VOLUME XII, NUMBER 1/SPRING 1983

NUCLEAR MATERIALS MANAGEMENT

Journal of the
INSTITUTE
OF
NUCLEAR
MATERIALS
MANAGEMENT

FEATURE ARTICLES

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EDITORIAL

DR. WILLIAM A. HIGINBOTHAM
Brookhaven National Laboratory
Upton, New York

Now that the United States is back in the IAEA, we can get back to work. The boycott not only delayed supporting activities in the U.S., but everywhere, since the IAEA, without U.S. participation, is hardly conceivable.

Again I return to an old theme. You will observe that there is only one technical article in this issue. That is because very few technical articles are submitted, whereas more than enough are submitted for presentation at the annual meetings.

It is understandable that an author would think of the big meetings of the INMM, ESARDA or the IAEA, in that acceptance for presentation should ensure that at least one of the coauthors (most safeguards papers have two or more authors) will be able to attend the meeting. However, Institute members have an obligation to communicate with each other and with non-members. In some cases, meetings present a better forum, in other cases it is the Journal.

Some types of paper are not suitable for presentation at meetings, because the material is not easily summarized and not assimilable by the attendees in 15 minutes. Examples are experiments that involve the presentation and analysis of reams of data; complicated theoretical analyses, and thought-provoking papers which require careful study. Of course, some of those interested in such papers will look them up after the proceedings are published; but good articles tend to get lost in these big volumes.

Once again, I appeal to the individual members and to the R&D groups to think about the Journal. It is now largely a newsletter. It can attain archival status (library interest) only if each issue contains technical articles of some lasting significance. Some of the more important articles only appear as institutional reports which are too often not readily available to others on the outside.

Once again I appeal for comments. The last issue had an article entitled: "Measures for Increasing IAEA Effectiveness" by Charlie Hatcher, which should have stirred-up questions, praise or criticism. Only one person observed that the title was somewhat misleading, since the subject is really how to evaluate various measures that have long been considered, though not so clearly identified.

The article in this issue by M.T. Canty and G. Stein should provoke some comments. Let's have them!

NUCLEAR MATERIALS MANAGEMENT is published four times a year, three regular issues and a proceedings of the annual meeting of the Institute of Nuclear Materials Management, Inc.

SUBSCRIPTION RATES: Annual (domestic) $40; annual (Canada and Mexico) $50; annual (other countries) $60; (shipped via air mail printed matter); single copy regular issues published in spring, fall and winter (domestic) $9; single copy regular issue (foreign) $11; single copy of the proceedings of annual meeting (domestic) $25; and single copy of proceedings (foreign) $40. Mail subscription requests to NUCLEAR MATERIALS MANAGEMENT, Journal of INMM, 8600 West Bryn Mawr Avenue, Chicago, Illinois 60631 U.S.A. Make checks payable to INMM.

DESIGN AND PRODUCTION
Design Two, Ltd.
600 North McClurg Court
Chicago, Illinois 60611 U.S.A.

INQUIRIES about distribution and delivery of NUCLEAR MATERIALS MANAGEMENT and requests for changes of address should be directed to the address in Chicago, Illinois. Allow eight weeks for a change of address to be implemented. Phone number of the INMM headquarters is (312) 693-0990.

Third-class non-profit bulk rate postage paid at Chicago, Illinois 60631 U.S.A.

ISSN 0362-0034

INMM WORKSHOP

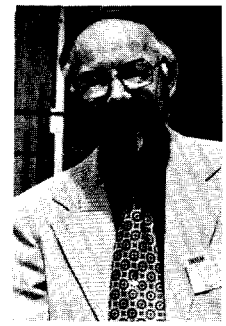
The INMM Workshop "Selected Topics in Statistical Methods for Special Nuclear Materials Control" was held in Oak Ridge, Tennessee, March 21-25. Attendees for the five day session were C.A. Hodge, Los Alamos National Laboratory; Larry D. Gwinn, Goodyear Atomic Corporation; Richard E. Green, Department of Energy; Koichi Konno, Power Reactor and Nuclear Fuel Development Corp. (Japan); Robert Marshall, Los Alamos National Laboratory; Carl Hassell, Jr., DOE-New Brunswick Lab.; Brian L. Richards, U.S. NRC (Region II); Hontas R. Bailey, Nuclear Fuel Services, Erwin, Tenn.; Martha C. Williams, Nuclear Fuel Services, Erwin, Tenn.; Patricia L. Sholl, Lawrence Livermore Laboratory, Livermore, Calif.; Thomas J. Lewis, DOE-Oak Ridge Operations Office; Rebecca J. Greer, DOE-Oak Ridge Operations; Sheryl Strouth, Nuclear Fuel Services, Erwin, Tenn.

Instructor for the course was John Jaech of Exxon Nuclear Company in Bellevue, Washington. Mr. Jaech is also the current chairman of INMM.

Attendees at the Oak Ridge session of the Statistical Methods Workshop included (front row l to r) Williams, Strouth, Sholl, Greer, Bailey, and instructor John Jaech. (Standing l to r) Konno, Hassell, Lewis, Richards, Gwinn, Green, Marshall, and Hodge.

CHAIRMAN'S COLUMN

JOHN L. JAECH
Exxon Nuclear Company, Inc.
Bellevue, Washington



In the Winter 1982 edition of this journal, the accompanying picture in this column inspired considerable comment from the readership. Please be advised that my beard is still intact. Although not intended to perform this function, the use of the archival picture did send us the welcome message that you members do peruse the journal, if for no other reason than to look at the pictures. Having received this message, we will try to be more current in our journal offerings in the future.

Your Executive Committee met in early February in Chicago. Normally, three such meetings are held annually, one in conjunction with the Annual Meeting of the Institute. At the February meeting, we acted upon the resignation of Ed Owings as Treasurer and Gary Molen as the Past Chairman member of the Executive Committee. I personally have worked with both of these gentlemen for the past several years and have appreciated their conscientious devotion to duty and their many hours of self-sacrificing labor for the good of the Institute. Their contributions will be missed. At the same time that we bid them farewell as members of the Executive Committee, we welcome their replacements: Bob Curl as Treasurer and Ed Johnson as Past Chairman Executive Committee member. Both have previously served in these capacities and we welcome their input and assistance.

Much business was transacted at the aforementioned meeting. Detailed plans for the upcoming Vail meeting were reviewed and decisions were made as needed. Committee reports were heard and actions taken as appropriate. I will not review all these reports but urge you to read elsewhere in this journal the contributions from the various Committee Chairpersons. As you will note, important steps forward are being taken in many areas. I hesitate to single out any specific areas for fear of omitting others of equal importance. We operate under the principle that all INMM activities are important; otherwise, we would not be committing our limited resources in their pursuit.

In spite of this hesitation to single out a specific area, however, I feel compelled to comment on our plans for providing a short course in conjunction with helping to prepare the membership for INMM certification as Safeguards Specialists or Interns. For whatever reason or set of reasons, it is clear that the membership has been slow to respond to the certification program. There has been considerable discussion taking place at Executive Committee meetings on this program going back several years to the time that the then existing program was placed on hold and the present one was being formulated. These discussions continue in depth and at times with rather intense feelings, and I am aware that similar discussions occur on an unofficial basis among the members. There is a feeling that members have been hesitant to participate because of fear of the unknown (similar to the reasons why segments of the public fear radioactivity), and that this fear can largely be removed by providing a survey course that touches on the elements covered in the certification examination.

In designing this course, and in your deliberations as to whether or not you will want to participate, I ask you to keep two thoughts in mind: (1) No short course can provide *all* the background material needed to become certified in this field nor in any other technically based field; the intent is to review basic principles and give necessary background information in specialty areas that differ from your own. Some prior knowledge and broad based experience will still be required and, indeed, certification as a safeguards professional *should* require such an experience base; (2) a survey course is being designed to provide this background to all individuals, and not only to those desiring to take the certification examination to be offered at the course conclusion. The course will particularly benefit any one relatively new to the field of safeguards from that point of view. For further information on this emerging program, read the appropriate columns elsewhere in this issue. For specific information not covered, contact our Certification Chairman, Fred Tingey, at (208) 526-9637.

One important aspect of running any business is the need to plan for the future. The same is true of a professional organization. The INMM has in place a Long Range Planning Committee chaired by Sam McDowell, a Committee who has deliberated on many occasions and in depth in recent years while formulating a long range plan for the INMM. The Executive Committee is now drafting a response to their plan, the final draft of which was turned over to the Executive Committee in early 1982. We regard this as an area of crucial importance. Any input that you members would like to provide as we plan for the future, or indeed, any input that you would like to provide in any area, will be welcome. I invite you to submit your ideas, thoughts, wishes, desires to me. Having made this offer in a previous column, and having been gently chided by a member who did respond after having a difficult time trying to determine my address and telephone number, here they are for your convenience:

Mr. John L. Jaech
Exxon Nuclear Company, Inc.
600–108th Ave. N.E., C00777
Bellevue, WA 98009
U.S.A.
Phone: (206) 453-4377

As a closing item, I call to your attention a few paragraphs of technical interest that may have some future impact in our area (although I seriously doubt it). Permission to reprint this item was received by the author, who has indicated to me that he first wrote the article on April 1, 1980. It first appeared in an underground newspaper and has not surfaced since then.

"WORLDWIDE CONVERSION TO BASE 12 IMMINENT

The trend towards universal conversion from base 10 to base 12 appears to be unstoppable, reports James Dussin, director of the United States Commerce Department's Numerical Systems Division. Under a base 12 system, numbers would be thought of in multiples of 12, instead of multiples of 10.

As any schoolchild knows, the superiority of the base 12 system over the base 10 system is due to 12's nature of being evenly divisible by 2,3,4 and 6. Ten is evenly divisible by only 2 and 5.

Industry enthusiastically supports the conversion to base 12. 'It would make things easier in life and in commerce,' says Robert Buggy, spokesman for the National Association of Manufacturers.

In base 12, explains Buggy, there are 50 seconds in a minute, 50 minutes in an hour, and 20 hours in a day. A foot would be 10 inches long and there would be 30 inches in a yard. The frustrations of base 10 functions would be reduced; one-third in base 12 is 0.4 and one-fourth is simply 0.3.

Promoters of the base 10 metric system are naturally miffed by the sudden popularity of base 12. The metric system would be utterly useless in a base 12 world.

Dussin urges civic-minded Americans to begin using base 12 immediately, especially when addressing mail, preparing tax returns, and in other government related transactions. Asked when he expects base 10 to be completely replaced, Dussin replied, 'In 10 to 15 years. Base 12, that is!'

—Submitted by our Fresno, CA. correspondent"

My reaction is that I would personally hesitate to report ID's (MUF's) in base 12 until the regulators have had the opportunity to study the issue. This may take some time. Whatever, the LEID would hopefully be in the same base as the ID, or else there might be some confusion as to their interpretation, vis-a-vis their present clarity.

P.S. Because of an unfortunate slip of the tongue that occurred while I was making a few remarks recently at a meeting of the Northwest Chapter of the INMM, the rumor is spreading that at the upcoming Vail meeting, "roommates" will be $45. I had meant to say that room *rates* will be $45. Hopefully, this clarification will not cause anyone to change plans to attend.

