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NUCLEAR MATERIALS MANAGEMENT

INMM

INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT

JOURNAL OF THE INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT

EDITORIAL

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

About a year ago, the INMM Executive Committee requested Tom Shea to review the editorial policy of the Institute and to make recommendations as to how the Institute might be more effective in communicating with its members and with other interested individuals and institutions. In order to perform this review and to establish a means to achieve the broader objectives, Tom persuaded six capable members of the Institute and myself to form, with him, an Ad Hoc Committee on Communications. He also prepared a prospectus and a plan of action which the Ad Hoc Committee discussed and recommended to the Executive Committee for adoption during the annual meeting in Columbus, Ohio, last July.

In view of the expanded scope of the Institute, the members of the Ad Hoc Committee were selected to represent the six areas of interest: international material control and accounting, international containment and surveillance, national material control and accounting, national physical protection, nuclear waste management, and transportation of nuclear materials. These six individuals are listed in this issue as associate editors for the six areas of activity.

According to our charter, the editor and associate editors are to:

- Establish the issues and topics which should be examined and encourage the broadest range of contributing along those lines.
- Identify prospective authors and invite contributed articles on selected topics of special interest.
- Coordinate critical reviews of such papers.
- Assist the editor and Institute staff in preparing lists of upcoming events and on other activities relating to the Journal.
- Identify topics for INMM monographs and identify and work with authors of such documents.
- Advise and assist other Institute committees, such as those concerned with training courses, workshops, meetings, or standards, to the extent that this may be useful.

The hope was that this committee should bring these assignments into full operation by the end of 1985, and that the Journal would then become the high quality publication which our profession needs.

This is too big an undertaking for the members of the communications committee or board of editors to accomplish without the active assistance and encouragement of our members, the several chapters of the Institute, and the many organizations or institutions which are engaged in the development and implementation of safeguards programs. You may have noticed that a significant fraction of the recent technical papers have been provided by the Vienna Chapter. To the members of that chapter we are most grateful. How about the other chapters, your government office, your company or institution?

The big meetings arranged by the Institute, ESARDA, the IAEA, etc., perform a very important communications service. ESARDA now publishes its Bulletin, which compliments the Journal. It is our hope that the Institute and the Journal will be truly international and comprehensive.

The associate editors, the officers of the Institute and I appeal for your cooperation. We will be calling on our fellow members for contributions, for editorial reviews, and for suggestion. But, don't wait until you are called upon. Volunteer now. We will be happy to add names to the communications committee and to bestow titles, if that might encourage anyone.

As regards contributions and suggestion, please send them to me. As in the past, three copies of contributed articles will speed their review and processing. I will arrange to send things to assistant editors or to others, as appropriate. I will also endeavor to ensure that the procedures are performed in a timely fashion.

Special thanks are hereby given to Tom Shea for his initiative and constructive contributions to this project. I wish to take this opportunity to express my thanks to the many members who have assisted me in the past in soliciting and reviewing papers, many of whom have never received the credit they deserved. Probably we will call on you again in the future.

This is your Journal and your Institute. Its stature and usefulness depends on you.

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CHAIRMAN'S COLUMN

YVONNE M. FERRIS
Rockwell International
Golden, Colorado

Have you ever tried to rent a car with an expired credit card? Rental car agencies just won't permit you to do that. The Institute of Nuclear Materials Management is in a similar position with delinquent dues. We simply cannot afford to supply members with the Journal, brochures, or meeting notices when they have not paid their dues. Although it may be heartbreaking to have to do so, the Institute must drop its delinquent members from its rolls. Roy Cardwell has an article on this subject in the Journal and I urge you to read it. Our Bylaws are very explicit on this point and Roy does his usually good job of explaining them. Please help Roy and his committee by remitting your dues as soon as you receive the invoice. Don't let them get lost in your in-basket.

In September 1981, the Institute revised its bylaws to include the membership grade of Fellow. So far, the Executive Committee has approved six senior members as Fellows. All we need to approve more members for this grade is nominees. Jim Lovett is the chairman of the Examining Committee and he would welcome the job of receiving your nominations, assuring that they meet the requirements and recommending them to the Executive Committee. The requirements for Fellow are listed in Article I, Section 4 of our Bylaws, and the way to nominate someone is described in Article II, Section 5 of the Bylaws. Jim's address is:

James E. Lovett
International Atomic Energy Agency
Vienna International Center
P.O. Box 200
Vienna A-1400, Austria

The annual meeting is just around the corner. The committee chairmen have worked very hard to arrange a challenging technical program in pleasant, efficient surroundings. Every detail is being attended to. Clear your calendar for July 22-24 and join us in Albuquerque for our 26th annual meeting.

ERRATA

K. J. Swyler, Brookhaven National Laboratory, was the author of the book review section published in Volume XIII, Number 2.

Recipient of the Meritorius Service Award in 1984 was Bernard Gessiness. Recipients of the Distinguished Service Awards were Carl A. Bennett and Vincent J. DiVito.

MEMBERSHIP COMMITTEE REPORT

ROY CARDWELL
Martin Marietta Energy Systems, Inc.
Oak Ridge, Tennessee

At the last meeting of our INMM Executive Committee in Albuquerque, I was a bit surprised to find that nearly six months into our 1985 fiscal year we still had **83 members** who had not paid their current dues. When I read the list of names, surprise turned to **shock**!

A quick "eyeball analysis" indicated that near a good one-half of those who were deliquent have been members of INMM for almost as long as myself. We now have a good, efficient, and timely billing system out of our headquarters; the bills were not returned; I have been in some kind of contact with most all of you during the past year; so I know you are still out there and still with us.

Every effort is made to keep headquarters administrative time and costs to a minimum, but special letters and phone calls to follow up on such things as dues only push them upward. So **please**...if you haven't sent your check, put it in the mail today. The publications you receive all year plus the mailing costs that continue to climb depend on your dues check, and I'm sure you'll agree that the technical information coming to you in the Journal and the Annual Meeting Proceedings alone can be valued at much more than cost of the annual dues.

In other matters, we shall soon be promoting the new grade of Sustaining Member, an opportunity for your company to join in supporting our nuclear materials management programs and efforts. The fees are based on the number of people in each organization and are reasonable; and there are some advantages which are very worthwhile to those who participate. Some of you will soon be getting letters from INMM to your company which we ask that you take to and discuss with the proper company officer (if, indeed, you are not that person yourself). If you are interested in seeing your company become a sustaining member and you do not get such a letter in a few weeks (our first list is rather limited because our sources were), then please call or drop me a line at Martin Marietta Energy Systems, Inc., PO Box Y, 9766, MS-9, Oak Ridge, TN 37831, phone (615)-974-1626 (FTS 624-1626) and I'll be happy to get one off to you in the next mail.

And oh yes, **attention Emeritus Members**, if you received a "Dear John" letter from INMM in the last few weeks, **please ignore it**! We are now trying to classify our members by grade in the computer and our system is not yet "bug free". Please stand by. You will have a personal letter from us in the near future, and your membership is still in full force and effect at this time.

Again, **please**, if you haven't sent your 1985 dues check, do it today. And thanks for being a member of INMM!

DEVITO NAMED VICE PRESIDENT OF GOODYEAR ATOMIC

Vincent J. DeVito has been named Vice President, Business Services of Goodyear Atomic Corporation by its parent company, The Goodyear Tire & Rubber Company (GT & R). Nathan H. Hurt became President and Richard L. Shepler was appointed Vice President, Site Operations. Goodyear Atomic, a wholly owned subsidiary of GT & R, operates the Portsmouth Area Uranium Enrichment Plant under contract to the U.S. Department of Energy.

In his new position, DeVito will be responsible for planning, both long-range and strategic, operations analysis and assistance to DOE in the marketing of enriched uranium. DeVito joined Goodyear Aircraft (now Goodyear Aerospace) in August 1950 as a member of its Training Squadron and was the recipient of the P. W. Litchfield award as its outstanding member. He worked in Manufacturing, Planning and Scheduling until 1953 when he was transferred to Goodyear Atomic as a materials accountability engineer. DeVito was one of the original Goodyear Atomic start-up team members to transfer to Southern Ohio.

He was named assistant to the superintendent of Uranium Control in 1962, and then became superintendent, Nuclear Materials Control, in 1970.

DeVito was named division manager with the formation of Goodyear Atomic's Safeguards and Security Division in 1978. He became Gaseous Diffusion Plant (GDP) Production Division manager in February 1983, and was promoted to plant manager, Gaseous Diffusion, in May 1984.

A U. S. Army Air Corps veteran, DeVito received a degree in business administration from The Ohio State University in 1949. He has served as secretary of the 800-member Institute of Nuclear Materials Management (INMM) since 1973. The Institute is an international organization designed to further the advancement of nuclear materials management in all aspects.

He and his wife, Jeanne, are residents of Lake White. They are the parents of five children.

Nathan H. Hurt, a President, reports to Robert E. Mercer, Chairman of the Board and Chief Executive Officer of GT & R. Hurt began his career with The Goodyear Tire & Rubber Company as an engineer in Akron, Ohio, in June 1947. Subsequently he was project engineer for various Goodyear chemical plant expansions. In 1952 he was transferred to Goodyear Atomic Corporation as Superintendent, Plant Engineering.

In February 1956, Hurt returned to the parent company as manager, Chemical Plants Engineering. He spent several years in Brazil managing the design and construction of a synthetic rubber plant there before returning to the United States first as manager of a rubber chemicals plant in Akron and later as manager of a new plant at Logan, Ohio.

Hurt returned to Goodyear Atomic in 1968 as manager, Plant Engineering and Maintenance Division. In 1972 he was promoted to deputy general manager. He was named general manager of Goodyear Atomic Corporation in 1977.

Hurt was graduated with honors from the University of Colorado at Boulder in 1947 with a bachelor of science degree in mechanical engineering. He also attended the Montana School of Mines at Butte and the University of Southern California and has completed executive management training at Penn State University.

Before joining The Goodyear Tire & Rubber Company in 1947, Hurt served four years with the U. S. Navy and was employed by the University of Colorado as an instructor of engineering mathematics.

He and his wife, Karin, live at Lake White, near Waverly. He has two sons and three step-daughters.

Hurt currently is vice president of the American Society of Mechanical Engineers, having served as chairman of its Executive Committee, Management Division, in 1982, and previously as an officer of its Rubber and Plastic Division. He is a member of the American Institute of Chemical Engineers, the American Society for Engineering Management and the Atomic Industrial Forum and holds memberships in Tau Beta Pi and Pi Tau Sigma, engineering and mechanical engineering honoraries, respectively. He is a Professional Engineer registered in the State of Ohio.

