignment with IAEA and returned to his home this August. His work for POTAS represents a major U.S. contribution to IAEA.

Leon Green
ISPO, Upton, New York

Posts Vacant in the IAEA

The Department of State, the U.S. Arms Control and Disarmament Agency and the Department of Energy have initiated a program to improve recruitment of U.S. nationals for employment in the IAEA.

In an effort to support this program, INMM will publish IAEA vacancies in all upcoming issues of the journal.

Department of Administration

Division: Personnel. Section: Staffing and Personnel Administration — Recruitment Unit. Position: Recruitment Officer. Grade: P-3. Vacancy #86/053. Opening: 7/15/86. Closing: 11/14/86.

Division: Languages. Section: Russian Translation. Position: Translator. Grade: P-3. Vacancy #86/051. Opening: 7/15/86. Closing: 11/14/86.

Division: External Relations. Section: Conference Services. Position: Conference Services Administrator. Grade: P-3. Vacancy #86/047. Opening: 7/15/86. Closing: 11/14/86.

Department of Nuclear Energy and Safety

Division: Scientific and Technical Information. Section: International Nuclear Information System (INIS). Position: Information Officer. Grade: P-3. Vacancy #86/052. Opening: 7/15/86. Closing: 11/14/86.

Division: Nuclear Fuel Cycle. Section: Waste Management. Position: Nuclear/Chemical/Environmental Engineer. Grade: P-4. Vacancy #86/048. Opening: 7/15/86. Closing: 11/14/86.

Division: Nuclear Fuel Cycle. Section: Nuclear Materials and Fuel Cycle Technology. Position: Nuclear/Chemical Engineer. Grade: P-4. Vacancy #86/043. Opening: 6/17/86. Closing: 10/17/86.

Division: Scientific and Technical Information. Section: Vienna International Center (VIC) Library. Position: Reference Librarian. Grade: P-2. Vacancy #86/042. Opening: 6/17/86. Closing: 10/17/86.

Department of Research and Isotopes

Section: Contracts Administration. Position: Head, Contracts Administration Section. Grade: P-4. Vacancy #86/049. Opening: 7/15/86. Closing: 11/14/86.

Division: Joint FAO/IAEA Division of Isotope and Radiation Application of Atomic Energy for Food and Agricultural Development. Section: Food Preservation. Position: Food Irradiation Specialist. Grade: P-3. Vacancy #86/046. Opening: 7/15/86. Closing: 11/14/86.

Division: International Centre for Theoretical Physics. Position: Research Physicist. Grade: P-4. Vacancy #86/038. Opening: 6/17/86. Closing: 10/17/86.

Division: Research and Laboratories. Section: Nuclear Data. Position: Data Services Coordinator. Grade: P-2. Vacancy #86/035. Opening: 6/4/86. Closing: 10/3/86.

Department of Technical Cooperation

Division: Technical Assistance and Cooperation. Section: Program Coordination. Position: Data Management Officer. Grade: P-1. Vacancy #86/054. Opening: 7/15/86. Closing: 11/14/86.

Division: Technical Assistance and Cooperation. Section: Fellowships and Training. Position: Technical Cooperation Fellowships Officer. Grade: P-4. Vacancy #86/050. Opening: 7/15/86. Closing: 10/15/86.

Division: Technical Assistance and Cooperation. Section: Asia and Pacific. Position: Associate Area Officer. Grade: P-3. Vacancy #86/045. Opening: 7/15/86. Closing: 11/14/86.

Department of Safeguards

Division: Safeguards Information Treatment. Section: Data Processing Services. Position: Operations Unit Leader. Grade: P-4. Vacancy #86/041. Opening: 6/17/86. Closing: 10/17/86.

Division: Development and Technical Support. Section: Systems Studies. Position: Safeguards Analyst. Grade: P-4. Vacancy #86/040. Opening: 6/17/86. Closing: 10/17/86.

Division: Development and Technical Support. Section: Technical Services. Position: NDA Specialist. Grade: P-3. Vacancy #86/039. Opening: 6/17/86. Closing: 10/17/86.

Division: Development and Technical Support. Section: Technical Services. Position: Containment/Surveillance Engineer. Grade: P-4. Vacancy #86/037. Opening: 6/4/86. Closing: 10/3/86.

(Several Positions) Division(s): Operations. Position: Nuclear Safeguards Inspector. Grade: P-3. Vacancy #86/SGO-3. Opening: 1/8/86. Continuous Recruitment until 12/31/86.

Division(s): Operations. Position: Nuclear Safeguards Inspector. Grade: P-4. Vacancy #86/SGO-4. Opening: 1/8/86. Continuous Recruitment until 12/31/86.