SAFEGUARDS COMMITTEE REPORT

ROBERT J. SORENSON, CHAIRMAN
Battelle Pacific Northwest Laboratories
Richland, Washington

The Government Liaison Subcommittee, chaired by Dick Duda, is continuing to hold bimonthly meetings with the State Department and ACDA regarding progress on the International Plutonium Storage concept and other international safeguards issues. The Subcommittee has reviewed a draft guidelines document for reprocessing plant safeguards design and agreed upon what work is required to summarize reprocessing plant safeguards capabilities. The subcommittee is also working with the AIF on a possible workshop for Congressional staff members.

The Low Enrichment Subcommittee met in Washington, D.C. in January to draft comments in response to the NRC's proposed amendment to 10 CFR Part 70 regarding material control and accounting requirements. This proposed rule change involves special nuclear material of low strategic significance which was published for comment on December 14, 1982.

Roy Nilson reports that in general the LEU Subcommittee was very pleased with the rule as published and felt that the reforms proposed will permit significant cost savings to the nuclear fuels fabrication industry without any increase in safeguards risks. The group was particularly pleased that the NRC's proposed changes are largely consistent with extensive studies and recommendations previously made by the Institute in 1976, and that the NRC staff has adopted and used a performance-oriented approach for overall system objectives, which has also been an Institute position.

A number of other issues are currently being considered by the Safeguards Committee. We plan to hold our next meeting in conjunction with the INMM annual meeting in July. We welcome anyone who wishes to attend our meetings.

HELP WANTED

T.E. SHEA, MEMBERSHIP COMMITTEE CHAIRMAN
INET Corporation
Sunnyvale, California

An organization like INMM can only succeed as long as it attracts and keeps active members. We don't advertise much, so the principal means for us to add new members is for each of us to keep a wary eye for potential members and to follow through. I want your help in reaching out to potential members, either by approaching likely candidates directly, or by sending me the name and address of one or more professionals engaged in nuclear materials management. If you send me that information, I will send a personal letter with an invitation to join the Institute, with or without mentioning your name, as you prefer. Think about the people you work with, or come in contact with through your work.

As of March 31, 1983, we are an organization of 704 members. Thirty percent of us live outside the United States. We are responsible for a great many activities related to nuclear materials management in private and public service, addressing both the abstract and the real. We establish policies, write laws and regulations, carry out the functions necessary for competent nuclear materials management, provide the needed equipment and services and verify that the activities satisfy their intended objectives. Our technology includes guard dogs and digital information filters, container seals and computers.

We come to INMM in search of a common meeting ground, a place to share our views, ideas and problems. We have succeeded in building an organization that serves the needs of nuclear materials management admirably, but more than that, the Institute meets those needs in a manner that is at all times a pleasure.

Through active participation in the Institute, you gain an improved understanding of the problems you face, and the range of solutions available. Your work is important to society and represents more than just a job, more a mission. Pitch in.

We are fortunate to have the following new members join us:

Harold Kelley, Eric Payne, Alvin Rickers, Jeffrey Arbital, Dean Guy, Bradley Strong, Humberto Vega, Richard O'Laughlin, William Bush, Andre Lagattu, Eckhard Haas, Palafox Garcia, Richard Hooper, GuySan Choi, Kinji Koyama, William Tunney, David Faller, John Veatch, William Bair and Obie Amacker, Jr.

You must be aware that membership fees for the Institute are very low in comparison to other professional societies, and have remained fixed for some time now. At present, an ad hoc committee has been formed to provide recommendations on membership fees and publication charges. The committee's recommendations will be presented to the Executive Committee at its next meeting, immediately preceding the Annual Meeting in Vail. In addition to finding new sources of revenue, the Institute is seeking to cut expenses which have little value. As a first step in that direction, the Executive Committee voted at its last meeting to discontinue the practice of issuing membership cards. Look for more changes in the future.

NONPROLIFERATION POLICY: THE NEED FOR A FRESH APPROACH*

JAMES DE MONTMOLLIN
Sandia National Laboratories
Albuquerque, New Mexico

Ever since 1945 the spectre of nuclear weapons has loomed in the American consciousness. Progress in applying nuclear energy to peaceful uses has been haunted by ever-present fears of nuclear war. Yet, the vast potential of nuclear energy drives the world relentlessly to seek benefits in spite of the attendant dangers. We cannot deny the benefits, nor can we forget the dangers; all we can hope to do is to curb the growth of nuclear weapons and strengthen the barriers that we have erected to keep peaceful uses separate.

The two aspects of nuclear-weapons control—in jargon terms horizontal and vertical proliferation—are generally separate policy issues, although they interact in important ways. Here we address only one aspect of the former: how to keep the peaceful use of nuclear energy from increasing the risk that additional countries will acquire nuclear weapons. That problem has been a principal concern of US policy since the beginning, with major shifts in approach at two points in the long history. The first was in 1953, when we abandoned the policy of secrecy and denial, turning to peaceful-use commitments verified by safeguards. The last shift, following the 1974 Indian explosion, was a return to a heavy emphasis on denial. It resulted from the sincere and dedicated efforts of individuals in Congress who have specialized on this issue, supported by actions taken by the Nixon and Ford Administrations, and especially by President Carter. The effect has been a pronounced shift in the strategy for the control of proliferation, supported by a cohesive group of policymakers who have made it their specialty, and which has led to a body of conventional wisdom that is seldom questioned as to its underlying premises. The Reagan policy differs only marginally from the policy that has prevailed since 1974, mainly with regard to US reprocessing and the selective application of the NNPA.

Unfortunately, the policy is based on faulty premises, and it is ineffective and even counterproductive. There are many who continue to point out the defects, fallacies, and misapprehensions of the conventional wisdom embodied in the policy. However, these are too often rearguard tactical skirmishes by those who are perceived to have special interests at stake. Those in Congress who have shown a continuing interest in controlling horizontal proliferation tend to hold similar views, they have an active constituency, and they have taken such strong and long-standing positions that their views are difficult to change. The country is thereby denied the benefit of healthy debate on this crucial issue. Meanwhile, the prospects for containing the spread of nuclear weapons continue to diminish, in large part because of the lack of positive world leadership by the US, as well as the effects of US policy that are actually counterproductive.

We must formulate a new nonproliferation policy that is comprehensive and coherent, to provide an alternative to the deeply-rooted conventional wisdom that currently goes without effective challenge. A small group of concerned senators and representatives must take the initiative to subject policy alternatives to constructive debate. The group should include both Democrats and Republicans, so as to prevent non-proliferation from becoming a partisan issue. New players are needed, especially ones who have been active in foreign relations and arms control, and who are not perceived as promoters of nuclear energy.

*This article reflects an individual opinion and not necessarily the views of the Department of Energy or Sandia National Laboratories.

Fallacies and Contradictions of The Present Policy

The controversy that has raged over nuclear power in recent years has polarized positions along ideological lines. Environmental issues, social preferences, ideological goals, emotional fears, frustrations over technology, ignorance of history and technology, and delusions over US omnipotence have all combined to obscure what is a pragmatic, simply-stated problem of foreign relations: how to influence countries to do what we would like them to do. With regard to the acquisition of nuclear weapons by additional states, there are two possible approaches: persuasion and denial of technical capability. The latter is the most certain, but only if it can be done. Persuasion depends on cooperation, and hence a community of interests, and not coercion.

Beginning in 1945, US policy was based on denial. Even at that early date it is doubtful that denial was effective. We excluded our own Manhattan-project partners, but that did not prevent the UK from exploding a device in 1952. The Soviet Union did it earlier, in 1949. Whether the Soviets were able to accomplish that through independent effort or with the assistance of espionage is irrelevant; the point is that the attempted denial failed. Even during the Manhattan project, the Canadians and collaborating French scientists were excluded in January 1944 from participating in fuel-reprocessing development. Nevertheless, by 1945 they had independently developed their own solvent-extraction process, four years before the present Purex process was developed.[1] By 1953 it had become apparent that many advanced countries had the technical potential to produce weapons and that many more would in time achieve it, if only incidentally in connection with peaceful uses of nuclear energy, and that continued attempts at denial would only lead to national self-sufficiency, with no means of assurance that peaceful uses would not be associated with weapon development.

The only other avenue to reducing the risks of horizontal proliferation in connection with peaceful uses is cooperation and persuasion: cooperation in the extension of peaceful uses and persuasion to renounce nuclear weapons and to accept safeguards verification of peaceful uses. Persuasion and cooperation are each essential elements: countries must be persuaded that it is in their own broader interest to abstain from nuclear armament, and that their peaceful nuclear activities must be visible so as to assure others that they are not a cover for military programs. Beyond that, many developing countries must be offered something in return—earlier access to peaceful uses—in exchange for formally renouncing the latent weapons option and permitting safeguards inspection. Each is a substantial surrender of national sovereignty that in most cases, especially the states of greatest concern, will not be made unless there are accompanying direct benefits to them.

1. Goldschmidt, Bertrand, *The Atomic Complex*, ANS, 1982, pp 58-59.

continued on page 8

continued from page 7

The policy of denial is based on the continuing myth that there is a technological barrier that prevents most countries from reprocessing spent fuel to separate the plutonium. There is no "reprocessing secret". Any of dozens of countries have long been technically capable of separating enough plutonium for at least a few weapons. Beginning in the late 1950's, techniques for separation on an industrial scale have been widely disseminated. The alleged technical barrier has little to do with reprocessing on a commercial scale. What makes the latter a more difficult technical problem is that it is constrained by other factors that have nothing to do with production for weapons: commercial profitability, high decontamination and recovery factors, waste disposal, and regulatory requirements. Reprocessing technology was never a barrier to the attainment of an explosive capability by any of the countries thus far, nor is it a barrier to preventing any in the future that are otherwise capable. Yet, the NNPA and proposed amendments to it put great emphasis on denial of technical capability to those countries "not possessing reprocessing technology".

A policy of technology denial, for technology not specific to weapons, is in violation of obligations that we, the principal architect of the Nonproliferation Treaty of 1968, undertook at the time. The Federal Republic of Germany signed the Treaty only after asking the US for reconfirmation that the Treaty would in no way limit access to all peaceful uses by non-weapon Parties, including specifically the use of plutonium fuels.[2] They, and others, accepted the Treaty only after that understanding was expressly reaffirmed by the US. With the reversion of US policy back to denial, beginning in 1974, we have tried to impose a revisionist redefinition of "proliferation" to mean the spread of plutonium peaceful-use technology rather than nuclear weapons.[3] It is symptomatic of the unreality of US nonproliferation policy that we, at the same time, reaffirm continued support of the NPT while legislating requirements that it be unilaterally abrogated in certain essential terms that we solemnly accepted. Such is a consequence of the return to a policy of denial, long after it had become ineffective and a structure of international cooperative arrangements had been erected to replace it.