Richard L. Shepler now has responsibility for all plant operations including production, maintenance and security.

Shepler joined The Goodyear Tire & Rubber Company in 1959 as a member of its Training Squadron in Akron, Ohio. He then served as a member of the Technical Services staff at the Jackson, Michigan, plant before being transferred to Philippsburg, Germany, in 1967 as Technical Service manager.

Shepler was transferred to Argentina in 1970 to serve as production superintendent and to Luxembourg in 1971 as assistant to the production director. He served as production director in a Goodyear plant in Turkey from 1973 through 1976 before being named plant manager of Goodyear's Scotland facility. He was named plant manager of Goodyear's tire production facility in Los Angeles in 1978.

Shepler was transferred to Goodyear Atomic Corporation in January 1980 initially on special assignment in the Production Division, and subsequently was named assistant general manager, Operations, in August 1980. He was named plant manager, Gaseous Diffusion Plant, in April 1981, and became plant manager, Gas Centrifuge Enrichment Plant, in May 1984.

Shepler received a bachelor of science degree in mechanical engineering from Purdue University in 1959. He also served four years with the U. S. Navy.

Shepler and his wife, Lori, have two children and live in Chillicothe.

INMM 1984-85
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Administrator	Beth Perry
Accounting Services	Carol Vraney

INMM CALENDAR OF EVENTS

JULY 22-25, 1985
26th Annual Meeting
Albuquerque Regent Hotel
Albuquerque, NM

Chairman
Charles M. Vaughan

SEPTEMBER 16-18, 1985
Transportation TWG Seminar
Hyatt Regency Washington on Capitol Hill
Washington, DC

Chairmen
John W. Arendt
Mimi Pellettieri

OCTOBER 7-11, 1985
Physical Protection Workshop
with Emphasis on Power Generating Facilities
Toronto, Ontario

Chairmen
James D. Williams
James C. Hamilton

TO BE ANNOUNCED
Decontamination and Decommissioning Seminar
Hyatt Regency Washington
on Capitol Hill
Washington, DC

Chairmen
E.R. Johnson
John McBride

TO BE ANNOUNCED
Error Propagation Seminar

Chairman
Darryl B. Smith

TO BE ANNOUNCED
Shortcourse on Safeguards
Certification

Chairman
Barbara M. Wilt

TWENTY-SIXTH ANNUAL MEETING

JULY 21-24, 1985
THE REGENT ALBUQUERQUE
ALBUQUERQUE, NEW MEXICO, USA

DEAR MEMBERS AND FRIENDS OF THE INMM

I am excited about the 26th annual meeting of the Institute of Nuclear Materials Management and extend a hearty invitation to all members of the nuclear profession to attend. The meeting will be held July 21 through 24, 1985 in Albuquerque, New Mexico, USA. Last year INMM celebrated 25 years as a warm and technically stimulating professional organization which continually promulgated leading safeguards technology. The INMM is dedicated to this type of on-going support to the nuclear professional.

The program this year is under the very capable leadership of Chairman John Lemming and a host of dedicated volunteers. This year's theme "UNLIMITED FRONTIERS" is quite appropriate in view of the changing nuclear climate. No longer can a nuclear professional be satisfied as an expert in a limited aspect of the industry. Today's and more importantly tomorrow's nuclear leaders must develop a broad perspective of the tasks and technology required for success. This year's meeting with quad- and quintcurrent sessions covering the multifaceted aspects of domestic and international nuclear activities represents an excellent opportunity for everyone to participate in their "special" area and at the same time develop a broadening perspective of the nuclear industry.

Again this year, the meeting will also provide a host of nuclear support vendors with informative exhibits. A poster session is also included and represents an excellent opportunity for small group discussions.

The meeting arrangements continue in the able hands of Tommy Sellers. He and local arrangements chairman Dennis Mangan are assuring a well organized and smoothly functioning meeting in The Albuquerque Regent and adjacent Convention Center.

The Convention Center has spacious meeting rooms, a convenient location for the exhibits and posters and a connecting shopping/restaurant mall. All of this adds up to the perfect setting for discussing new safeguards techniques, renewing past friendships and developing professional relationships. Kathie Mangan and Nina DeMontmollin are organizing an excellent spouses' and family program, once again confirming the Institute's goal to provide a complete program for all attendees.

Enclosed is the registration packet. It includes specific information on the technical program, the airlines program and the registration form. Please return the form as soon as possible noting the pre-registration deadline.

Y'all come to Albuquerque in July!

Sincerely,

Charlie Vaughan

Charles M. Vaughan
INMM Vice Chairman and
Annual Meeting Committee Chairman

TWENTY-SIXTH ANNUAL MEETING

JULY 21-24, 1985
THE REGENT ALBUQUERQUE
ALBUQUERQUE, NEW MEXICO, USA

UNLIMITED FRONTIERS PRELIMINARY SCHEDULE

SUNDAY, JULY 21, 1985

8:00 a.m.-3:00 p.m.	EXECUTIVE COMMITTEE MEETING
4:00 p.m.-8:00 p.m.	REGISTRATION
6:00 p.m.-8:00 p.m.	INMM CHAIRMAN'S RECEPTION

MONDAY, JULY 22, 1985

7:15 a.m.-8:00 a.m.	SPEAKERS' BREAKFAST
7:30 a.m.-5:00 p.m.	REGISTRATION
9:30 a.m.-4:00 p.m.	EXHIBITS
8:30 a.m.-10:30 a.m.	SPOUSES' HOSPITALITY
8:30 a.m.-12:00 noon	PLENARY SESSION Chairman, Yvonne M. Ferris Rockwell International Golden, Colorado
2:00 p.m.-5:15 p.m.	SESSION A MEASUREMENT TECHNOLOGY SESSION B NONPROLIFERATION PANEL SESSION C PHYSICAL PROTECTION SYSTEMS SESSION D WASTE MANAGEMENT
6:30 p.m.-	OLD TOWN EVENT Margarita/Sangria Sip at The Regent sponsored by Science & Engineering Associates Transportation to and from Old Town via the "Mollie Trollies" courtesy of Integrated Security Systems Mexican Fiesta at the Sheraton Old Town provided by E G & G Albuquerque INMM members and friends will enjoy this special evening in Albuquerque's historic Old Town. The restaurants are delightful, the architecture is fascinating, the shops are charming and the vendors selling their wares beneath the shade of an old portal are colorful. This is a special evening for the entire family. Dress is casual.

TUESDAY, JULY 23, 1985

7:15 a.m.-8:00 a.m.	SPEAKERS' BREAKFAST
7:30 a.m.-5:00 p.m.	REGISTRATION
9:30 a.m.-4:00 p.m.	EXHIBITS
8:30 a.m.-10:30 a.m.	SPOUSES' HOSPITALITY
8:30 a.m.-12:00 noon	SESSION A MEASUREMENT CONTROL AND ASSURANCE
	SESSION B IAEA SAFEGUARDS
	SESSION C PHYSICAL PROTECTION HARDWARE AND ITS USE
	SESSION D WASTE MANAGEMENT
	SESSION E POSTERS
2:00 p.m.-4:00 p.m.	SESSION A MATERIAL CONTROL AND ACCOUNTABILITY
	SESSION B MEASUREMENT TECHNOLOGY
	SESSION C PHYSICAL PROTECTION—VULNERABILITY, SABOTAGE AND LEGAL ISSUES
	SESSION D WASTE MANAGEMENT
	SESSION E CONTAINMENT AND SURVEILLANCE
4:00 p.m.-4:30 p.m.	ANNUAL BUSINESS MEETING
7:00 p.m.-8:00 p.m.	RECEPTION
8:00 p.m.-10:00 p.m.	26TH ANNUAL BANQUET & AWARDS

WEDNESDAY, JULY 24, 1985

7:15 a.m.-8:00 a.m.	SPEAKERS' BREAKFAST
7:30 a.m.-12:00 noon	REGISTRATION
9:30 a.m.-2:00 p.m.	EXHIBITS
8:30 a.m.-10:30 a.m.	SPOUSES' HOSPITALITY
8:30 a.m.-12:00 noon	SESSION A CONTAINMENT AND SURVEILLANCE
	SESSION B MC&A SYSTEMS AND AUDITS
	SESSION C PHYSICAL PROTECTION AND ENTRY-CONTROL SYSTEMS
	SESSION D WASTE MANAGEMENT
2:00 p.m.-5:15 p.m.	SESSION A INTERNATIONAL SAFEGUARDS
	SESSION B CONFIRMATORY MEASUREMENTS
	SESSION C PHYSICAL PROTECTION RELATED TO THE INSIDER, SAFETY AND TRAINING
	SESSION D WASTE MANAGEMENT

COME TO ALBUQUERQUE

...for INMM's 26th Annual Meeting. Join us for the "UNLIMITED FRONTIERS" program which encompasses the expanding expertise of safeguards professionals. Special sessions on measurement technology, physical protection, transportation, waste management, material control and accountability, containment and surveillance, confirmatory measurements and international safeguards have been arranged. Quad- and quintcurrent sessions will be held during the three day meeting at the Albuquerque Regent Hotel and Convention Center.

Albuquerque is located in America's great Southwest. Two of the nation's major interstate highways, I-40 and I-25, intersect in Albuquerque. The city is served by Amtrak and 17 commercial and commuter airlines (please note INMM's special program with American Airlines and Pacific Northwest Airlines).

Major attractions during non-meeting times include:

- Sandia Peak Tramway—a breathtaking 2.7 mile trip up to the top of Sandia Peak over some of the most awesome scenery in the U.S. This is the longest aerial tramway in the world.
- National Atomic Museum—located on Kirtland Air force Base, this museum houses a unique historical collection of nuclear weapons, including examples of the world's first two atomic bombs.
- Indian Pueblo Cultural Center—a complex operated by the 19 Indian pueblos in New Mexico including a museum, art gallery, restaurant and gift shop.
- Rio Grande Zoo—known for its program to breed and protect endangered species, the zoo has used adobe architecture extensively in the animal compounds and features a replication of a tropical rainforest and the very popular praire dog town.

DRESS

Albuquerque weather in July is predictably warm with mean temperatures in the high 70's (minimum 63, maximum 92). Nights are slightly cooler, especially if a trip to the mountains is planned. Either business or casual attire is appropriate for INMM meeting sessions, with business attire for evening social activities on Sunday and Tuesday. The Monday evening event in Old Town is casual.