UN salary scale estimates at step 1 of grade (not including post differential):

P-1 Assistant Officer: $22,500 gross/$17,000-$18,000 net

P-2 Associate Officer: $30,000 gross/$21,200-$23,000 net

P-3 Second Officer: $37,700 gross/$25,500-$27,500 net

P-4 First Officer: $47,500 gross/$30,200-$33,000 net

P-5 Senior Officer: $61,000 gross/$36,200-$39,500 net

D-1 Principal Officer: $70,000 gross/$40,000-$43,500 net

How to Apply

Applications must include a vacancy notice number, and should be mailed to the United States Mission to the International Atomic Energy Agency, Kundmanngasse 21, 1030 Vienna, Austria (Attention: Ronald Bartell). After U.S. Government endorsement is given, the Mission will forward the application to the Division of Personnel at the IAEA.

U.S. Candidates must also send a photocopy of the original application to: (for positions in the Department of Safeguards) P.O. Box 650, Brookhaven National Laboratory, Upton, N.Y. 11973; (for all other positions) IO/T/SCT, Rm. 5336, Department of State, Washington, D.C. 20520.

• A second edition of *Safeguards Instrumentation: A Computer-Based Catalog* was prepared by the Technical Support Organization (TSO), Brookhaven National Laboratory (BNL), under the auspices of the Office of Safeguards and Security, U.S. Department of Energy. The document can be obtained by contacting Clemens Auerbach (telephone 516-282-2914, FTS 666-2914), or the National Technical Information Service, Springfield, VA 22161. Like the earlier edition, the new Catalog was assembled from a database stored in an HP-3000 computer at BNL. The database is again made up of an Equipment File, a Reference File and a Source File.

The new edition includes entries from the previous edition, appropriately updated, unchanged or deleted. Other changes include minor revisions of the categories and addition of a status detail line where it appeared useful. An effort was made to consolidate listings of similar equipment types into more generic entries. Items of a given General Type are no longer listed alphabetically but appear in a subject-oriented sequence.

Users of the Catalog are invited to interact with the database in the following ways:

1. The HP-3000 computer in which the database is stored can be readily accessed and searched by anyone with access to a compatible terminal. An updated version of the User's Guide has been issued as an informal report. *User's Guide to "Safeguards Instrumentation: A Computer-Based Catalog" Database*, by Clemens Auerbach, B.J. Biittner and D.K. Kirby, and may be obtained from its senior author on request.

2. All three files of the database can be modified or expanded by TSO staff. Users are invited to submit corrections, modifications or new entries. Written guidelines for preparing such material may be obtained from Clemens Auerbach.

September 29-October 3
International Topical Meeting on the Operability of Nuclear Power Systems in Normal and Adverse Environments (ANS), Albuquerque, N.M. *Contact:* LLoyd L. Bonzon, Divison 6446, Sandia National Lab, P.O. Box 5800, Albuquerque, N.M. 87185 (505) 844-4313.

September 29-October 3
Course on Fundamentals of Nondestructive Assay of Nuclear Materials. Los Alamos, N.M. *Contact:* Linda Robinson, U.S. DOE Safeguards Technology Training Program. MS-E550, Los Alamos National Lab, Los Alamos, N.M. 87545.

September 30-October 3
29th Conference on Analytical Chemistry in Energy Technology, Knoxville, Tennessee. *Sponsors:* Oak Ridge National Lab, United States DOE. *Contact:* W.R. Laing, Technical Program Chairman, Oak Ridge National Lab, P.O. Box X, Oak Ridge, TN 37831.

October 5-11
13th World Energy Conference, Cannes, France. *Contact:* E. Ruttley, World Energy Conference, 34 St. James St., London SW1A 1HD

October 5-24
Seminar/International Basic Training Course on State Systems of Accounting for Control of Nuclear Material (SSAC), Yalta, USSR. *Contact:* Conference Service Section, IAEA, P.O. Box 100, A-1400 Vienna, Austria.

October 6-8
International Conference on CANDU Fuel, Chalk River, Ont., Canada. Sponsored by the Canadian Nuclear Society; cosponsored by the American Nuclear Society.

October 6-10
Advisory Group on International Safeguards and Criteria for Underground Disposal of High-Level Radioactive Waste, Vienna, Austria. *Contact:* Conference Service Section, IAEA, P.O. Box 100, A-1400, Vienna, Austria.

October 13-17
Standing Advisory Group on Safeguards Implementation, Vienna, Austria. *Contact:* Conference Service Section, IAEA, P.O. Box 100, A-1400, Vienna, Austria.

October 16-18
Fall Meeting of the Atomic Energy Society of Japan, Fukuoka, Japan. *Contact:* Atomic Energy Society of Japan, No. 1-13, 1-chome, Shimbashi, Minato-ku, Tokyo 105, Japan.

October 19-21
WNFM 13th Annual Meeting and International Conference on Nuclear Energy, Holiday Inn, Brugge, Belgium. Sponsored by the World Nuclear Fuel Market. *Contact:* Donna P. Cason, Administrative Director, WNFM, 5720 Peachtree Pkwy., Norcross, Ga. 30092 (404) 447-1144.