The myth of US dominance as a supplier, the second foundation of current US policy, is no more real than the technological barrier. Many advanced countries, now joined by India, Brazil, and Argentina, export nuclear materials and equipment. The US had a monopoly only in enriched uranium, and only up to about 1970. By 1981 the US supplied only 13 percent of Western Europe's demand.[4] Projections of plutonium in spent fuel subject to US control under export agreements show a steady decline over the next 15 years, especially with countries not party to the NPT. US influence through export control, the basis of the strategy legislated by the NNPA, is a depleting as well as a declining resource. It is depleting because attempts to apply it more aggressively result in further loss of export markets, with clients considering the US to be the source only of last resort.

Worst of all, the present policy has contributed greatly to the growing controversy that threatens the structure of international arrangements upon which everything depends. The prospect is that the NPT may not survive beyond its expiration in 1995, unless there is positive and constructive leadership to reverse the present trend. US policy is of central importance to that end.

2. Arms Control and Disarmament Agency, *Documents on Disarmament*, 1969, pp 609-610.
3. Congressional Research Service, Library of Congress, *Nuclear Weapons Proliferation and the International Atomic Energy Agency*, A report to the Senate Committee on Government Operations, March 1976, p CRS-3. Also see the preamble to the NNPA, which refers to the proliferation of nuclear explosive capability not weapons.
4. During 1981, the uranium enrichment purchases in the European Community were: Eurodif, 61%; Soviet Union, 16%; United States, 13%; Urenco, 10%. Bertrand Goldschmidt, *The Atomic Complex*, ANS 1982, p 418.

The Basis for a New Policy

A policy based on denial is doomed to failure because the necessary conditions for it no longer exist. We must return to a policy of cooperation and persuasion, strengthening and extending the structure of international arrangements that includes the IAEA and the NPT. The policy must provide incentives for increased international interdependence in peaceful nuclear activities, and disincentives for national self-sufficiency. The present policy does just the opposite.

A characteristic of the world nuclear economy is that it has developed with a large degree of interdependence and international trade. At the same time, sources of natural uranium are widespread, and it is within the technical capability of many countries to achieve complete nuclear independence, using natural-uranium reactors where necessary. Self-sufficiency comes at a higher economic cost, but security of supply is an even more dominant consideration. States will be inclined toward greater interdependence for economic reasons, but not at the expense of a secure supply of nuclear materials and equipment.

The present international structure, based on the IAEA and the NPT, fosters interdependence. Our policy should be to strengthen them: not merely with technical assistance and professions of support, but by moves with real substance. We must renew our commitment under Article IV of the NPT by renouncing our revisionist definitions of peaceful uses. Our export policy should make a sharp distinction between NPT parties and non-parties. Our obligations to NPT parties in good standing are a commitment made when we signed the treaty, and there have been no actions by NPT parties that justify our changing them unilaterally. At the same time, non-parties to the NPT obtain exports from us under more favorable terms than those sometimes offered by the States that are bound by the treaty.

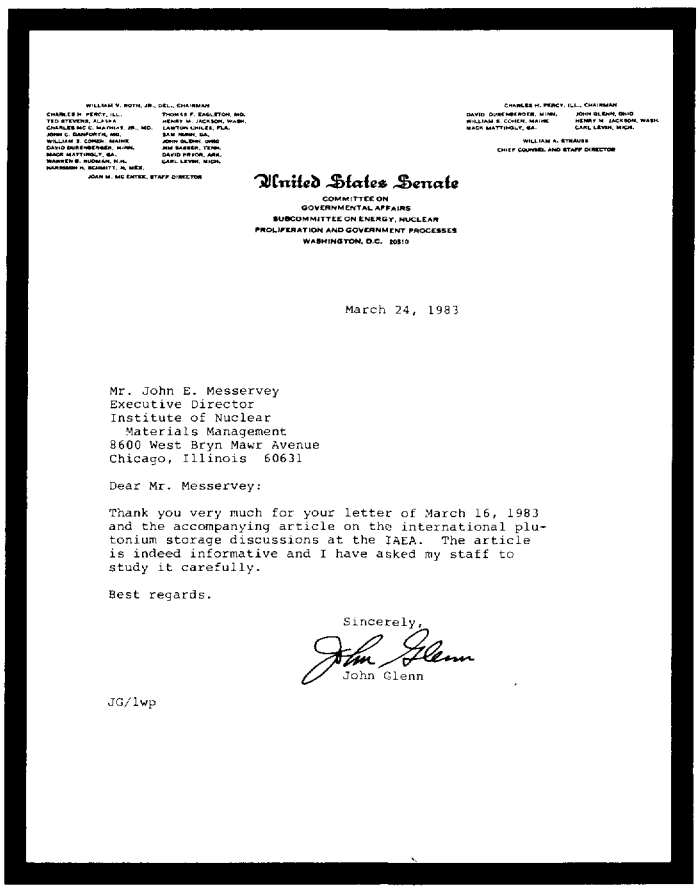
We should take the lead in extending the web of interdependence through such measures as International Plutonium Storage and supply assurances, recognizing that any international arrangements must offer direct benefits to each prospective member State. We must work to restore the confidence in our good-faith intentions that has been badly damaged by our policies since 1974. We must explore innovative ideas such as uranium/plutonium exchange, perhaps in connection with plutonium storage, to allow all States to recover plutonium values without increasing proliferation risks. In short, we must reclaim our role of international leadership, and abandon attempts at coercion and denial.

The Need to Consider A New Congressional Policy

If there is to be a reappraisal of US policy, it must have a solid base of support in Congress, where no alternative policy that would avoid the faulty premises under which we have labored since 1974 has ever been formulated and developed as a clearly-understood alternative. Whatever any Administration may do, US policy must remain consistent over a period of decades, commensurate with the lifetime operational cycle of nuclear commitments and operations. The responsibility thus falls on Congress, to anchor a new policy in some revised form of the NNPA that will assure both effectiveness and constancy. New initiatives are needed to subject the conventional wisdom that obscures present thinking to open and constructive debate. We are badly in need of leadership that will take that initiative.

INTERNATIONAL PLUTONIUM STORAGE

In the winter 1982 issue, NUCLEAR MATERIALS MANAGEMENT featured an article, "Progress Toward an International Plutonium Storage Regime", by James de Montmollin. This article was widely circulated among policymakers in the U.S. government and elsewhere. The following is a sampling of responses received to date.



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United States Senate

COMMITTEE ON
GOVERNMENTAL AFFAIRS
SUBCOMMITTEE ON ENERGY, NUCLEAR
PROLIFERATION AND GOVERNMENT PROCESSES
WASHINGTON, D.C. 20510

March 24, 1983

Mr. John E. Messervey
Executive Director
Institute of Nuclear
Materials Management
8600 West Bryn Mawr Avenue
Chicago, Illinois 60631

Dear Mr. Messervey:

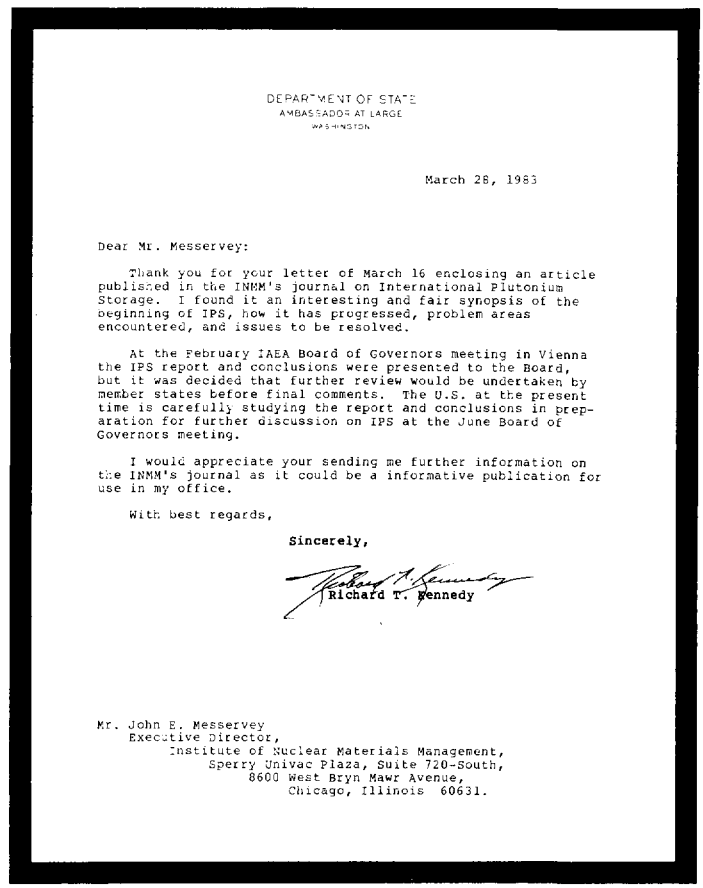
Thank you very much for your letter of March 16, 1983 and the accompanying article on the international plutonium storage discussions at the IAEA. The article is indeed informative and I have asked my staff to study it carefully.

Best regards.

Sincerely,

John Glenn

JG/lwp



DEPARTMENT OF STATE
AMBASSADOR AT LARGE
WASHINGTON

March 28, 1983

Dear Mr. Messervey:

Thank you for your letter of March 16 enclosing an article published in the INMM's journal on International Plutonium Storage. I found it an interesting and fair synopsis of the beginning of IPS, how it has progressed, problem areas encountered, and issues to be resolved.

At the February IAEA Board of Governors meeting in Vienna the IPS report and conclusions were presented to the Board, but it was decided that further review would be undertaken by member states before final comments. The U.S. at the present time is carefully studying the report and conclusions in preparation for further discussion on IPS at the June Board of Governors meeting.

I would appreciate your sending me further information on the INMM's journal as it could be a informative publication for use in my office.

With best regards,

Sincerely,

Richard T. Kennedy

Mr. John E. Messervey
Executive Director,
Institute of Nuclear Materials Management,
Sperry Univac Plaza, Suite 720-South,
8600 West Bryn Mawr Avenue,
Chicago, Illinois 60631.

Airline Service
Scheduled airline service is available throughout Rocky Mountain Airways. RMA flies the new DeHavilland Dash-7 STOLcraft to the Vail Stolport at Avon, Colorado. You should request your travel agent to investigate *through flights* to Vail as airfares (depending upon airline) may be less expensive. Please ask for the "special fare" (limited seating) of approximately $74.00 round trip.

Transportation from Vail Stolport to Marriott's Mark Hotel is available by pre-arranged shuttle bus. The airport is approximately ten miles west of the Hotel. You may either secure pre-arranged reservations by giving your flight number, time and date to the Hotel in advance, or you may call the Hotel bellman upon arrival and the Hotel will send a shuttle bus. There is no charge for this service.

Parking
Parking is available at Marriott's Mark Hotel at no charge.

Registration
Registration will be available from 4:00 p.m.-8:00 p.m. Sunday, July 10, 1983; 7:30 a.m.-5:00 p.m. Monday, July 11, 1983; 7:30 a.m.- 5:00 p.m. Tuesday, July 12, 1983; and 7:30 a.m.-12:00 noon Wednesday, July 13, 1983.

Dress
Vail is a casual rocky mountain conference center. Casual dress is the order of the day. Business attire is seldom seen in Vail. Although summer days in Vail are warm, evenings can be cool. Sweaters and light jackets are useful.