REGISTRATION

Registration will be available:

4:00 p.m.-8:00 p.m.	Sunday, July 21, 1985
7:30 a.m.-5:00 p.m.	Monday, July 22, 1985
7:30 p.m.-5:00 p.m.	Tuesday, July 23, 1985
7:30 a.m.-12:00 noon	Wednesday, July 24, 1985

ROOM RESERVATIONS

To reserve accommodations at our headquarters hotel, The Regent Albuquerque, simply call the Regent directly, identify your affiliation with INMM and request a confirmation. Special rates of $49.00 single/double have been arranged at The Regent Albuquerque. Additional housing has been arranged at La Posada de Albuquerque, a quaint southwestern inn located one block from the Conference Center. La Posada rates are $39.00 single/double.

The Regent Albuquerque
201 Marquette Avenue, NW
Albuquerque, NM 87103 USA
505/247-3344
800/545-4444

La Posada de Albuquerque
2nd and Copper Streets
Albuquerque, NM 87103 USA
505/232-9090
800/621-7231

SAFEGUARDS COMMITTEE REPORT

LEON D. CHAPMAN
Sandia National Laboratories
Albuquerque, New Mexico

Safeguards Committee/ACDA Meeting
The Safeguards Committee met with the U.S. Arms Control and Disarmament Agency, January 23, 1985. The Agency outlined U.S. plans for the 5-year NPT Review Conference to be held next September. It was observed that at the previous conferences the advanced countries, particularly the weapon states, have been attacked by the less developed countries for alleged failure to live up to their treaty obligations; in particular, Article IV which guarantees access to nuclear materials and technology, and Article VI wherein the weapon states are committed to good-faith efforts toward arms reduction. The strategy outlined by the agency is to emphasize the positive aspects of the treaty as a whole and the progress since 1980 on Article IV. Consultations have been held with other weapon states and advanced countries to coordinate positions prior to the conference. The Agency appeared reasonably optimistic over the prospects for deflecting attacks on the Article VI issue, in spite of the lack of progress on arms control.

Safeguards Committee/NRC Meeting
In the afternoon of January 23, 1985 the Safeguards Committee met with Robert Burnett, Director, Division of Safeguards and his staff of the U.S. Nuclear Regulatory Commission (NRC). Several important safeguards topics of interest were discussed.

The Low Enriched Uranium (LEU) Reform Rule Status was reviewed. All five Commissioners voted positive on the acceptance of the rule on January 23, 1985 and it is expected to be published in the *Federal Register*. The rule development and publishing process has taken about 3½ years.

The High Enriched Uranium (HEU), Category I Material, Material Control and Accounting (MC&A) Reform Amendment will be carried forward by only one person due to severe cuts in NRC budgets and personnel. It is expected to go to the Commission in April, 1986. NRC has reviewed the public comments received on this rule and has taken direct action to address the major comments in the cost/benefit analysis. There is still some concern over the different inventory periods required by NRC and other governmental agencies.

Safeguards concerns in the area of spent fuel, waste, and decommissioning activities were discussed by NRC. Two facilities have requested a license to store spent fuel material on their site. Reactor pool storage at reactor sites are approaching capacity and will require some kind of temporary storage until DOE implements a more permanent spent fuel storage site. A dry cask storage at a reactor site which will hold up to 36 fuel assemblies is being considered. A generic rule making process on this type of dry cask storage would handle most of the needs for temporary reactor spent fuel storage. NRC is also considering other alternatives.

Any new MC&A rule amendments will proceed very slowly due to NRC cuts in funding and staff. The next area which may get attention is in the area of Category II materials. This is very tentative at this point in time.

The Insider Rule package comment period has been extended from December 7, 1984 to March 7, 1985. Approximately 120 people have commented on the rule with the primary area of controversy in the area of psychological testing. In addition, the continual observation requirement of personnel is receiving many comments. Hopefully, this rule will be published in the September, 1985 timeframe. This rule was first started in 1976.

The status of the IAEA (International Atomic Energy Agency) Safeguards Implementation was covered in detail by the NRC. There have been problems for the U.S. in meeting the 30-day reporting requirements to the IAEA after an inventory has been taken. Apparently, the U.S. has problems in meeting the IAEA reporting deadlines. NRC will look into this area to alleviate the problem. General Electric has been selected to participate.

Physical protection requirements for Truck Bomb threats are being examined by the NRC at this time. There is no indication as to what direction, if any, that NRC may take.

Discussion of Safeguards Methodology acceptance and usage resulted in identification of minimal activities in this area. There apparently is not a need at this time for standardization.

The safeguards of non-power reactors is an area in which the NRC staff has not received guidance from the Commission. This is an area that may have some future activity, but at the present time, there is no active work taking place.

The last area of discussion with the NRC involved the transportation of spent fuel. The current reform rule has been closed for public comment and the NRC is extending its analysis period. No dates were noted for completion in this area.

INMM Safeguards Committee Meeting
The INMM Safeguards Committee met in Washington on January 24, 1985. A review and summary of all of the above items were discussed. A brief update report by Dick Duda on the Government Liaison Committee was provided. The status of the INMM position papers in this area was discussed.

Once the LEU guidance is published by NRC, the LEU subcommittee will probably have a coordination meeting. Charles M. Vaughan will set up the meeting.

The HEU/Category I Subcommittee reported on the previous meetings held with NRC and the Licensee concerning the new Category I Reform Amendment. Larrie Trent, Babcock & Wilcox Company, volunteered to serve as chairperson of the Category I Subcommittee.

Two new members were added to the Safeguards Committee: Tom Collopy, Nuclear Materials Manager, United Nuclear Naval Products, Uncasville, CT; And Larrie Trent, Manager, Nuclear Materials Control, Babcock & Wilcox Company, Lynchburg, VA. Tom and Larrie have both been very active participants in the Category I Subcommittee.

TECHNICAL WORKING GROUP ON PHYSICAL PROTECTION REPORT

JAMES D. WILLIAMS, CHAIRMAN
The WLS Group
Albuquerque, New Mexico

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

- Approximately 40 papers on all aspects of Physical Protection to be presented at the INMM Annual meeting, July 21-24, 1985, Regent Hotel, Albuquerque, NM.
- Physical Protection Systems with Emphasis on Power Plant Security and Other Facilities Requiring High Security, October 7-11, 1985, Toronto, Canada.
- Security Force Training—March 1986 (Tentative).
- Information Display and Control Systems—October 1986 (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-Sixth Annual Meeting of INMM will be held July 21-24, 1985 at the Regent Hotel, Albuquerque, New Mexico. A special effort has been exerted to make this meeting especially meaningful to those of us involved in Physical Protection studies and applications. There will be five sessions of Physical Protection papers. I encourage all of you to attend to support these authors who have prepared this fine collection of papers.

The Workshop "Physical Protection Systems with Emphasis on the Insider Threat" was held October 23-26, 1984 in Kerrville, Texas. The weather was bad, but the workshop was a big success. Additional information about this workshop is given below. The success of this workshop was due primarily to the efforts of Jim Hamilton, Program Chairman, Goodyear Atomic.

Physical Protection Systems with Emphasis on the Insider Threat
The Physical Protection Technical Working Group sponsored a workshop entitled "Physical Protection Systems with Emphasis on the Insider Threat" during October 23-26, 1984 at The Inn of the Hills, Kerrville, Texas. The purpose of this workshop was to discuss physical protection problems and solutions, with emphasis on the insider threat. The workshop allowed participants the opportunity to present, discuss and exchange information on the problems associated with physical protection.

Seventy-nine participants from the United States, Canada, Federal Republic of Germany, and Japan were in attendance. The registration on the evening of October 23, was followed by a get acquainted cocktail party. Wednesday morning, October 24, the opening session began with a welcome on behalf of the Institute and a brief history of the INMM with emphasis on past and future activities of the Working Group.

Steve Scott, Sandia National Laboratories, gave the keynote address "Integrating the Elements of Intrusion Detection and Entry Control into Physical Protection Systems For Detecting Insider Activities."

Physical protection workshop attendees had the opportunity to discuss products with Southwest Microwave, Continental Page Engineers and Eye Dentify, Inc.

Seventy-nine participants met to discuss "Physical Protection Systems with Emphasis on the Insider Threat," October 23-26 in Kerrville, TX. The workshop co-chairmen were J. D. Williams, WLS Group and James C. Hamilton, Goodyear Atomic.

Eight consecutive workshops were held. The titles of these workshops were as follows:

1. Deployment of Barriers (Active and Passive) to Minimize Insider Actions. Moderator: John W. Kane, Sandia National Laboratories.

1A. A second workshop on the same topic as #1 was Moderated by Arturo Salvi, EBASCO Services.

2. Maintenance Procedures Which Minimize Possible Insider Actions. Moderator: W. Ted Aichele, Rockwell Hanford.

3. Contingency Planning Using Threat Analysis Techniques. Moderator: Laura B. Thomas, Wackenhut Advanced Technologies Corporation.

4. Physical Protection Methods For Protection Against Unauthorized Acts by an Insider. Moderator: I.G. Waddoups, Sandia National Laboratories.

5. Contraband Detection and SNM Detection. Moderator: Laura B. Thomas, Wackenhut Advanced Technologies Corporation.

6. Positive Personnel Identification and Access Control. Moderator: Russell Maxwell, Sandia National Laboratories.

7. Alarm Assessment by Video, Guard Towers, Etc. Moderator: Frank Smith, EBASCO Services.

8. Minimization of False Alarms by Combination of Sensor Logic and Special Application of Sensors. Moderator: Chelk D. Jin, Ontario Hydro.

In each of the sessions the session moderator set the stage for the discussions. Every attendee was asked to identify himself and to give a brief description of their activities in that particular field. The attendees were also asked to identify at least one question or topic to be discussed by the group. Typically each session involved about twenty people. Thursday afternoon J.D. Williams presented a paper "Overview of Intrusion Detection Sensors—1984."

Product displays were presented by three vendors who had been invited by those attending the meeting. The vendors participating were Southwest Microwave, Continental Page Engineers, and Eye Dentify Inc. At the conclusion of the vendor displays a dinner for the participants was held in the Inn's dining room. During a closing session each moderator presented a summary of the discussions held in his session.