October 19-22
The High-Level Waste Business — Transportation, Storage, and Disposal, Charleston, S.C. Sponsored by the Atomic Industrial Forum. *Contact:* AIF, 7101 Wisconsin Ave., Bethesda, Md. 20814-4805.

October 19-23
Joint Power Generation Conference (IEEE, ASME, AIChE), Portland, Ore. *Contact:* M. I. Olken, Gibbs & Hill, 393 Seventh Ave., New York, N.Y. 10001 (212) 760-4032.

October 29-31
32nd Annual Nuclear Science Symposium, Washington, D.C., sponsored by the Nuclear and Plasma Society of the Institute of Electrical and Electronic Engineers, USDOE, USNBS. *Contact:* Donald E. Stilwell, NASA/Goddard Space Flight Center, Greenbelt, Md. 20771.

November 10-14
International Symposium on Nuclear Materials Safeguards, Vienna, Austria. Sponsored by the International Atomic Energy Agency. *Contact:* IAEA, Conference Service Section, P.O. Box 100, A-1400, Vienna, Austria.

November 10-14
Technical Committee on Treatment and Conditioning of Abnormal Radioactive Waste at Nuclear Power Plants, Vienna, Austria. *Contact:* IAEA, Conference Service Section, P.O. Box 100, A-1400, Vienna, Austria.

November 10-28
U.N. Conference for the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy, Geneva, Switzerland. *Contact:* U.N. Conference for the

CALENDAR

Promotion of Peaceful Uses of Nuclear Energy, Vienna International Center, P.O. Box 500, A-1400, Vienna, Austria.

November 16-21
ANS Winter Meeting, Sheraton Washington Hotel, Washington, D.C. Held in conjunction with the AIF Annual Conference. *Contact:* General Chairman Raymond W. Durante, Schneider Enterprises, 1 Farragut Sq./So., N.W., 7th Floor, Suite 700, Washington, D.C. 20006.

November 17-19
Specialists' Meeting on Nuclear Data Correlations and Covariances, Rome, Italy. *Contact:* Conference Service Section, IAEA, P.O. Box 100, A-1400, Vienna, Austria.

November 17-21
Seminar on Safeguards Accounting Data (11th Safeguards Workshop/Seminar), Vienna, Austria. *Contact:* Conference Service Section, IAEA, P.O. Box 100, A-1400, Vienna, Austria.

December 1-5
Course on Gamma Ray Assay of Nuclear Materials, Los Alamos, New Mexico. *Contact:* Linda Robinson, USDOE Safeguards Technology Training Program, MS E-540, Los Alamos National Lab, Los Alamos, N.M. 87545.

December 1-6
Materials Research Society, Fall Meeting, Boston, Mass. *Contact:* Materials Research, Suite 337, 9800 McKnight Road, Pittsburgh, Pa. 15237.

January 20-23, 1987
INMM Spent Fuel Storage Seminar IV, Loew's L'Enfant Plaza, Washington, D.C. *Contact:* Beth Perry, 60 Revere Drive, Suite 500, Northbrook, IL 60062 (312) 480-9573.

January 27-29, 1987
Annual Reliability and Maintainability Symposium (ASME, ASQC), Philadelphia, Pa. *Contact:* V.R. Monshaw, RCA, Astro Electronics, P.O. Box 800, MS55, Princeton, N.J. 08540.

January 28-31, 1987
American Physical Society, General Meeting, San Francisco, Calif. *Contact:* The American Physical Society, 335 E. 45th St., New York, N.Y. 10017.

February 8-12, 1987
12th BWR Operating Plant Technical Conference (NP&CSD), Monterey, Calif. *Additional Information:* Full sponsor.

Feburary 23-24, 1987
National Symposium on Atomic Energy. *Sponsors:* Atomic Energy Society of Japan, 39 related societies. *Contact:* Atomic Energy Society of Japan, No. 1-13, 1-chome, Shimbashi, Minato-ku, Tokyo 105, Japan.

March 30-April 2, 1987
INMM Seminar — Bias in Nondestructive Assay for Nuclear Material Accountability, Hilton Harvest House, Boulder, Colorado. *Contact:* Beth Perry, INMM, 60 Revere Drive, Suite 500, Northbrook, Ill. 60062 (312) 480-9573.

May 12-14, 1987
ESARDA 9th Symposium on Safeguards and Nuclear Material Management, London, England. *Contact:* L. Stanchi, CEC-JRC, 1-21020 Ispra (Varese), Italy.

The events listed in this calendar were provided by Institute members or taken from widely available public listings. We urge INMM members, especially those from countries outside the United States, to send notices of other meetings, workshops or courses to INMM headquarters.