Western Style Barbeque July 12, 1983
On Tuesday evening an outdoor western style barbeque will be held. The festivities will start at 5:00 p.m. with a western style reception, live music, and fine western barbeque cuisine. Western style dress is encouraged.

Questions?
If you have any questions prior to our annual meeting, please write Ed Young, Chairman, INMM Arrangements Committee, c/o Rockwell International, Energy Systems Group, Rocky Flats Plant, Safeguards and Security, Post Office Box 464, Golden, Colorado, 80401.

1983 ANNUAL MEETING TECHNICAL PROGRAM COMMITTEE REPORT

JOSEPH P. INDUSI, CHAIRMAN
Brookhaven National Laboratory
Upton, New York

The Technical Program Committee for the 24th Annual Meeting to be held in Vail, Colorado, during July 10–13, 1983 is pleased to announce that our plans are now complete. We have scheduled a Plenary Session which addresses the revitalization of the U.S. nuclear fuel cycle. For this session we have scheduled prominent speakers who will discuss from various perspectives such issues as experience in safeguarding the fuel cycle, utility viewpoints, and the issue of fuel reprocessing. An invited panel discussion entitled "Clarifying the Role of the IAEA" will provide a forum for exchanging views on this very important aspect of safeguards. An invited session on International Plutonium Storage (IPS) and a contributed session on international safeguards techniques and methods provide coverage of more technical international safeguards issues.

This year we have set aside a specific time for the Poster Session and Exhibits although you may view these presentations at other times if you wish. Because of specific interest by INMM members we have scheduled three invited/contributed sessions on trends in improved accountability, item accountability techniques, and the issue of the insider threat. Other contributed sessions will address physical protection analysis and operations, systems studies, sabotage protection and emergency planning, and spent fuel management and transportation.

The Chairman of the Technical Program Committee is Joseph P. Indusi of Brookhaven National Laboratory. The Invited Papers Subcommittee is chaired by Robert Brooksbank of Bechtel National, Inc., and the members of this subcommittee are Alan Bieber, Jr., Richard Duda, Thomas Sellers, Peggy Scott, and Roger Smith. Roy Cardwell and C.W. (Bill) Wilson of the Union Carbide Corporation are the Co-Chairmen of the Poster Session. John Lemming, of the Monsanto Research Corporation is the Chairman of the Contributed Papers Subcommittee. The members of this subcommittee are Charles Petrie, William Mee, and John Hockert.

The Technical Program Committee wishes to thank Marlene Yadron and John Messervey for their support and assistance in planning for this meeting.

INMM EXECUTIVE COMMITTEE
CHAIRMAN John L. Jaech
VICE CHAIRMAN Yvonne M. Ferris
SECRETARY Vincent J. DeVito
TREASURER Robert U. Curl
MEMBERS AT LARGE
Richard F. Duda
Glenn A. Hammond
E.R. Johnson
Tommy A. Sellers
Charles M. Vaughan

INMM COMMITTEE CHAIRMEN

Annual Meeting Arrangements	Tommy Sellers
Annual Meeting Program	Joseph Indusi
Awards	Karl J. Bambas
Bylaws & Constitution	Roy Cardwell
Certification	Fred Tingey
Education	Harley Toy
Long Range Planning	Sam McDowell
Membership	Tom Shea
N-14 Standards	Jim Clark
N-15 Standards	George Huff
Physical Protection TWG	Jim Williams
Safeguards	Bob Sorenson
Statistics TWG	Carl Bennett
Waste Management TWG	E.R. Johnson

INMM CHAPTER CHAIRMEN

Japan	Yoshio Kawashima
Vienna	Tom Beetle
Central	Harvey Austin
Southeast	Mary Dodgen
Northwest	Curt Colvin

INMM CALENDAR OF EVENTS

JULY 10-13, 1983
INMM 24th Annual Meeting
Marriott's Mark Hotel, Vail, Colorado

SEPTEMBER 6-9, 1983
Spent Fuel Management and Waste Disposal Seminar
Hyatt Regency on Capital Hill, Washington, DC

OCTOBER, 1983
Multi-Disciplined Education/Certification Course
Site to be determined

OCTOBER 18-21, 1983
Integrating the Elements of Delay, Intrusion Detection, and Entry Control into Physical Protection Systems
Hyatt Regency Long Beach, Long Beach, California

NOVEMBER 14-17, 1983
Security Personnel Training TWG
Albuquerque, New Mexico

NOVEMBER 28-DECEMBER 2, 1983
ANS/INMM Topical Course
Safeguards Technology: The Process-Safeguards Interface
Hilton Head Island, South Carolina

JULY 15-18, 1984
INMM 25th Anniversary Annual Meeting
Hyatt Regency Columbus, Columbus, Ohio

NANCY M. TRAHEY ELECTED TO ASTM BOARD OF DIRECTORS

Nancy M. Trahey

Nancy M. Trahey, chief, Standards and Evaluation Branch of the U.S. Department of Energy (USDOE), New Brunswick Laboratory, Argonne, Illinois, was elected to a three-year term on the Board of Directors of ASTM. Trahey, a resident of Darien, IL, began her term of office on 1 January 1983.

A 1962 graduate of Immaculate Heart College with Bachelor of Science and Art degrees in chemistry, Trahey began her career as a chemist that same year for Rockwell International-Atomics International Division. In 1971, she joined USDOE New Brunswick Laboratory as a chemist and has since held the positions of chief, standards and reference materials section; and principal scientist, standards and reference materials. She assumed her present position in 1981.

Trahey has concentrated her career in such areas as analytical chemistry of irradiated and non-irradiated nuclear fuel materials and the development and evaluation of wet chemicals, radiochemical and gamma ray spectrometric techniques.

Trahey is also a member of ASTM's Standing Committee on Terminology and Committee C-26 on Nuclear Fuel Cycle. The latter is one of 138 standards-writing committees within ASTM. A nonprofit organization with headquarters in Philadelphia, ASTM is concerned with the development of voluntary consensus standards for materials, products, systems, and services.

In addition, Trahey is a member of the Nuclear Chemistry and Technology Division of the American Chemical Society; the Membership Steering Committee, the Executive Committee of Isotopes and Radiation Division, and the Nuclear Fuel Cycle Division of the American Nuclear Society; and the Institute for Nuclear Materials Management, as well as the Subcommittee of Physical Standards of the American National Standards Institute.

VIENNA CHAPTER REPORT

WINSTON C. H. ALSTON
International Atomic Energy Agency
Vienna, Austria

Chapter Membership

Membership of the Vienna Chapter for 1982–1983 stands at 78. This is an increase of 18% over that of last year. Our members represent 26 different nationalities.

Executive Committee

The Balloting Officer, Frank O'Hara, announced the election results for the 1982–1983 Executive Committee on August 25, 1982, as follows:

Chairman:	Tom Beetle	
Vice Chairman:	Ben Agu	
Secretary:	Mike Kaplan	
Treasurer:	Cathy Morimoto	
Members at Large —	2-year term:	Winston Alston
		Jim Lovett
	1-year term:	John Ahlquist
		Dino Pontes
Past Chairman:	Les Thorne	

September

Vienna is a city of countless Heurigens—informal restaurants where the wine of the day can be tasted. About 30 INMM members and wives spent an evening at the Fuhrgasse Huber in Grinzing. There were no speeches but Willy Higinbotham, who was in Vienna to attend a conference, helped to close the meeting by leading a group of "singers".

October

At the meeting held on October 13, 1982, Mr. H. Gruemm, Deputy Director General for Safeguards, addressed us on the topic "From the September General Conference to the February Board Meeting". He gave 35 members and 3 guests a fascinating and candid review of Safeguards problems as well as immediate and long term projections. He gave a survey of future and past Safeguards Policies and gave us an insight into the current political and technical considerations that affect the running of the department. In this regard he touched on effects of the recent re-organization and career structures for Safeguards personnel. It was mentioned that some 300 inspectors would be required by 1988 to perform some 30,000 mandays of inspection effort.

As regards the problems encountered with a rapidly expanding Department of Safeguards, Mr. Gruemm ended his talk with the thought that it was "better to have growing pains than sclerosis".

Guests at the luncheon were Professor N. Khrysochoides, University of Athens, Mr. S. Guardini of ISPRA and Mr. G. Buska of the Directorate of Euratom Safeguards, Luxembourg.

November

The IAEA was the venue for a symposium entitled "Recent Advances in Nuclear Material Safeguards" held from November 8th to 12th, 1982. Several Chapter members presented papers during the symposium: Abedin-Zadeh, Agu, Bahm, Beetle, Ferraris, Gruemm, Hough, Kaieda, Kaniewski, Keepin, Lovett, Pasternak, Pontes, Ramalho, Rosenthal, Rundquist, Sanatani, Shimojima, Taylor, Terrey, Turel. Chapter members who were chairmen of various sessions of the symposium included Tom Beetle, Carlos Buechler, Bob Keepin, Dave Rundquist, and Les Thorne. Jim Lovett was the organizer and Scientific Secretary.

The Chapter maintained an INMM Information office at the symposium with a display of past journals and proceedings. Information brochures and membership forms were available.

On November 11th the Chapter was the host at a wine and cheese party for symposium registrants, Chapter members and guests. The party, which was sponsored by INMM, was attended by about 40 members and 60 registrants including guests.

December

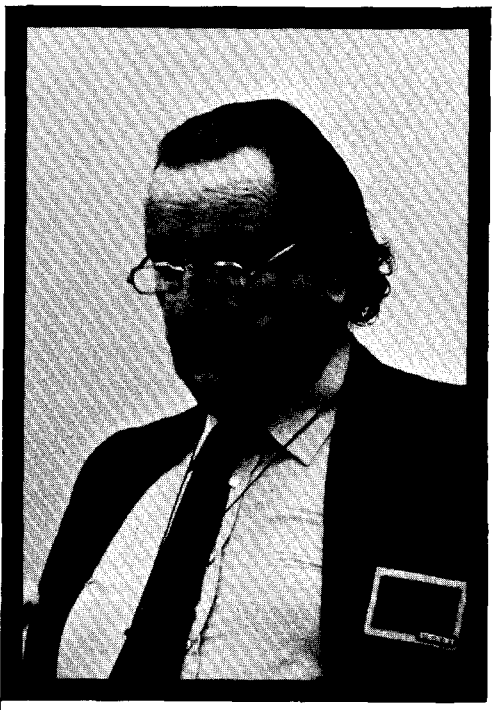
A lunch hour meeting was held on December 8th in the Vienna International Centre at which time Dr. F. Brown of the Atomic Energy Division of the Department of Energy (United Kingdom) addressed 24 Chapter members and a guest.

Dr. Brown gave us an interesting historical review of some of the milestones of safeguards development over the past 25 years. He reminded those present that some of the apparently very scientific concepts built into the early safeguards agreements were essentially the result of a compromise involving political considerations. As regards current safeguards topics, Dr. Brown mentioned the role of SAGSI (Special Advisory Group on Safeguards Implementation) and touched on the status of the Hexapartite (Enrichment) negotiations. He considered that Reprocessing Plant Safeguards problems were still far from being solved. In his opinion International Safeguards form the cornerstone of international nonproliferation policy, and he felt that in the present climate bilateral agreements would not work. He concluded that "an enemy of safeguards was an enemy of World Peace".