Special thanks go to Jim Hamilton, Workshop Chairman; to each of the session moderators; to the participants; and to the vendors. The outstanding efforts of all of these people was the basis for the workshop success.

A REMINISCENCE, 1944-45

Chapter 5

R.D. Smith

The jokes were as flavorful as the songs, but mostly much more spicy. They very often started with the line, "Whatcha makin out there?" Here are some of the answers:

1. "Time and time again." (This referred to time-and-half or double-time pay which many of the local people never understood. Being mostly farmers, they were used to drudging many long hours for no particular extra reward.)

2. "The front ends of horses to send to Washington for assembly." What explanation is needed for that?

3."Wooden behinds for hobby-horses." I never understood it, but we did have huge quantities of a large dowel rod—mayby ¾ or ⅞ inches in diameter—with a hole drilled through the length of it. All we did was slice it into little wooden washers about ⅜-inch thick. Bushels of them were made and carted off to be used—I never knew how!

4. "Green paint. We're going to spread it on the ocean. When the German U-boats come up, they'll think they're still under water because it will cover the periscopes. When they get up high enough, we'll shoot them down with our antiaircraft guns."

Green paint! We called it "gunk." It was the most awful chemical mess I've ever seen. It was mostly a nitric acid solution; but, as I've mentioned before, it was likely to contain in addition sulfuric, hydrochloric, oxalic, and maybe half-a-dozen others. It was mostly a copper solution, with some uranium of course but it seemed that it also contained some of every other metal in the periodic table. We chemical people had our hands full. You see, the uranium had to be separated and purified for the Beta stage.

One day Evelyn and I were to be on day-shift. We were at Cove Lake then, so we got up at about 4:00 a.m. We had a small breakfast and coffee and arrived at about ten minutes to five at the bus stop down the hill. There were the usual bus waiters. There was one guy though who had a kitten. It was a very small kitten—barely weaned. The guy who had it was neither better or worse than the others who rode the buses. He was hymn-singing man. But Evelyn and I knew the fate of that poor little cat. He would be played with by a bunch of rough men and abandoned to die. We couldn't have that. Evelyn asked for the cat. The man said "sure." She dashed up the hill to the cabin with the little thing in her arms. He was safe in the cabin and she was back in time for the bus and the songs, a little breathless but ready.

So we had a cat—a male, marauding cat—a tiger stalking in the low jungle that he knew. Yet it was clear he loved us, and we loved him. We looked at him closely as he grew. He had something in him of just about everything a domestic cat should not be! He was atrocious! So, we named him "Gunk."

But he reminded me of some of my earlier barrack mates. That cat was so darn smart it was scary! We usually left a window open so Gunk could jump in. One night he did jump in, earlier than we expected him, and ran straight to the bathroom, making strange noises as he went. When we got there, he was sitting in the sink stinking of kerosene. He had gotten away from somebody sick enough to try the ultimate burning cat joke. It took us about an hour to get the little guy so he wasn't frothing at the mouth. He recovered. I wonder if the sick, sick person who perpetrated that ever recovered.

We were on day-shift one day and had made plans after the shift to go to the circus in Knoxville with a friend of Evelyn's. Evelyn was leaving Gunk locked in the cabin. That was a long shift for Gunk because we left at about 4:30 a.m. and would not return until 12:00 to 1:00 a.m. the next morning. Of course he was left plenty of food and water and a pan of sand or something.

When we got home we noticed that his pan was clean. And the cabin was clean. He had used the commode! How the little fellow figured that out we'll never know! He'd done everything but flush it. I consider it extraordinary.

Only one thing more about Gunk the cat. One day he brought his girl friend home to us. It was like a son was doing it. He jumped in the window first. That's the only time I've ever seen a cat strut. He walked all around the room in a very unusual way—not his usual gait at all. I suppose cats can't throw out their chests, but Gunk did everything else. He talked the whole time, but we don't understand meows and mews. He turned to the window and he said something.

In through the window came a little ball of gray fluff. She was adorable. She was a gray tabbie and had Persian in her background. She had beautiful silver pantaloons adorning the back parts of her thighs. A fine looking little cat! She was as cute as she could be; but, unlike Gunk, she didn't have a brain in her head. And she stayed. We had her for some years. We called her Chippy. When Gunk brought a girl friend home, it was home!

Gunk was so proud of her. We've never seen such a love affair between two animals. Then some S.O.B. poisoned Gunk and he died. As I said, Chippy stayed with us a long time.

Having Gunk around was a delight, but working with *gunk* was a nightmare. Building 9207 was designed to deal with gunk. The whole building was designed to be a continous diethyl ether extraction unit. I think no one was supposed to get tipsy in that building. It had the best hood system I've ever seen and the best anti-explosion devices. The whole building was a marvel of caution.

Wouldn't you know, about the time 9207 was finished a number of other extractants for uranium had been found. There was penta-ether, with which I had worked. There was another ether, the name of which I don't recall (I'll show my ignorance...was it, maybe, dibutyl carbitol?) and there were other things. All were much safer than diethyl ether and just as efficient. So 9207 was never used for its intended purpose. It's a little sad in a way. Of course the building has always been put to good use. It is now occupied by the Oak Ridge National Laboratory Biology Division.

A little more on that theme. In 1944 and 1945 there was no holding back. If we thought we knew something might work, we started to do it. Moreover, if we thought several things might work, we started to do them all; and each one would be worked at diligently. We had no time to deliberate. It was thought that Germany might be competing with us on similar projects. (I used the words "we" and "us" to mean the United States. Certainly I, personally, had nothing to do with those decisions.)

That explains, I hope, why we had three tentative isotope separation processes in Oak Ridge simultaneously at that time—the calutrons, gaseous diffusion, and thermal diffusion. That explains why we went ahead with 9207; we knew it would work, and we weren't too sure about the other ways. There must never have been a costlier war.

We had 75,000 people in Y-12. If you don't count all the construction workers, we had 23,000. Somehow all those people had to be accommodated. There were canteens and cafeterias all over the place. We had some of the biggest restrooms I've ever seen. And, believe me, we needed them. Every now and then we'd have an outbreak of what we called the "Tennessee Trots" for which there is no cure but a restroom. That was because someone had left a residue of G.I. soap in a kettle. It came with the territory.

Can you imagine supervising 75,000 people? If a person were lazy enough or unconcerned, he or she could simply get lost in that huge crowd. Such a person could just walk around the big plant or find a place to sleep. The chances are he or she wouldn't even be missed! A few did that, I'm sorry to say, but the great majority did just the opposite. They knew what they were supposed to be doing and they did it. If they had a question, they'd go to a "straw boss" like me and get an answer. I'm sure some of the answers were right.

Now I'd like to tell you about one man, an "exempli gratia" of dedication. I don't know his name—perhaps I never did. I'd say he was about forty—but he was graying. He was an uneducated, ignorant country man who had probably never done anything but farm other men's fields. He was single. He had a room in one of the dormitories in Oak Ridge. We were all upset about our wartime enemies, but not like that man. He was assigned a pick-up truck and a route. He was to pick up samples at many places and deliver them to the appropriate singing laboratories. He was not the only one with that assignment, but it turned out he was almost enough by himself.

Gradually, he transferred his meager belongings from his dormitory room to his truck. And, finally, he was living in that truck! He'd nap in the truck between his rounds. He worked almost 24 hours a day, seven days a week. Of course there were occasional exigencies during which he would be gone for a couple of hours. It seemed, though, that he was always there. The man seemed to have a clock in his head; his pick-ups and deliveries were flawless. The only complaint I ever heard about him was that he wasn't cashing his paychecks soon enough! They must have been huge paychecks with all "time-and-time-again."

His hair was usually mussed. He usually had a several day's beard. His clothes were terrible. He wasn't very clean, but I think I've never seen a greater patriot. How many men would actually come into Y-12 to live and work "round the clock"? He was indeed an example.

The man I have described was only an example. Some of the women were almost as dedicated or probably just as dedicated, but they didn't demonstrate it in as eccentric a way. Some would work twelve-hour shifts until they dropped. Many times we had to send women home because they simply couldn't go on any longer.

Some of you may not believe this history. It's hard for me to believe myself, and I was there. That period was so electric one could almost feel it in the air. We had a National challenge, a terrible dare, and it was accepted. When I began this series of articles I vowed that everything in them would be true. To the best of my knowledge, I've kept my vow. However, almost forty years have gone by, and my sort-of-average head is fallible like anyone else's. So if anyone detects a fallacy, please forgive me. It was unintentional.

I intend to write a few more articles in this series and then, after trying to clear the detritus that has accumulated on my desk and table, to get back to my stamps. A nice young man at Y-12 asked me a few years ago how long I had been collecting. I told him 48 years. He was thunderstruck. I was 58 at the time.

NEXT: The War Ends

WORKSHOP HELD ON USE OF PROCESS MONITORING DATA FOR MATERIAL CONTROL AND ACCOUNTING

"Use of Process Monitoring Data for Material Control and Accounting" was the title of the Material Control and Accounting Technical Working Group workshop held February 12-16, 1985 at the Opryland Hotel, Nashville, TN. The workshop was attended by 37 people.

The two and a half day workshop began with four keynote presentations moderated by Donald E. Emon, U.S. Department of Energy:

"The Regulatory Perspective"—Robert J. Dube, U.S. Nuclear Regulatory Commission

"The DOE Perspective"—H. Rodney Martin, U.S. Department of Energy—Idaho

"The Commercial Perspective"—Charles M. Vaughan, General Electric Company

"The International Perspective"—Darryl B. Smith, Los Alamos National Laboratory (for E. Arnold Hakkila)

During the remainder of the workshop, attendees met in small group sessions to discuss topics of interest which were determined by the committee from results of a registration questionnaire. All groups discussed the topic of "Designing an MC&A System Using Process Monitoring." Moderators for these sessions were:

Glenn A. Hammond, U.S. Department of Energy
Darryl B. Smith, Los Alamos National Laboratory
Kenneth W. Foster, Monsanto, Mound Laboratory
James W. Tape, Los Alamos National Laboratory
Bob Hester, E.I. DuPont, Savannah River
Clifford E. Johnson, Westinghouse Idaho

Other workshop sessions and moderators included:

"The Safeguards Use of Process Monitoring to Help Resolve Alarms"
Moderator—Brian Smith, Battelle Pacific Northwest Laboratory

"Safeguards Trade-Offs Involving Process Monitoring Information"
Moderator—Robert J. Dube, U.S. Nuclear Regulatory Commission

"Safeguards Trade-Offs Involving Process Monitoring Information"
Moderator—Wendell L. Belew, U.S. Department of Energy

"The Safeguards Use of Process Monitoring to Help Resolve Alarms"
Moderator—Peter Dessaules, Rockwell Hanford

"Independent Evaluation of Safeguards Systems Utilizing Process Monitoring Information"
Moderator—Leon Green, Brookhaven National Laboratory

"Statistical Considerations in Incorporating Process Monitoring Information into a Safeguards System"
Moderator—Donald E. Emon, U.S. Department of Energy

"Safeguards Systems Utilizing Item Processing Information"
Moderator—Larrie K. Trent, Babcock & Wilcox

At the end of the workshop, each moderator presented a summary of the discussions held in the sessions. This portion of the program was led by Brian Smith, Battelle Pacific Northwest Laboratory. A printed copy of the summary sessions was distributed to each attendee after the conclusion to the workshop. Special thanks go to Darryl B. Smith, Technical Working Group Chairman, Donald E. Emon and Robert J. Dube, Workshop Co-Chairmen and to Brian Smith who served on the committee.