A guest at the lunch was Murray Duncan, Scientific Advisor to the Ambassador of Canada in Vienna.

The 1982–83 Executive Committee of the INMM Vienna Chapter (left to right): Mike Kaplan, Secretary; Ben Agu, Vice Chairman; Winston Alson, Member at Large; Cathy Morimoto, Treasurer; Tom Beetle, Chairman; John Ahlquist, Member at Large; Les Thorne, Past Chairman; Jim Lovett, Member at Large. Dino Pontes, Member at Large, is not shown. ▼

Dr. Fred Brown of the Atomic Energy Division of the Department of Energy (United Kingdom) addressed the Vienna Chapter at its December 8, 1982, luncheon meeting. ▶



Dr. Hans Gruemm, IAEA Deputy Director General for Safeguards, addressed the October 13, 1982, Vienna Chapter meeting on the topic "From the September General Conference to the February Board Meeting". ▶

Bob Keepin (l) and Ralph Jones (r) attended the symposium "Recent Advances in Nuclear Material Safeguards" held November 8–12, 1982, at the IAEA. Dr. Keepin was also a session chairman. ▼

Jim Lovett was the organizer and Scientific Secretary of "Recent Advances in Nuclear Material Safeguards" held at the IAEA November 8–12, 1982. ◀

Photos courtesy of INMM Vienna Chapter Member Albano de Moncada.

CERTIFICATION BOARD REPORT

DR. FRED TINGEY, CHAIRMAN
University of Idaho
Idaho Falls, Idaho

The Certification Board announced the next written examination for both Safeguards Intern and Safeguards Specialists will be held in conjunction with the annual meeting in Vail, Colorado on July 11, 1983. The requirements for a Safeguards Intern are: (1) a college degree, or (2) graduation from high school plus three years experience in Safeguards or five years experience in related fields. The requirements for a Safeguards Specialist are: (1) satisfactorily certified as a Safeguards Intern and two years experience as a professional employed in Safeguards, or (2) a college degree and five years experience as a professional in Safeguards, or (3) graduation from high school, four years experience in Safeguards related activities and an additional five years experience as a professional employed in Safeguards. Interested applicants for the examination to be conducted in Vail should obtain an application blank from the Board Chairman, Dr. Fred H. Tingey. P.O. Box 778, Idaho Falls, ID 83402, and return it prior to the examination date. Those desiring to do so can pay the certification fee of $100 for Safeguards Intern and $250 for Safeguards Specialist in conjunction with the payment of fees for the annual meeting.

The written examination will encompass six categories of application: (1) general, (2) accounting, (3) material control, (4) physical protection, (5) measurements, and (6) statistics. The Safeguards Intern examination will consist of a total of 100 questions from all categories with at least 15 from each category. The Safeguards Specialist examination will consist of 150 questions with at least 65 questions from the applicant's field and at least 15 questions from each of the remaining five categories. All questions are multiple choice or true and false. The examination takes approximately three hours.

A satisfactory (passing) grade for certification as a Safeguards Intern is 60% or better in each category, and 70% or better in the applicant's specified field, with an overall grade of 65% or better. In addition, the Safeguards Specialist must successfully pass an oral examination to follow shortly after the written examination and to be administered by designated members of the Certification Board.

In addition to the examination in Vail, the Certification Board in conjunction with the Education Committee is sponsoring a training session in early Fall, date and time to be announced, which will focus upon the six areas of Safeguards and will conclude with the taking of the Safeguards examination by interested participants. To better schedule a time and location for this training session, those individuals who may be interested in attending such a session should, at the earliest opportunity, advise Dr. Tingey at the above address of their interest.

TECHNICAL WORKING GROUP ON PHYSICAL PROTECTION REPORT

JAMES D. WILLIAMS, CHAIRMAN
Sandia National Laboratories
Albuquerque, New Mexico

The presently scheduled and planned workshops of the Technical Group on Physical Protection are listed below:

- Integrating the Elements of Delay, Intrusion Detection, and Entry Control into Physical Protection Systems, October 18–21, 1983
- Security Personnel Training, November 14–17, 1983
- Protection Against the Insider Threat, Spring 1984 (Tentative)

Workshops on other subjects of interest to physical protection personnel will be considered if enough interest is expressed. Additional details about the group activities are given below.

General

The Twenty-Fourth Annual Meeting of INMM will be held July 10–13, 1983 at Marriott's Mark Hotel, Vail, Colorado. A number of physical security papers will be presented.

The workshop, Central Control and Information Display Systems, was held in Atlanta, Georgia February 14–17, 1983. This was a workshop in a new area and it was very successful. Additional information about it is given in the last section of this report. The success of this workshop was due primarily to the efforts and dedication of Larry Barnes, AGNS.

Security Personnel Training

Contact Fred Crane
International Energy Associates Limited
Suite 600
600 New Hampshire Ave. N.W.
Washington, DC 20037
Telephone 202/342-6717

We regret to announce that Dr. L. Paul Robertson died suddenly on February 8, 1983. Paul was the Technical Program Chairman and principal organizer of the workshops on this topic held in Gatlinburg, Tennessee, August 1980 and St. Charles, Illinois, October 1981. His contribution to INMM and to this technical area will surely be missed.

Fred Crane has agreed to chair the third workshop concerning the training of security personnel. It is tentatively planned to be held November 14–17, 1983 in Albuquerque, New Mexico.

If you have ideas about topics to be covered or suggestions to make about this workshop, please contact Fred Crane.

Integrating the Elements of Delay, Intrusion Detection and Entry Control into Physical Protection Systems

October 18–21, 1983
Place: Long Beach Hyatt Hotel, Long Beach, California
Contact James C. Hamilton
Goodyear Atomic Corporation
P.O. Box 628, Mail Stop 1231
Piketon, Ohio 45661
Telephone 614/289-2331, Ext. 2204
FTS 975-2204

This workshop will be the fourth workshop on intrusion detection and entry control. During this workshop, the delay element (fixed barriers and activated barriers) will also be discussed. If you have ideas of specific topic to be covered or suggestions to make about this workshop, please contact Jim.

Protection Against the Insider Threat

This workshop has been tentatively planned to be held in the Spring of 1984. A session on this topic will be held during the Twenty-Fourth Annual Meeting of INMM, July 10–13, 1983 at Marriott's Mark Hotel, Vail, Colorado. If sufficient interest in this topic is indicated, the plans will be finalized. Please notify J. D. Williams, Division 9269, Sandia National Laboratories, P.O. Box 5800, Albuquerque, New Mexico 87185 of your interest in this workshop.

Central Control and Information Display Systems

Larry Barnes
Workshop Chairman
Allied General Nuclear Services
P.O. Box 847
Barnwell, SC 29812

The Physical Protection Technical Working Group sponsored a workshop entitled "Central Control and Information Display Systems" during February 14–17, 1983 in the Southern Conference Center of the Colony Square Hotel, Atlanta, Georgia. The purpose of the workshop was to provide the participants the opportunity to present, discuss, the exchange information on central control and information display systems applied to high security applications.

Thirty-five participants from the United States and Canada included representatives from the Royal Canadian Mounted Police; National Bureau of Standards; NASA, DOD, and DOE contractors; national laboratories; equipment suppliers and installers; architectural engineering firms; and commercial power generating companies.

Registration on the evening of February 14 was followed by a get acquainted cocktail party.

Tuesday morning, February 15, the opening session began with a welcome on behalf of the Institute by Jim Williams, INMM Technical Working Group on Physical Protection, Chairman. Jim gave the group a brief history of the INMM with emphasis on past and future activities of the Working Group.

The keynote session was conducted by Larry Barnes, Workshop Chairman, Allied General Nuclear Services. He reviewed the status of control and information display systems and identified problems which still existed.

Four consecutive workshops were held. Each workshop was repeated four times so that each participant attended all four of the sessions but with a different group each time.

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The Design Installation Session was moderated by Kitu Krishnamurthy, Bechtel National, Inc. This session addressed the following questions.

1. Who should be involved in establishing design criteria, detailed design and installation of the system?
2. How will data be collected and who will be responsible for data services provided to Central Control from Operations, Safety, Health Physics and Nuclear Materials Control?
3. What data will Central Control make available to Operations, Safety, Health Physics and management?
4. Who has authority to call for response and identify status that could cause actions that bypass system or shutdown under conditions of plant upset, attack, and/or accidental situations?
5. What area of expertise should be represented in the design/installation group?
6. How will the equipment be procured?
7. If a competitive procurement is chosen, what will be the basis for selection?
8. What sources will be used to locate manufacturers of alarm reporting systems?

The Hardware Session was moderated by Rick Beckmann, Sandia National Laboratories. This session addressed the following questions.

1. What types of alarms and how many alarms of each type must be reported by the alarm reporting system?
2. Which alarm transmission techniques are most appropriate?
3. If multiplexing is used, what factors would be considered?
4. Will the system use remote SECURE/ACCESS switches which must be operated by someone at the alarm location?
5. Should the system use non-security personnel from other organizations and departments which are responsible for the alarmed area?
6. What type of line security should be used?
7. Should remote units be programmable?
8. Should the system report tampering with sensors, junction boxes and equipment enclosures, line faults and equipment malfunctions?
9. What do you expect an operator to do when tamper alarms and other faults are received?
10. In general, how much of the alarm reporting system is affected by the failure of a single component?
11. How is the system checked for malfunctions which would fail to report alarms?
12. What provisions exist for periods of system failure?

Opening session

Typical workshop session

The Display Consoles Session was moderated by John Ellis, Allied General Nuclear Services. This session addressed the following questions.

1. Are security, fire, safety, and other related information all displayed and controlled at one location?
2. Is the location area alarm panel merely a readout (passive) display with no operator decision controls with the guard located in an assessment or fighting position?
3. What information does the console operator need when an alarm occurs?
4. How are buildings and zones popularly designated at the facility?
5. What type of displays are required to present information?
6. What records and logs should the system produce?
7. Should reports be hard copy and display on demand and/or automatic?
8. What actions must be taken when an alarm is received?
9. What actions are taken when a building is opened or closed?
10. How does the operator interact with the system?
11. How large an area can one operator and annunciator cover?
12. What combination of alarm displays and TV assessment monitors saturate the operator?
13. How do you protect against an internal threat to the annunciator system (covert by-pass)?
14. How much work space and file space is required for the operator?
15. Do annunciator functions require more than one operator at certain times? When?
16. What additional electronic equipment must interface with the operator while he is performing annunciator duties?
17. What are the tolerance thresholds for confusion and disorientation for operators on two, three, or four simultaneous alarms.?

During the session video tapes prepared by Larry Barnes, Allied-General Nuclear Services; Ray Moore, National Bureau of Standards; and Rick Beckmann, Sandia National Laboratories added to the discussion and allowed the participants to see systems developed by the respective organizations.

The Nature of the Central Control Problem was moderated by Frank Smith, Ebasco Services. This session addressed the following questions.

1. What are the main threats against which the system is intended to provide protection?
   —Terrorism, sabotage, diversion of SNM
   —Protecting classified/sensitive materials/information
   —Theft/protection of plant property
   —Enforcing "No Trespassing" regulations
   —Controlling access during upset conditions and special situations.
2. What information is needed to provide this protection?
3. Who will evaluate the data?
4. Who will be called to resolve or assess potential problems related to each threat?
5. What regulations are applicable to the facility and equipment that present special problems for the personnel and/or design and installation?
6. What are the advantages and disadvantages if the security force is in-house personnel or if provided by contract with an outside service?
7. Should you have specialized classes or guards or should every guard perform all duties?
8. How much training (formal and on-the-job) should be required before a new guard is qualified in procedures and familiar with facilities?

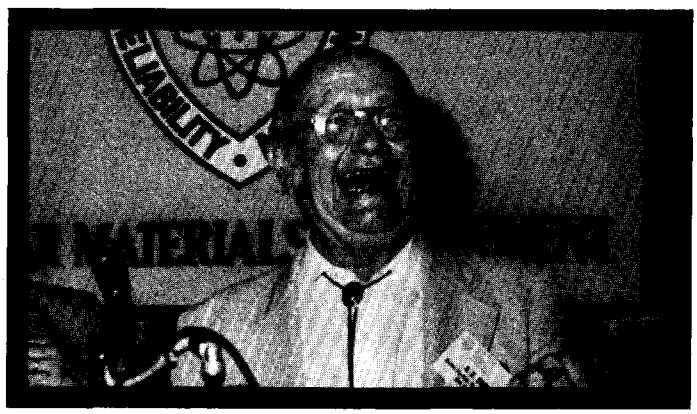
Following the first day's session, a dinner for the participants was held at the Colony Square Hotel. During the closing meeting on Thursday morning, each session moderator presented a summary of the discussion items in his session. More complete summaries and a final list of the attendees will be compiled into the proceedings of the workshop. Copies of the proceedings will be mailed automatically to each participant.

Special thanks go to Larry Barnes, Workshop Chairman; to each of the session moderators whose outstanding effort was the basis for the workshop's success; and to the participants, especially those who furnished video tapes and other material. The contributions of the INMM staff, and the contribution of the Allied-General staff, especially Jack Shaffer, are also greatly appreciated.

Typical workshop session

Dinner meeting

A REMINISCENCE, 1944



R. D. Smith, better known to most of us as "Smitty," retired on December 31, 1982, after 39 years with Oak Ridge Y-12 Plant. He grew up in Gloversville, New York, was educated at Columbia University, and came almost immediately thereafter to Oak Ridge with the U.S. Army on the Manhattan project where he has remained ever since. A charter member of INMM, he was presented the Meritorious Service Award in 1982 after long service to the Institute.

This is the first in a series of articles in which he recounts the unusual circumstances and the many odd and humorous stories that were a part of the early days in Oak Ridge. They are presented here, unabridged, and (as those of you who know him would say) only as Smitty could tell them.

Roy G. Cardwell

In 1944, Oak Ridge was a place one would hardly believe today. There was omnipresent mud—inevitably, indoors, as well as outdoors. There was a constant smell of sulfur dioxide because everyone with a stove burned Tennessee soft coal. The roads were bad, except for the ones the Army had just repaved. The bridges across the Clinch River were execrable. The general appearance of the emerging town was tacky, what with G.I. trailers, hutments, flattops, efficiency apts., etc.

In the Spring of 1944, when I arrived—I noted all those things—but I also saw the dogwoods as I walked along Tennessee Avenue (which the Army had almost finished) and I fell in love with the whole thing. Speaking about my arrival, it was on the evening of March 31. Stepping off the bus, carrying my barracks bag, I sank into the stupid mud over the tops of my G.I. boots. So, my first day in Oak Ridge was April Fool's day, 1944.

Well, the first month and a half or so were not so great; I was assigned to digging drainage ditches in the barracks area. (If anyone cares, it was located right around where the Ark Bowling Lanes are now situated.) Thank the Lord no Sergeants made us polish out boots. I know why; they couldn't keep their own polished.

There was one big guy who kept us entertained. He knew operas. He could sing them, or arias from them, in the foreign languages. I think he was a baritone, because he attempted both the tenor and bass ones. He'd crack a little in high tenor or low bass (I wish I could remember his name); at any rate he kept us happy, even though digging.

Finally one day I was called to the orderly room and told I'd been assigned to Y-12. Of course I went. I was interviewed by an older man named Dr. Clarence Larson. You'll remember that he was later Director of ORNL, President of the Union Carbide Corporation-Nuclear Division, and finally a Chairman of the Atomic Energy Commission—in that order. He asked me in which branch of chemistry I'd like to work. I told him I didn't care—anything from bench chemistry to unit operations. He assigned me to the analytical laboratory.

The analytical laboratory was in Building 9203 which was newly finished. It was a rather large room crossed by lab benches row-on-row. There was perpetual fog in the room, ammonium chloride, because hydrocloric acid and ammonium hydroxide bottles were open at the same time. It was the most ingenious analytical laboratory I have ever seen—an assembly line.

The whole operation of the assembly line was explained to me, lab bench by lab bench, except what we were doing. We were working on something called, simply, "T". The analyses we were doing were clearly gravimetric; we were obviously measuring some element with which I was not familiar from my boyhood amateur chemistry laboratory, or from my high school chemistry, or from my two years of college chemistry. It made me feel stupid. I had been proud of my knowledge of inorganic chemistry—I've always hated organic—but this was clearly inorganic. Then, why were we using so much oxalic acid?

At that time I didn't know—nor much care. I was going to be doing what I had always wanted to do; I was going to be a chemist. The glassware was exquisite and complicated. The compounds we were working with were extremely colorful and obviously just as complicated. I remember writing to my Mother something to the effect that I had found my niche. And I had. Except for some stupid summer jobs, before the Army, I've never worked anywhere but Y-12 and have loved every minute of it (with minor exceptions).

And then we got to the back bench; that was my assignment. With three other G.I.'s, it was to be manned twenty-four hours a day, seven days a week. (If you've never been on rotating shifts, try a fun time.) I don't know how they feel in Parliament, but I was extremely proud to be a back-bencher. We were to do continuous diethyl ether extractions.

Now diethyl ether is something else. (I had had several operations in which that was the anesthetic; it worked, but the after effects were too much. Here I was with this huge can of diethyl ether, this two-liter—maybe five-liter—Erlenmeyer flask, and a beaker to cover it. Of course you all know, one doesn't contain diethyl ether very well at room temperature. Working in this very peculiar atmosphere, I'd be a bit tipsy in about fifteen minutes. So I sang.

Now I'm not a good singer, but I'm not bad "ether." And some of the girls in the lab were outstanding. One in particular should be mentioned. Her name was Ann Hummel, a soprano, and a natural musician. She was also a blonde beauty. (I ought to, I suppose, mention here that I was already married, and that, in spite of the many temptations, I kept that in mind.) Anyway, she could harmonize with anything. She was on the first bench, as far from me as you could get in that room. But when we raised our voices in song, particularly on the night shift, the whole laboratory was obliged to join in or cover their ears. Most joined in and it was real fun.

Do not get the impression that we were not working. Lord, how we worked. Our shift got the reputation for doing more and better work than the other three shifts. I blame it on the singing and, in turn, on the effect diethyl ether has on me. It's shameful, I suppose, but I got so I loved the stuff. No supervisor we ever had told us to stop singing, which I think is significant.

Before I put you to sleep with diethyl ether, let me put in one final story. Evelyn, my dear wife, came down to Oak Ridge in June 1944 and she mentioned casually that I always smelled of ether. We both thought about that (she's at least my equivalent as a chemist); here's this compound that is so ephemeral that a watch-glass full is gone in seconds, yet I smelled of it still at the end of a three-day break. So, I went to one of my supervisors, and now long-time friend, Forrest E. Clark, and asked why. He told me that diethyl ether is protein-soluble; that it was in my skin and my clothes and that it comes out, but it takes a long time. It's a wonder I didn't spontaneously combust on one of my cigarette breaks.

There's one more thing I'd like to tell you about. It has to do with the strict security arrangements we had at that time. No one was to tell anyone anything, and we didn't. There was a one-through-five Roman numeral code on our badges. I was a III, but at this time I can't remember which way it went, i.e., whether a one was cleared for everything or a five. At any rate, it was supposed to mean what you could know.

I want to stress this a little. We were really indoctrinated. We lived "the secret" and we didn't know what it was. Sure, we knew what we were doing; we were analyzing for "T", but we didn't know what "T" was, or why we were doing it.

With that background, you may find the following incident humorous. One day a very distinguished-looking gentleman approached the back bench. He was very obviously "somebody", but I couldn't see his badge. The little Roman numeral, which meant so much at the time, was not apparent. I don't know whether it was how he was standing, or whether some article of his clothing was covering it. He was most civil and engaged me in conversation. After the nice preliminaries he asked: "What do you do with your analytical residues?" I answered that I put them in the five-gallon bottles over there, with a thumb-over-the-shoulder gesture, and explained the procedure. He persisted. "Where do they go then?" I told him "some place they call "salvage", and then it really hit me. I said, "Sir, I don't know you. I'm not sure I should be answering your questions. Please direct them to my supervisors." He looked at me kind of funny and left.

About five minutes later, Forrest Clark stormed out of the lab office and said "What did you say to Dr. Conklin?" I told Forrest, essentially that I had said "get lost." Forrest told me Dr. Conklin and the whole lab were proud of me. It was a funny feeling to have told off the Works Manager of Y-12 and gotten away with it.

We all must remember when we were young and did foolish things. It is nice, once in a while, to remember when we did something not so foolish. At the age of twenty-one, I had managed to do one thing right.

NEXT: The secret riddle of "T" is solved.

BOOK REVIEW

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NUCLEAR PERIL, The Politics of Proliferation, The Hon. Edward J. Markey, with Douglas C. Waller, Ballinger, Cambridge, Massachusetts, 1982, 183 p., $14.95.

Probably the best thing that can be said about this book is that it is as brief as it is. Written by Congressman Markey (D., MA.), the book is not so much a polemic against the concept of nuclear power as it is a rather disconcerting example of self-puffery. Nearly half of the book is a description of Markey's efforts to work for the override of Carter's decision to send fresh fuel to India for Tarapur, against the unanimous advice of the NRC, plus a recounting of a not-very-interesting episode at the 1980 Democratic Convention, wherein Markey threatened to run for Vice-President in order to get approval to address the delegates for a few minutes on the subject of nuclear power. All this is done in a juvenile "Oh, wow, look at me!" style which is nothing so much as embarrassing. One hopes that Markey's staffer, Waller, is responsible for these parts, since sycophancy is less repulsive than egomania. At least I think it is.

Even in these times, which are hardly auspicious for the pro-nuclear community, this book has not had very much impact or exposure. This is clearly because it is so bad, and is only a superficial rehash of arguments which have been often made elsewhere, usually by people a lot more eloquent and intelligent. Nevertheless, since this is a book written about nuclear power by one of its chief Congressional critics, it may be of some interest to review the principal positions and rationales provided, if only to realize the weaknesses and lack of serious thought that support them.