Donald E. Emon, U.S. Department of Energy, served as co-chairman for the "Use of Process Monitoring Data for Material Control and Accounting" workshop, February 12-15, 1985 in Nashville, TN.

Robert J. Dube, U.S. Nuclear Regulatory Commission, co-chairman for the "Process Monitoring" workshop presented one of the keynote addresses.

Brian Smith, Battelle Pacific Northwest Laboratory, organized the "Process Monitoring" workshop sessions and moderated the summary session.

N-15—METHODS OF NUCLEAR MATERIAL CONTROL ACTIVITIES REPORT

During the past several months a number of changes have taken place within N15. George Huff has assumed the chairmanship of N15 Committee replacing Neil Harms. In addition Jim Frank has taken over the responsibilities of N15 Secretary from Bob Kramer. They may be contacted at the following addresses.

George A. Huff 330 E. Cordova St. #369 Pasadena, CA 91101 Ph. 818/440-7995	D. J. (Jim) Frank Systems Analysis, Bldg. T-750D Rockwell International Rocky Flats Plant Golden, CO 80401 Ph. 303/497-7855

Also we have lost the services of Fred Tingey, Chairman of INMM-11, Training and Certification and John Darby, Chairman of INMM-10, Physical Security. They have been replaced by Barbara Wilt, INMM-11, and John Hockert, INMM-10. Needless to say, with all of the above changes in the committee structure we have been spending a great deal of time getting organized.

As of November 8, 1984, Committee N15 on Methods of Nuclear Material Control was approved as an Accredited Standards Committee by ANSI. As a result we have prepared in accordance with ANSI procedures a formal set of procedures/policies to be followed by N15 in the future. This procedure has been approved by a majority of the N15 Committee Chairman.

Congratulations are due to Yvonne Ferris, Chairman of INMM-5, Measurement Control. She and her subcommittee have recently published a new standard "Derivation of Measurement Control Programs—General Requirements", ANSI N15.41-1984. This standard is now available and may be purchased from ANSI at $7.00 per copy, plus a shipping and handling charge.

There will be a N15 Committee meeting on July 25, 1985 at the Regent Hotel, Albuquerque, New Mexico. This meeting is in conjunction with the 26th Annual Meeting of INMM, July 22-25, 1985. For items to be placed in the agenda, contact either the Chairman or Secretary.

The current status of standards being revised is given below:

Standard		**Status**
ANSI N15.5-1972	Statistical Terminology and Notation for Nuclear Materials Management.	Extension to Nov. 1985 approved by ANSI; currently being balloted.
ANSI N15.8-1974	Nuclear Material Control for Nuclear Power Plants.	Ready for reaffirmation by July 31, 1985; extension requested from ANSI.
ANSI N15.9-1975	Nuclear Material Control Systems for Fuel Fabrication Facilities (A Guide to Practice).	Ready for reaffirmation by July 31, 1985; extension requested from ANSI.
ANSI N15.10-1972	Classification of Un-irradiated Plutonium Scrap.	Extension to Nov. 1985 approved by ANSI; currently ready for ballot.
ANSI N15.13-1974	Nuclear Material Control Systems for Fuel Reprocessing Facilities (A Guide to Practice).	Recommended for withdrawal; to be discussed at July committee meeting.
ANSI N15.16-1974	Limit of Error Concepts and Principles of Calculations in Nuclear Material Control.	Ready for reaffirmation by July 31, 1985; extension requested from ANSI.
ANSI N15.17-1975	Concepts and Principles Statistical Evaluations of Shipper-Receiver Differences in the Transfer of Special Nuclear Materials.	Extension to Nov. 1986 approved by ANSI; work in progress with peer review anticipated by Dec. 1985.
ANSI N15.18-1975	Mass Calibration Techniques for Nuclear Material Control.	Extension to Nov. 1985 approved by ANSI; currently in peer review.
ANSI N15.19-1975	Volume Calibration Techniques for Nuclear Material Control.	Extension to Nov. 1985 approved by ANSI; currently in peer review.
ANSI N15.20-1975	Guide to Calibrating Non-destructive Assay Systems.	Extension to Nov. 1985 approved by ANSI; being reaffirmed as currently written.
ANSI N15.22-1985	Calibration Techniques for Calorimetric Assay of Plutonium Bearing Solids Applied to Nuclear Material Controls.	Ready for reaffirmation by July 31, 1985; extension requested from ANSI.

"SAFEGUARDING NUCLEAR MATERIALS" PUBLICATION AVAILABLE

"Safeguarding Nuclear Materials" is the title of the latest publication available from INMM. The purpose of the pamphlet is to provide the public with an understanding of the measures employed in safeguarding peaceful uses of nuclear energy. Written in a question/answer format, the brochure focuses on domestic and international safeguards issues related to verification activities of the International Atomic Energy Agency.

Complimentary copies of the publication can be obtained from INMM headquarters. Special thanks go to James M. DeMontmollin and his writing group for their efforts in writing and editing of the publication.

SPENT FUEL STORAGE SEMINAR

The Waste Management Technical Working Group sponsored a seminar on "Spent Fuel Storage" at the Hyatt Regency Washington on Capitol Hill, January 14-16, 1985. The seminar was attended by 87 people who met to review the latest information on spent fuel storage technology, to learn first hand of the programs being pursued by the U.S. Department of Energy and other countries and to review issues, both technical and institutional, which may impact the implementation of utility and/or DOE planning.

E.R. Johnson of E.R. Johnson Associates served as general chairman of the seminar and John A. McBride, E.R. Johnson Associates was the technical program chairman. Session topics and moderators included:

Spent Fuel Storage Equipment, J.R. Clark—Nuclear Fuel Services, Inc.

Spent Fuel Consolidation, N.B. McLeod, E.R. Johnson Associates, Inc.

Pool Storage and Spent Fuel Storage Issues, J.A. McBride, E.R. Johnson Associates, Inc.

Program Research and Development Announcements (PRDA), Carl Conner, U.S. Department of Energy

National and International Programs, Roger Hilley, U.S. Department of Energy

The proceedings which contain twenty-one of the presentations is available from INMM headquarters. Payment ($200.00 U.S. funds) must accompany orders.

BOOK REVIEW

JACK ALLENTUCK
Brookhaven National Laboratory
Upton, New York

The State and Nuclear Power: Conflict & Control in the Western World—
J.A. Camilleri
University of Washington Press, Seattle, 1984, xviii, 347 pp. $25.00

The stated purpose of this study is "...not to examine the cases for and against nuclear power. Rather it is to analyse the political, cultural and international discussions of the conflict to which it has given rise, and more particularly to focus attention on the role of the advanced capitalist state in the establishment and subsequent development of the nuclear industry."

Camilleri, Senior Lecturer in Politics at La Trobe University in Australia disingenously explains limiting his study to advanced capitalist states as opposed to "socialist" or "centrally planned" economies with the assertion that "The socialist industrial state has...performed an equally significant function in the harnessing of nuclear energy, but when compared to the...capitalist state there may...be a qualitative difference in the scope and mode of intervention." "Intervention" is an inappropriate term when describing the actions of a socialist state in establishing an industry or introducing an innovative technology. Camilleri goes on to say that the centrally planned economies have had to operate within a framework of economic and military competition whose workings are still largely determined by the international capitalist system. Certainly as regards military competition the latter statement is arguable.

While the exclusion of socialist industrial states from the study makes the task more manageable it has decreased the value of the work in a manner analogous to the way in which a biological experiment is reduced in usefulness if performed without a control group. Indeed, as the author shows a principal impediment to the development of nuclear power in the advanced capitalist states has been popular rejection of the "ethics" of risk taking. In the absence of such rejection would the outcome of state intervention have been the same? The examination of such outcomes in societies where grass-roots discussions of the ethics of risk taking did not take place would have provided a useful counterpoint.

The study is structured on consideration of the factors which account for the commitment of major western governments to the commercial development of nuclear power, the evolution of the commitment since the launching of the "Atoms for Peace" program, and the economic and administrative functions of the state. These issues are addressed with reference to the United States, the United Kingdom, Federal Republic of Germany, France, Sweden, and Brazil. In addtion, the author discusses certain aspects of international trade in nuclear equipment, fuel and technology and touches briefly on attempts to control such trade to further political, commercial and security objectives. The book's eight chapters are headed "Origins of the Peaceful Atom," "The Emerging Nuclear State," "The State's Authority Under Challenge," "The Crisis of Legitimacy," "The Impact of Recession," "The Politics of the Fuel Cycle," "International Nuclear Politics" and the "Crisis of Capitalism." Camilleri is more successful in handling certain of these issues than in others. He is better at narration then at analysis although both are tainted by an anti-U.S., anti-capitalist bias.

Any expectation which the reader might have of finding in "The Origins of the Peaceful Atom" and in "The Emerging Nuclear State" the answer to the question posed by the author as to the motivation which accounts for the commitment of advanced capitalist states to the commercial development of nuclear power is frustrated. Camilleri provides us with an interesting account of the arguments used to "sell" nuclear power to the public; faith in the inevitability of scientific progress, national interest, economic advantage. Pervasive throughout this account is the idea that these selling points masked other motives, motives which the author never reveals.