Markey's chief argument is that even though he considers nuclear power to be inherently unsafe, the main reason he supports a phase-out of all nuclear plants is because of the danger of proliferation of nuclear weapons which is increased by the presence of nuclear fueled electricity. The chief stupidity which I find in the book is the often repeated assertion that horizontal proliferation is more dangerous and more immediately so, than vertical proliferation. That attitude clearly shows that a U.S. Representative, who takes a particular interest in nuclear matters, has not the foggiest idea of even the orders of magnitudes of such vital questions. And I find that truly frightening. Consider: the U.S. and U.S.S.R. have tens of thousands of nuclear warheads between them; they are both moving in the direction of changing nuclear strategies to arm themselves with first strike weapons (MX, Pershing 2, SS-20, etc.) which will in turn force them to arrange defenses on a hair-trigger basis. Anyone who does not see that as a most ominous clear and immediate danger, which threatens the human race, just does not understand the problem. And yet, we have Markey, who professes a concern about these matters, more worried about a Third World Tin Hat dictator maybe coming up with one or two weapons over the next few decades, than he is about the very real trend to the brink in superpower weapons development. Why? Because Markey is attempting to rise in the ranks using the domestic nuclear issue, and is more concerned about using domestic reactors as a device for propelling him into the national spotlight, than he is about making the world a safer place in which to live.

On the Tarapur issue, I agree with Markey but, again, I keep having the feeling that his chief interest is not to halt the spread of nuclear weapons, but rather to use the issue to make a name for himself politically. The tone of his recounting of the story lends credence to this attitude on my part. Markey persistently paints himself as a brave iconoclast and destroyer of traditions in describing the events and maneuvering Congress, when actually he was merely acting in the same way that every other ambitious Representative does. I count him as right on this issue, but almost by accident.

With regards to nuclear safeguards, the IAEA system is attacked as inadequate. Nowhere, however, does Markey advocate strengthening the Agency. Israel's attack on the Iraqi reactor is justified (clearly, this is contradictory to most of Markey's arguments and is obviously done on his own narrow political grounds) even though it weakened the IAEA and international safeguards in general. "The Islamic Bomb," which Markey references, clearly took the position that the Iraqis were on the order of a decade from even the possibility of a bomb, but Markey ignores this fact, as he does all others which do not serve his short-term political goals.

In repeating false claptrap about the IAEA's program of inspection for the Iraqi reactor, Markey is clearly unaware of many facts in the case which are well-known. He claims that France had shipped 80 kg. of fresh fuel to Iraq. That is false. About 12 kg. had been supplied and were irradiated, which would have made it virtually impossible for the Iraqis to handle. He asserts that there were plenty of "open spaces" which could be adapted to hold natural uranium for breeding purposes. He does not mention that if all the "open spaces" and, indeed, the whole reactor core were blanketed with natural uranium, the reactor would be barely able to produce a bomb's worth of plutonium per year. He also does not mention that, in order to do that, the whole reactor would have to be devoted to plutonium production and to nothing else. The process could not possibly have escaped the notice of the IAEA inspectors, let alone the French technicians, who would actually be running the reactor for a decade or more, until Iraq developed its own personnel to replace them. Markey also confuses the inspection plan of the reactor before fuel loading with that which would have been installed once the reactor started functioning. The 4-month inspection plan was universally admitted as adequate for safeguarding while the reactor was being finished. It would not have been continued once the reactor was turned on; a totally different regime of inspection had almost been prepared for this mode, and would have been perfectly adequate for safeguarding the reactor at this point. Markey claims the 4-month cycle would have provided inadequate safeguards for the operating reactor; he is right; however, the IAEA never had any intention of using this mode once the reactor was on the air, and it is dishonest to claim that they did. One could go on and on, but it is not worth dissecting every piece of misinformation presented here. The only question I have is whether the underlying philosophy is one of purposeful misrepresentation or of widespread ignorance. I would tend towards the latter explanation, except for the fact that Markey has a rather poor track record for candor and integrity.

For example, one remembers that on November 1, 1982, just the day before the mid-term elections, Markey hit the press with a totally false statement, based on the Sandia study of worst-case reactor accidents. Markey and the Washington Post claimed that the probability that a worst-case accident would occur before the year 2000 was 2%. In fact, the correct number was 2 in a MILLION! Neither Markey nor the Post ever retracted that statement even though it was disproved almost immediately. To me, that is an indication of bad faith, and leads me to think that many of Markey's distortions in his book are purposeful, not accidents. Incidentally, Markey's motive in this was clear: as he gleefully tells in his book, he is learning to manipulate the mass media for his political ends, and the day after his press conference, Markey was re-elected, an anti-nuclear referendum passed overwhelmingly in Massachusetts, where he held his press conference, and an anti-nuclear referendum in Maine, while defeated by a large margin, did much better than expected.

On the question of nuclear power in general, apart from proliferation questions, Markey is no more straightforward. He denies that nuclear replaces much oil; in this, he is repeating canards originated elsewhere by people who evidently have trouble with deeper concepts, such as multiplication and division. Nuclear power has already displaced over a million barrels of oil per day; this is 25% of our current oil imports. The fact that coal could also displace oil is not relevant; nuclear has displaced oil, and is continuing to do so. In a few years, the figure of 2 million barrels per day will be reached. In other words, our imported oil will be reduced by ⅓ by nuclear power. Obviously this is highly significant, both domestically, where we will find ourselves less susceptible to foreign blackmail, and internationally, because our leaving the market allows much more oil to be there, reducing pressures which have already led to at least one war. Markey's suggestion that nuclear power can be replaced by coal should be communicated to our local anti-nuclear forces in Long Island. Knowing that coal is unacceptable to Long Islanders, they have, believe it or not, advocated continued and increased reliance on foreign oil as an alternative to nuclear power. Markey, uncritically, also repeats arguments advanced by Amory Lovins in a Foreign Affairs article of over two years ago. Lovins held that nuclear power only had a future in those countries with a strong centralized government, and was in retreat elsewhere. Both Lovins and Markey are apparently unaware that virtually every government in the world is strongly centralized (with a few exceptions, such as Canada and Japan, which happen to have strong nuclear programs). Apart from that, since Lovins' ill-fated prediction, massive increases in nuclear power programs have occurred in many countries, such as Spain, Italy, China, and others. Even Denmark and the Netherlands are now opening debate on whether to go in the nuclear direction.

Markey's apparent lack of feel for the international scene is clearly reflected in his advocacy of a halt to furnishing foreign nations with any nuclear help, in the belief that this would effectively end nuclear power. He is, of course, unable to explain why Carter's attempt to do this just in the reprocessing area was rejected and ignored by virtually every nation in the world with interest in nuclear matters. If a ban on reprocessing did not work, what makes Markey think that the US has the leverage to end nuclear power across the world, when, first, we have less leverage than we had then, and second, when many nations strongly rely on nuclear power to keep their economies going? Beyond this, his plan would lead to the immediate collapse of the Non-proliferation Treaty, and, most likely, to increased efforts on the part of several nations to acquire nuclear weapons. The mind boggles continually at the shallowness of thought displayed.

Finally, for those interested in Markey's solutions to our energy needs for the foreseeable future, he advocates increased use of coal to take up the slack created by his phase-out of nuclear plants, while waiting for the golden solar age. Like so many other anti-nuclear propagandists, he ignores the well-known fact that coal is the most deleterious energy source yet concocted by man, in terms of its effects on health, on the environment, and, probably, on the climate of the world in the short-to-mid-term. Thus, those who pretend to defend life and the ecosystems on spaceship Earth often argue for policies which are most dangerous to those values they allegedly hold dear. The pendulum will eventually swing back, but it will take a while. One hopes the damage that will be done will be limited.

UNDECLARED MATERIAL AND THE LIMITATIONS OF INTERNATIONAL SAFEGUARDS

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ABSTRACT

Attention is drawn to fundamental difficulties in addressing proliferation scenarios involving undeclared nuclear material in the context of existing safeguards agreements.

1. Introduction

Over recent years, as safeguards practitioners have addressed the problems of implementing technical control measures in the nuclear fuel cycle, they have come to a gradual realization of the practical limitations inherent in them. Conventional material accountancy as applied to detect diversions from commercial bulk processing facilities, for example, may fail to meet quantified standards of timeliness and significant amount recommended to the IAEA by its technical advisors. Such quantified guidelines are in fact now being understood as providing a basis for design and intercomparison of safeguards systems, but not as absolute criteria for judging their effectiveness. Similarly, the initial enthusiasm of proponents of extended containment/surveillance techniques as an alternative to accountancy has been considerably dampened by the difficult conceptual problems of defining and quantifying stand-alone systems.

In this paper a further limitation will be pointed out which has to do with the problem of coping with misuse strategies involving undeclared nuclear material. The discussion presented here does not fall into the category of "restrictive, legalistic interpretations" intended to hold irksome inspections and control procedures to a minimum. Rather a plea is made for the exercise of moderation in our expectations of what can be achieved in the cause of non-proliferation by the passive control regime handed down to us.

We begin, in the following section, with a discussion of the fundamental goals set out for safeguards. States' obligations in connection with declaration of nuclear material are discussed in section 3 and a definition of "undeclared material", as understood in the present paper, is attempted. In section 4 we describe the roles played by the technical control measures of material accountancy, containment and surveillance in achieving safeguards objectives. Then, in section 5, the effect of the postulate of undeclared material on the structure of objectives and prescribed measures is investigated. Our conclusions are summarized in section 6.

2. Safeguards goals

Nuclear weapons proliferation must be seen mainly as a political problem. Measures to solve this problem can therefore first of all be found on the political level. Technical measures, like safeguards, can support the political non-proliferation regime by enhancing confidence that states' nuclear activies are indeed directed toward peaceful ends.

Whereas nuclear weapons proliferation is an essentially political problem, international safeguards employ technical procedures. Their objectives, therefore, are defined mainly at the technical level. Although they address the problem of detection of clandestine military activities in states with formal non-proliferation commitments, they do so in an indirect way. Various means of achieving such a detection capability are in principle conceivable. The one which has enjoyed widest international acceptance

and which is embodied in all bilateral control agreements concluded with the IAEA pursuant to the Non-Proliferation Treaty is the verification of the continuing presence of nuclear material in the member states' peaceful nuclear fuel cycles. INFCIRC/153 /1/, which forms the basis for all such bilateral agreements, formulates this idea as follows (paragraph 28):

".... the objective of safeguards is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and the deterrence of such diversion by the risk of early detection."

Deterrence by "risk of early detection" is clearly an essential component of safeguards objectives, but virtually impossible to quantify. Efforts at quantification have therefore been restricted to the concepts of "timely detection", "significant quantity" and detection probability. Indeed, this failure to quantify risk lies behind the recognition that quantified detection times and significant quantities should not provide on absolute yardstick for assessing safeguards effectiveness.

INFCIRC/153 understands the term "nuclear material" as being "any source or any special fissionable material as defined in Art. XX of the (IAEA) Statute". An unexplained disappearance of such nuclear material from a state's nuclear facilities is taken as evidence of non-compliance with the NPT, and it is the exclusive task of safeguards to discover and report any such disappearance as soon as possible. This fixation on fissionable material as opposed, say, to a control of facilities or technology, has led necessarily to the establishment of nuclear material accountancy as a measure of fundamental importance (INFCIRC/153, para. 29). In this regard, it is not an exaggeration to say that NPT-safeguards are founded on the principle of conservation of matter. Containment and surveillance of nuclear material also play an important part in safeguards but only insofar as they complement or reinforce conclusions based on material accountancy.

3. The declaration of nuclear material under INFCIRC/153

INFCIRC/153 does not make a direct statement regarding the material that is to be declared by a state undertaking a safeguards agreement with the Agency pursuant to the NPT. Paragraph 1 prescribes as a basic undertaking that the state "accept safeguards, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere". This same formulation is used in para. 2 setting out the material on which it is the "right and obligation" of the Agency to apply safeguards. Paragraph 7 requires the state to "establish and maintain a system of accounting for and control of all nuclear material subject to safeguards procedures under the Agreement". Paragraph 40 specifies that safeguards procedures are to be "in respect of nuclear material listed in the inventory provided for in paragraph 41". Paragraph 41, in turn, simply repeats the formulation "all nuclear material in the State subject to safeguards under the Agreement". Nevertheless it seems quite clear that <u>all</u> sensitive nuclear material must be declared by any state upon entering into a safeguards agreement modeled upon INFCIRC/153. This is reinforced by the fact that, in paragraph 36ff, material which may be exempted from safeguards is listed explicitly, thus implying that exceptions to the rule are permitted only in those specific cases.

It may then be concluded that any failure to declare nuclear material not explicitly exempted from safeguards upon entering into a safeguards agreement, or any failure to declare the creation or acquisition of such material at any subsequent time, constitutes a breach of the NPT on the part of the state involved. On the other hand it must be obvious that the detection of a violation of this kind does not fall within the scope of the technical objectives of safeguards set out in paragraph 28. The purpose for which undeclared material has been acquired or produced is a priori unknown and it would therefore be incorrect to speak of the diversion of such material from peaceful nuclear activities. In what follows we shall understand the term "undeclared material" to mean

- any source or special fissionable material, not explicitly exempted from safeguards and located within a state party to an INFCIRC/153 type agreement, <u>the existence of which has never been made known to the IAEA.</u>

Unfortunately the existence of undeclared material in a state under NPT-safeguards has very

profound implications on the way in which technical control measures can be applied to declared material. This problem will be discussed in the following.

4. Technical control measures

4.1 Material accountancy

Material accountancy under NPT-safeguards is based on a formalized structure of material balance areas (MBA's). In each nuclear facility containing safeguarded nuclear material, one or more MBA's are defined in such a way that material flows crossing their boundaries and the physical inventories contained within those boundaries can be established as needed on the basis of measurements. At regular intervals, negotiated and set out in the safeguards agreement, the operator compares for each MBA the book inventory (defined as previously verified physical inventory corrected for subsequent receipts, shipments and measured losses) with the current physical inventory. The necessary data are gathered at well-defined and agreed upon key measurement points (KMP's) to which the inspectorate has access for verification purposes. The reported difference between book inventory and physical inventory, historically "material unaccounted for" or MUF, can then be written:

$$MUF = I_n + F_n - I_{n+1}$$

where I_n is the physical inventory determined after the n^{th} balance period and F_n is the net flow into the MBA during the $n + 1^{st}$ period.
The KMP's are associated with the various terms in the balance equation and can be classified as flow KMP's and inventory KMP's. For example a flow KMP is a point at which material movements to or from an MBA are determined by the operator, reported to and verified by the inspectorate.

Within this simple picture it is possible to make more precise what is meant by "diversion of the material from peaceful nuclear activities". There are two cases possible:

1) "External diversion". The unreported removal of safeguarded material from the MBA to some other place. If we understand "passing through" a KMP as implying measurement, reporting and verification of the corresponding material movement, then an external diversion can be said to be a by-passing of the output flow KMP's.

2) "Internal diversion". An intentional concealment of a portion of the inventory within the MBA, i.e. a by-passing of an inventory KMP.

The attractiveness of material accountancy lies in the fact that, irrespective of where, when or how the diversion, whether internal or external, took place, the effect is to give rise to MUF and hence to an anomaly signalling the possibility of illegal behavior. Diversion path analysis can be then restricted to examining the ways in which the operator might defeat the accounting system itself, but need not include the actual diversion activities (removal paths or concealment of material). In fact, an operator intent on defeating the accountancy measures - i.e. diverting a significant quantity without generating a significant MUF - has only two alternatives open to him:

- diversion into MUF
- data falsification.

In the former case the operator tries to conceal the diversion in his own measurement uncertainties. If this is possible with an unacceptably low detection probability, then of course the material accountancy measures should be improved. An attempt should be made to ensure that the limit of error of MUF is small compared to what is defined to be a significant amount for the MBA in question.

As regards the second alternative, given that the initial physical inventory of the MBA is agreed upon and verified, the operator can, in the course of any balance period,

a) understate his receipts
b) overstate his shipments/losses
c) overstate his final physical inventory.

Strategy a) clearly cannot in general be detected by verification of declared inputs, since receipts can be understated simply by failing to report some of them. However, it must be accompanied by a shipper/receiver difference or, in the case of collaboration, by a MUF in some other MBA. It is thus detectable by accountancy procedures external to the MBA in question. Such a strategy may also be characterized as a by-passing of an input flow KMP, and is obviously only sensible in facilities in which the strategic value of the material can be enhanced prior to its diversion.

Strategies b) and c) can be detected directly by adequate measurement verification at the declared flow and inventory key measurement points.

4.2 Containment/Surveillance

Containment and surveillance measures are applied by the IAEA in order to aid and simplify the procedures associated with material accountancy. In recent years a consensus among safeguards experts has been arrived at whereby C/S measures are classified into two broad categories, conventional and extended.

Conventional C/S can best be thought of as comprising those C/S measures applied directly at the accountancy KMP's. A typical example would be the application of seals to inventory items following their physical verification by a safeguards inspector. Remeasurement of the sealed items for future flow or inventory verifications could then be waived as long as seal and associated containment remain intact.

Extended C/S is a relatively new concept which arose historically out of deliberations associated with the problem of safeguarding large reprocessing facilities. A safeguards system logically independent of, and acting in parallel with material accountancy was thought desirable. The ESARDA working group on containment and surveillance has agreed upon a definition for extended containment/surveillance - which we present here /2/:

"Containment and surveillance measures regarded as extended ..... seek to ensure, by surveillance of certain locations and conditions associated with diversion of nuclear material, that the inventory within the area in question is only changing at the defined KMP's, and that these changes are the declared inventory changes which are recorded in the complementary materials accounting system."

It is now generally agreed that extended C/S techniques can be useful in arriving at a decision regarding the continued presence of safeguarded material. The wording of INFCIRC/153, on the other hand, leaves no doubt whatsever that, whether complementary extended C/S is applied or not, material accountancy procedures must be in effect as a safeguards measure of fundamental importance.

5. Undeclared material

The preceding section summarizes, according to the authors' understanding, the logical fabric of safeguards as they are practiced under INFCIRC/153. Although it is not yet fully clear that quantitative detection goals applied as guidelines by the IAEA can always be met, a self-consistent framework of measures directed toward the achievement of defined goals has been laid out. We would like to suggest in this section that the introduction of undeclared material into the discussion of proliferation scenarios which are to be countered by technical safeguards destroys this fabric entirely. Safeguards analysts and practitioners are left with no firm basis upon which to design control systems or assess their effectiveness.

As already mentioned, material accountancy relies upon the principle of conservation of matter. The material balance equation (section 4.1) is nothing other than the time integral over one balance period of the continuity equation, the mathematical formulation of that famous principle. It follows that a safeguards approach which takes into account material whose existence is, by definition, unknown to the controlling authorities and which can in principle be injected into a fuel cycle at any convenient place and time, cannot be based upon material accountancy. The postulate of a hidden and, presumably, inexhaustible source of undeclared material renders the principle of conservation of matter meaningless. Under these circumstances, a closed material balance will have safeguards significance only to the extent that containment and surveillance measures are successful in isolating the safeguarded facilities from the surrounding world. Such measures would have to be effected on the entire periphery of the MBA's, not just at key measurement points, and would necessarily assume the fundamental role in the control system. Moreover they would have to be foolproof. A failure or alarm in the peripheral C/S system could no longer be resolved by a back-up physical inventory, since any apparent breach of C/S would necessarily discredit the accountancy system.

The de facto elevation of containment/surveillance to the dominant role in safeguards is neither in the spirit of INFCIRC/153 nor is it likely to lead to control systems capable of reaching objective conclusions.

An excellent, if highly controversial, example is provided by the commercial gas ultracentrifuge enrichment facility. A quantified safeguards goal for

such a facility would be the detection within one year of diversion of 75 kg of U-235 in the form of low enriched UF_6. Material balances in centrifuge enrichment plants, relative to throughput, are among the most accurate in the entire fuel cycle. It is generally accepted that this detection goal can be met for plant capacities up to 2000 t swu/a using accountancy and verification techniques. If one now proposes, as is being done in international discussions, that the safeguards approach take explicitly into account undeclared material scenarios (e.g., the production of LEU from undeclared feed) an essentially solved problem must be reopened. An "airtight" containment must be devised to keep material out of the plant and inspection activities agreed upon for the verification of the absence of nuclear material inventories. Unlike spent fuel reprocessing facilities, sturdy, virtually impenetrable containment barriers for nuclear material are nowhere present in enrichment plants. "Natural" containments for the process MBA, such as the cascade hall buildings, are thin-shelled and must be breached with high frequency by personnel and equipment. Extended containment/surveillance systems are thus manifestly inappropriate and the whole question of the safeguardability of the facility poses itself.

6. Conclusions

Firmly entrenched in INFCIRC/153 and agreements based on that document is the requirement that material accountancy play a fundamental role in international safeguards. In the context of material accountancy, diversion strategies can be clearly defined and the assurance of non-diversion can be expressed objectively, often quantitatively. In the authors' view it would be a great pity to set safeguards goals so high that they become, by definition, unachievable by such accepted methods. Implementing material accountancy is an exacting technical problem at best. Placed in an international safeguards environment, the difficulties are compounded by the need for independent verification of source data in such a way that the objective, quantifiable results inherent in material accountancy can be used to make statements of safeguards significance. This is a serious conceptual problem, statistically non-trivial and often expensive to put into practice. The question must now be asked whether, with the inclusion of undeclared material in diversion and misuse scenarios, too large a burden is being placed on international safeguards as a whole.

Stockpiles of undeclared material, just like undeclared facilities, undeniably represent a proliferation risk and constitute, by their very existence, a violation of the NPT. However, they fall outside the scope of a control regime founded, by agreement, on the verification of voluntarily supplied information. Other institutional arrangements /3/ may well have to be designed to deal with them. International safeguards, we feel, cannot do so and at the same time retain an intact logical foundation.

Explicit reference to undeclared material is notably absent in INFCIRC/153, a document whose acceptance by the great majority of the world's nations represented a major advance in the limitation of the spread of nuclear weapons. As we have tried to point out, the technical means available to detect and deter proliferation are, and always will be, limited. Setting unlimited technical objectives will, in the long run, destroy the credibility, and therefore the usefulness, of safeguards.

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