The author's account of what he terms the bureaucratization of science in America starts with the statement "From its inception, it was characterized by secrecy, lack of public accountability and the tacit alliance between science and the military establishment... Indeed the Atomic Energy Act, 1946, better known as the McMahon Act, granted the newly-established Atomic Energy Commission extraordinary powers to call upon the services of intelligence agencies, including the FBI and the CIA, and to conduct the most exhaustive vetting of employees, *ostensibly* for reasons of national security." Aside from its tone, the first sentence is unexceptionable. Yes, the Manhattan Project, in a nation fighting for the life of a free people required secrecy; public hearings could not be held, if that is what Camilleri's interpretation of public accountability requires; the alliance between science and the military establishment, was not tacit, it was overt in the Manhattan Project as in other wartime r&d projects for example, radar. The second sentence is typical of the author's pervasive use of innuendo based on half-truths. The fact that the CIA was established in 1947 makes it unlikely that it was referred to in the Atomic Energy Act of 1946 even if employing the CIA in security investigations of prospective AEC staff would not have been illegal. If vetting prospective AEC staff was only *ostensibly* for reasons of national security, what was the real underlying purpose? If Camilleri knows, his audience should be informed.

The author recounts how many of the leading scientists of the Manhattan Project became, after the war, part of the government's scientific establishment and how in due course government policy makers became the "prisoners" of expert advice which they could not independently assess. This is true in part but Camilleri incorrectly bases this conslusion on an assumption that scientific advisory committees were monolithic and alternative views did not reach politicians. This assumption contradicts an example which the author cites of a discouraging assessment by Philip Sporn, then chairman of the Advisory Committee on Co-operation between the AEC and the Electric Power Industry, of the prospects of nuclear power. Also cited by the author are pessimistic views on the subject expressed by the AEC's General Advisory Committee.

Camilleri express an idyllic view of the nature of pre-nuclear science, which came to an end with its bureaucratization, claiming that "scientific effort could no longer be directed exclusively towards the search for truth as conceived by the founders of modern science and affirmed through the centuries of classical tradition but had to respond to the specific, economic, political and military objective set by the state..." At best such a view is naive. Camilleri fails entirely

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to mention government-funded basic science in physics, in biology and medicine and other areas. The author goes on to tell us that... "the bureaucratization of science...is part of larger phenomenon whereby science and technology are wedded to the means of production..." Are the builders and experimenters at accelerator facilities such as Fermi Lab, CERN and Brookhaven National Laboratory "wedded to the means of production?" In fact, not much thought is required to recognize that a nuclear reactor is the same if it serves the "means of production," in the Marxist sense, in a centrally planned economy or in an advanced capitalist economy. The same of course is true of scientists and technologists serving a socialist state or a capitalist enterprise. The only observable difference as regards nuclear power is the greater concern for the health and safety of the public on the part of technologists and politicians in the capitalist state than in the socialist state. Consider for example, the construction of nuclear power reactors without containment structures, a practice only recently ended in the Soviet Union.

Camilleri is at his best in the chapter "The Crisis of Legitimacy" where he discusses "the socio-cultural crisis unleashed by the nuclear controversy...the lack of ethical consensus as to what constitutes an acceptable level of risk." He defines as central to the ethical case of the opponents of nuclear power "The inequity of risk distribution, the inadequacy of available information, and the lack of citizen participation..." Nowhere however does he raise the fundamental question of why, of all government decisions arrived at without grass-roots participation, only decisions relative to nuclear power have resulted in such acrimony.

In the final chapter we find the following revealing statement:

> "Opposition to nuclear power thus became an integral part, perhaps the focal point of a larger movement committed to resisting what was deemed to be the 'colonization of the life-world'...At issue was the prevailing mode of production and consumption and the international competition for power and wealth which is expressed and reinforced. To the extent that the advanced capitalist state was seen as one of the main institutional props for this international division of labour, it inevitably became the target of anti-nuclear agitation and the arena for social and political upheaval."

Camilleri tells us here that anti-nuclear agitation is merely a mask for an attack on the prevailing "capitalist" mode of production and a movement for social and political upheaval. He may very well be correct.

SUSTAINING MEMBERSHIP LIST GROWS

RCA-GOVERNMENT COMMUNICATIONS SYSTEMS and ROCKWELL INTERNATIONAL– ROCKY FLATS PLANT have shown their support for the Institute of Nuclear Materials Management and the safeguards profession by becoming Sustaining Members of INMM. Other Sustaining Members are:

E G & G Idaho
E.R. Johnson Associates
Republic of South Africa
Brandt Periodicals
Euratom
UNC Nuclear Industries

Sustaining Member plaques will be presented to these companies during the banquet program at the 26th Annual Meeting on Tuesday, July 23, 1985 in Albuquerque, NM.

Sustaining member contributions are based upon the total number of corporate employees. Annual dues are as follows:

Total Number of Corporate Employees	Annual Dues
0-19	$250.00
20-49	$500.00
50 or more employees	$750.00

In order to join as a Sustaining Member, contact Beth Perry at INMM headquarters for an application.

N14 ACTIVITIES REPORT

The N-14 Management Committee met on March 24, 1985 in Tucson, AZ. Charles E. McDonald, U.S. Nuclear Regulatory Commission joined chairman John W. Arendt, vice chairman M. Pellettieri, secretary Marilyn Warrent and members Richard Helsig, James W. Lee, and Edmund C. Tarnuzzer on the management committee. They are updating the members of the subcommittees prior to the next meetings which are scheduled on July 25, 1985 and September 18, 1985.

The committee will sponsor a technical seminar on transportation to be held September 16-18, 1985 at the Hyatt Regency Washington on Capitol Hill. John W. Arendt will serve as general chairman with Mimi Pellettieri as program coordinator for this two and a half day seminar. The program will focus on standards recently approved by the N14 committee, standards under development and the use of standards.

Chairman Arendt reports that the following three standards are being balloted at this time:

Addendum to N14-1982, "Packaging of Uranium Hexafloride for Transport"

N14.29 (formerly N679-1976), "Guide for Writing Operating Manuals for Radioactive Materials Packaging"

N14.9.2, "Packaging of Nuclear Power Plant Radioactive Process Wastes for Transportation"

A VERSATILE SYSTEM FOR MEASURING NUCLEAR WASTE IN 55-GALLON DRUMS*

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ABSTRACT

A californium-based active assay system has been tested for measuring nuclear waste in 55-gal drums. The unit can be operated in either a thermal- or fast-neutron interrogation mode. In tests of the thermal mode, the detection limits observed were 12.5 mg for plutonium and 6.2 mg for ^{235}U. The fast mode is recommended for accountability measurements where accuracy is of greater concern. Measurement of actual nuclear facility waste indicated more fissile material than was detected by passive gamma-ray counting.

I. INTRODUCTION

A ^{252}Cf-based assay system designed and assembled at Los Alamos National Laboratory has been tested for measurement of fissile material contained in 55-gal drums. The unit employs the active technique of neutron interrogation and delayed neutron detection. Fissile isotopes, such as ^{233}U, ^{235}U, or ^{239}Pu, are irradiated by a ^{252}Cf neutron source, and the induced fissions are detected by emission of delayed neutrons after the source has been retracted to an isolated storage position. Because the process of irradiation and delayed neutron counting is cyclical, this type of instrument is referred to as a Shuffler.[1,2] The particular unit used for measurement of 55-gal drums is shown schematically in Fig. 1.

The assay chamber was originally designed for passive measurement of plutonium.[3,4] Modifications consisted of adding a transfer tube for scanning the neutron source along the drum axis, a neutron shield supported above the assay chamber, and a drum rotator. The original $^{10}BF_3$-filled neutron detectors were exchanged for activated charcoal-lined ^{3}He-filled neutron detectors. A microcomputer was incorporated into the system to control source movement and to facilitate data analysis and printout. The source control hardware is similar to the hardware developed for spent-fuel assay.[5]

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The detectors were deployed so that detection of passive neutrons would be uniform.[3] Thus, the detection of delayed neutrons is also uniform. The source-scanning and drum-rotation features were incorporated to achieve a uniform neutron interrogation. Features available to improve interrogation uniformity are the scanning speed, the dwell time, and the rotation speed. The freedom possible with a computer-controlled scan is more than adequate to obtain a uniform interrogation.

The shielding used to isolate the neutron source during background and delayed neutron counting is a significant advancement over that used in the prototype and Savannah River Plant (SRP) Shufflers.[1,2] Those instruments have only a 5° bend to prevent line-of-sight between the assay chamber and storage position. Furthermore, the 1.3-cm-diam transfer tube is surrounded by a 5-cm-diam Teflon tube to allow easy insertion and removal. Because Teflon does not contain hydrogen, the tube yields a larger effective tunnel for neutrons. The Shuffler being developed for spent-fuel assay corrects these deficiencies by using a double bend in the transfer tube and no Teflon sheath.[6] The 55-gal-drum test bed described here carries the improvement one step further by using a spiral path into the shield (Fig. 1). Figure 2 shows the reduction in source background as a function of position along the spiral. The continuous curve of the spiral achieves close to the theoretical maximum polyethylene shielding, a factor of 10 per 15 cm.[7]

II. INTERROGATION MODES

A removable cadmium liner was constructed for the passive system to help establish the moderator content of drums.[4] The cadmium liner also permits selection of an interrogating neutron flux that is either thermal or fast (epicadmium). For thermal interrogation, the cadmium liner is removed and the source transfer tube is surrounded with an approximately 1-cm-thick polyethylene cover. Neutrons thermalize within the cover and polyethylene walls, then interrogate the drum. In the fast interrogation mode, the polyethylene cover is removed and the cadmium liner is installed. Neutrons directly from the source

(2.3-MeV average energy) interrogate the drum, and the cadmium liner prevents neutrons thermalized in the assay chamber walls from entering the drum. Hence, the designation of epicadmium interrogation. An even more penetrating neutron spectrum was achieved with the Shuffler at SRP by using an assay chamber lined with boron and steel in addition to cadmium.[2]

Thermal interrogation has the advantage of using the maximum fission cross section. Thus, the maximum signal is obtained. However, thermal-neutron absorption is appreciable for many elements, resulting in a reduced neutron flux, which in turn leads to a reduced signal. At thermal energies, a lump of fissile material may not be fully interrogated, resulting in the material being underestimated. Thus, adverse effects in thermal interrogation tend to yield a reduced response.

An energetic interrogation, above the cadmium threshold or higher, is less subject to matrix absorption and lumping effects and thereby potentially more accurate. The lower fission cross section requires a larger source to achieve the signal possible with thermal interrogation. Because the drums are large enough to permit some matrix materials to thermalize interrogating neutrons, the potentially adverse effects of thermal interrogation can be present in an energetic interrogation. Moderation can lead to an increased signal if no neutron absorbers are present or a decreased signal if sufficient absorbers are present.

A. Thermal-Neutron Interrogation

Thermal interrogation can be used effectively for low-level detection and for assaying materials that have a uniform composition, provided the fissile material is not too dense. The uranium and plutonium data in Fig. 3 illustrate these applications. The plutonium calibration (dashed line in Fig. 3) is based on the uranium data with allowance for the increased plutonium fission cross section and the decreased delayed neutron yield. The combined effect of these two nuclear properties results in the plutonium signal being about one-half the magnitude of the uranium signal.

The ^{235}U enrichment of the items shown in Fig. 3 ranges from natural enrichment (0.7%) to high enrichment (93%). The delayed neutron signal is linear with ^{235}U content. A contribution from ^{238}U is not readily apparent in the data given in Fig. 3, showing that the interrogating neutrons have at least been moderated below the ^{238}U fission threshold.

The materials used to generate the data shown in Fig. 3 were selected to avoid self-shielding effects. The four lowest data points are for uranium diluted with graphite powder; the three highest points are for high-enriched uranium plated 1.4-mg/cm^2 thick. Thermal-neutron penetration of high-enriched uranium is about 700 mg/cm^2; thus, the coatings are thin.

Low-level detection of plutonium is demonstrated by data shown in the upper left-hand insert in Fig. 3. The nominal screening level is the 10-nCi/g fiducial established for transuranic (TRU) waste.[8] For waste packaged in 55-gal drums, the TRU screening limit corresponds to about 10 mg of plutonium. Detection at the 10-nCi/g level has been defined as observing a signal that is three times the background in a 1000-s assay.[9] The plutonium-contaminated samples (upper left-hand corner) consisted of 8 mg of plutonium deposited on rags and 10 mg of plutonium in solution.

The detection limits calculated using the calibration curves shown in Fig. 3 are 6.2 mg of uranium and 12.5 mg of plutonium. Further improvements in low-level detection are readily possible. Modifications include (1) increasing the californium content of the neutron source from 0.7 to 2 mg (well within the range of available and manageable sources), (2) decreasing the height of the assay chamber from 122 cm (48 in.) to 102 cm (40 in.) to improve the neutron interrogation efficiency, and (3) increasing the neutron detection efficiency from 18 to 25% by having the active area of the detector tubes fully cover the assay chamber.

Reducing the background contribution also improves the detection limit. The shield surrounding the assay chamber is composed of aluminum-walled water tanks. The joints between the tanks provide a neutron path into the assay chamber. Eliminating these cracks would reduce this source of background by a factor of 2 or more. Operating the detector at sea level instead of at the 2200-m (7200-ft) Los Alamos altitude would reduce the cosmic-ray-induced background by about a factor of 6 (Ref. 4). By combining improvements possible in the background contribution with improvements possible in the assay chamber and by increasing the source strength, the detection limit can be reduced to below 1 mg for either uranium or plutonium. The corresponding TRU waste sensitivity is then about 1 nCi/g, well in excess of the 10 nCi/g fiducial.

B. Fast-Neutron (Epicadmium) Interrogation

Fast-neutron interrogation is suited for accountability measurements. Uranium and plutonium are generally accounted for to the nearest gram. Thus, the lower limit for accountability is 0.5 g. Because this limit is considerably higher than the waste screening limit, sensitivity can be sacrificed for accuracy. Fast-neutron interrogation generally reduces the effects of neutron poisons and self-shielding.

Correction factors have been developed to account for the separate effects of absorption and moderation. Absorption is monitored by measuring the neutron flux during interrogation, and moderation is measured by the neutron energy shift, that is, thermalization. The latter measurement has proved successful for monitoring the hydrogen content of reactor fuel pins.[10] Correcting the combined effects of moderation and absorption is difficult, but possible for many cases. On the other hand, self-shielding is not correctable by any demonstrated means; thus, fast-neutron interrogation is preferred when lumping could occur.

Table I compares the correction factors for thermal- and fast-neutron (epicadmium) interrogation. The correction factors are multiplicative so that a unity value (1.00) indicates no correction. A value greater than 1 means that the observed response must be increased to account for a decrease in the interrogating neutron flux. On the other hand, a correction factor less than 1 means the response must be decreased. Thermalization of an energetic neutron flux results in an increased response because of the larger fission cross section at lower energies. Purely thermal interrogation has only a decreased response because of absorption. However, correction factors given in Table I are relative to a standard so that it is possible to get increases or decreases in the quoted values for either the thermal or epicadmium interrogation.

The drums of waste presented in Table I provide a range of fissile material loading and matrix type. The fissile material is enriched uranium. The combustible material includes paper, plastics, wood, rags, and mop heads. The noncombustible material includes plumbing, concrete, and failed equipment.

The data displayed in Table I show that the corrections are significantly smaller, closer to 1, for epicadmium interrogation than for thermal interrogation. Thus, the potential for greater accuracy with more energetic neutron interrogation is confirmed. The thermal corrections are all greater than unity in Table I, indicating that the drums of waste are more neutron absorbing than the standard, often considerably more absorbing. In comparison, corrections for epicadmium interrogation are both less than and greater than 1, indicating more moderation or more absorption, respectively, than the standard.

A detailed inspection of Table I shows that the first three drums listed, all noncombustible, are predominately neutron absorbing for both thermal and epicadmium interrogation. The next six drums, all combustible, show absorption for thermal interrogation and moderation for epicadmium interrogation. The thermal-neutron absorption for these drums is appreciable, making selection of the correction factor critical to obtaining even a factor-of-2 assay. Drum 8, the most absorbing of the drums, was analyzed by neutron activation to determine the neutron poison that yielded the high absorption.[11] The measurement showed that chlorine was the poison. It is found in several compounds and materials used at the facility. The last three drums, all classified noncombustible, show absorption for thermal interrogation and moderation for epicadmium interrogation.

Because of smaller correction factors and reasoning based on fundamental principles (demonstrated by test matrix material measurements), epicadmium interrogation is considered more accurate than thermal-neutron interrogation. Figure 4 compares the epicadmium assay to an assay of the drums made using a segmented gamma-ray scan (SGS). When the gamma-ray and neutron assay agree, the data lie on the solid line plotted in Fig. 4; when the neutron assay indicates more material, then

TABLE I

COMPARISON OF CORRECTION FACTORS FOR THERMAL AND EPICADMIUM NEUTRON INTERROGATION FOR 12 DRUMS OF WASTE

Drum	Type[a]	Correction Factor Thermal	Correction Factor Epicadmium
Std	C	1.00[b]	1.00[b]
1	NC	1.20	1.21
2	NC	2.04	1.16
3	NC	1.40	1.05
4	C	5.38	0.65
5	C	5.15	0.94
6	C	4.45	0.80
7	C	6.52	0.80
8	C	10.04	0.91
9	C	5.93	0.80
10	NC	1.54	0.93
11	NC	1.42	0.75
12	NC	3.61	0.99

[a]C = combustible, NC = noncombustible.

[b]Assumed as reference value.

the point lies above the solid line; when the neutron assay indicates less material, the point lies below the solid line. The vertical error bars are estimated from scatter between different flux corrections. The differences arise from various assumptions about distribution of the fissile material, and distribution and composition of the matrix material.

The heterogeneous composition of the drums violates the assumption of uniformity for SGS assay.[12] Both the heterogeneous nature of the matrix material and the uranium distribution can result in erroneously low SGS assays. A possible upper limit for the SGS assay is indicated by the dashed line in Fig. 4. All the neutron measurements are consistent with this limit. Thus, the higher neutron assays are considered possible, but not confirmed. Material in the highest three drums will be removed, inspected, and reassayed in smaller containers by gamma-ray counting.

III. SUMMARY AND CONCLUSIONS

A californium neutron source-based active assay instrument has been demonstrated for detection of low-level fissile material in 55-gal drums at the 10-nCi/g fiducial. The system can be readily reconfigured for more accurate measurements at accountability levels. For improved performance, the 55-gal drum system can be optimized for either application.

The system is operated in the thermal-neutron interrogation mode for maximum sensitivity. A 1000-s assay detects 12 mg of plutonium or 6 mg of uranium at the 99% confidence level. The system can be improved to detect better than 1 mg of ^{235}U or ^{239}Pu in 1000 s or, equivalently, 10 mg of either isotope in 10 s. In the latter case, the time used in drum handling determines the throughput. Because thermal-neutron interrogation is susceptible to neutron poisons, it is not recommended for accountability measurements.

When the system is operated in the fast-neutron interrogation mode, effects of neutron poisons can be considerably reduced. Typically, the accuracy improved by a about factor of 8, with improvements of a factor of 100 not uncommon. Appropriate corrections are necessary to take full advantage of potential improvements. Fast-neutron interrogation allows lumps of fissile material to be more fully interrogated.

Destructive analyses are under way to help determine whether significantly more enriched uranium is found by the Shuffler system operated in the fast mode than by passive gamma-ray counting. To date, evidence indicates that detection of additional uranium by fast-neutron interrogation is probable.

ACKNOWLEDGMENTS

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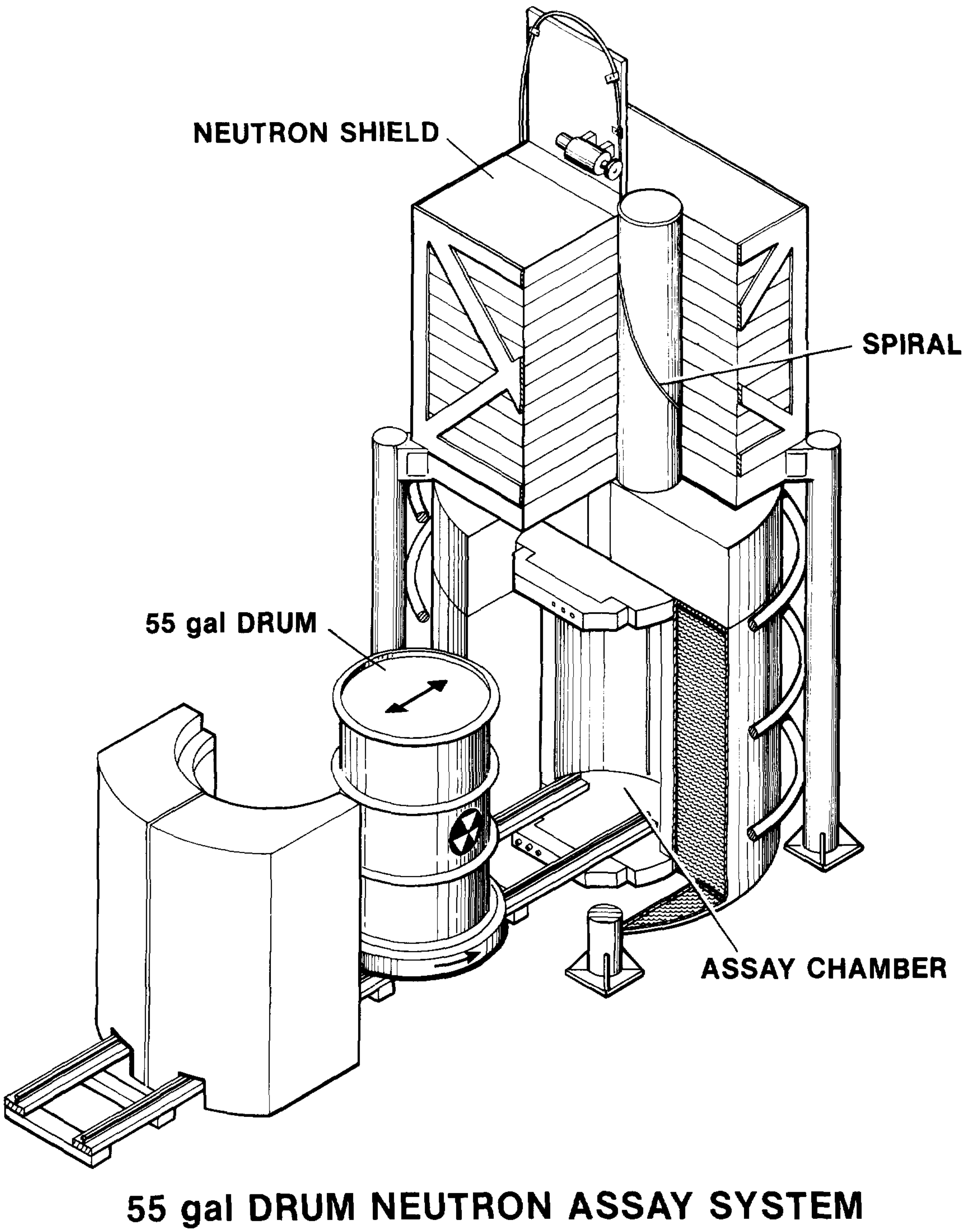

Fig. 1. Schematic of the Shuffler assay unit used for 55-gal-drum test measurements.

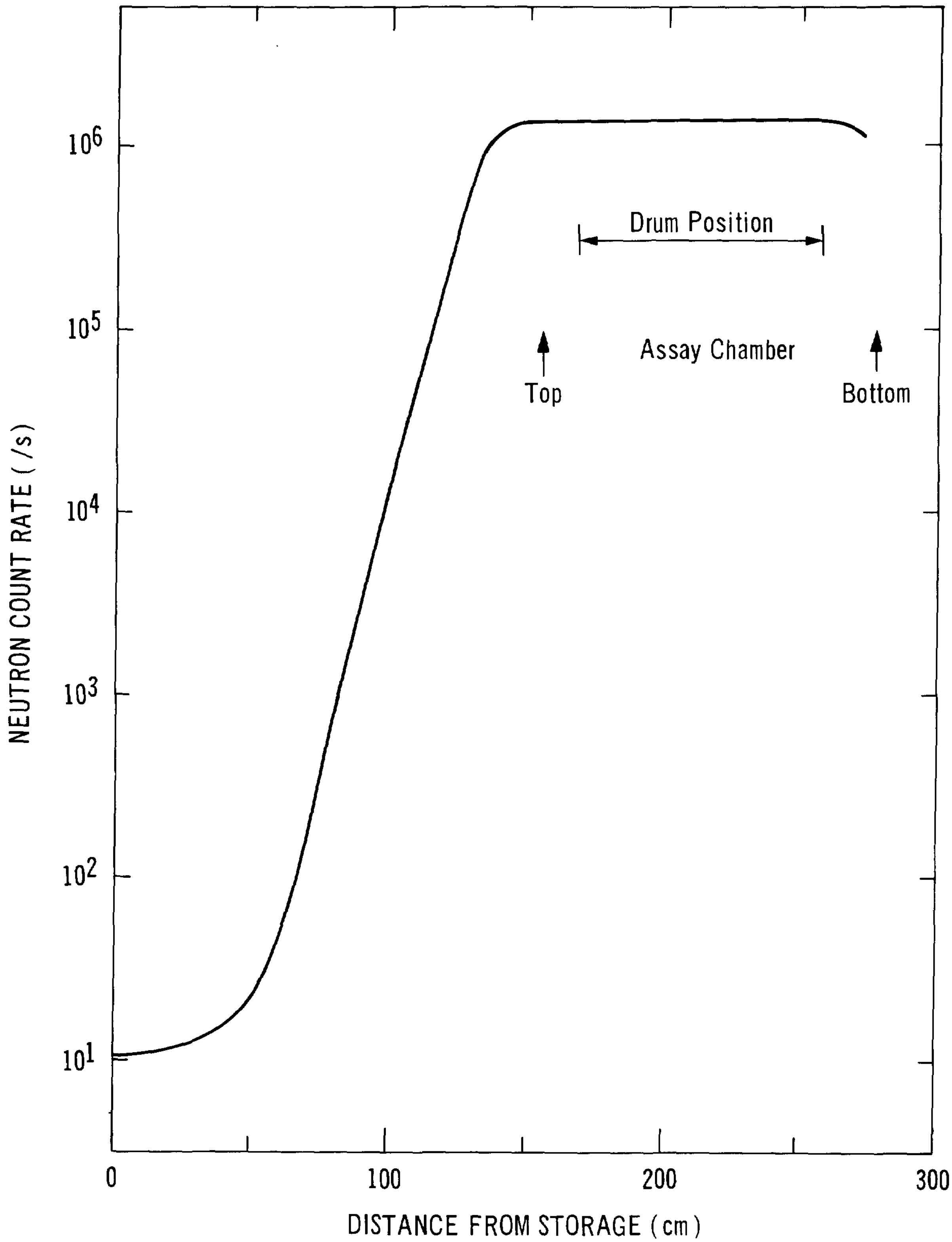

Fig. 2. Source isolation achieved with the Shuffler assay unit.

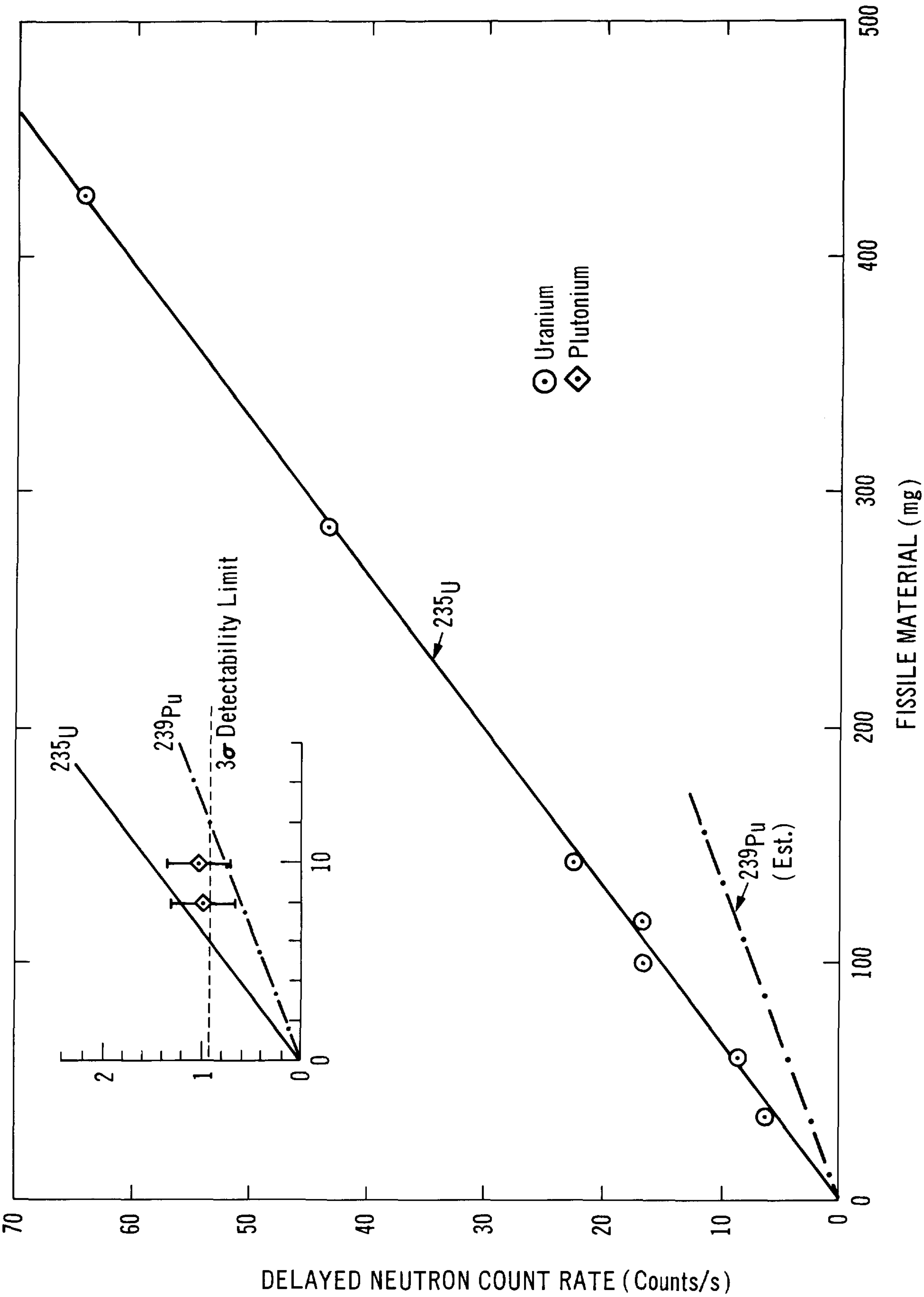

Fig. 3. Thermal interrogation data for detection of small quantities of uranium or plutonium.

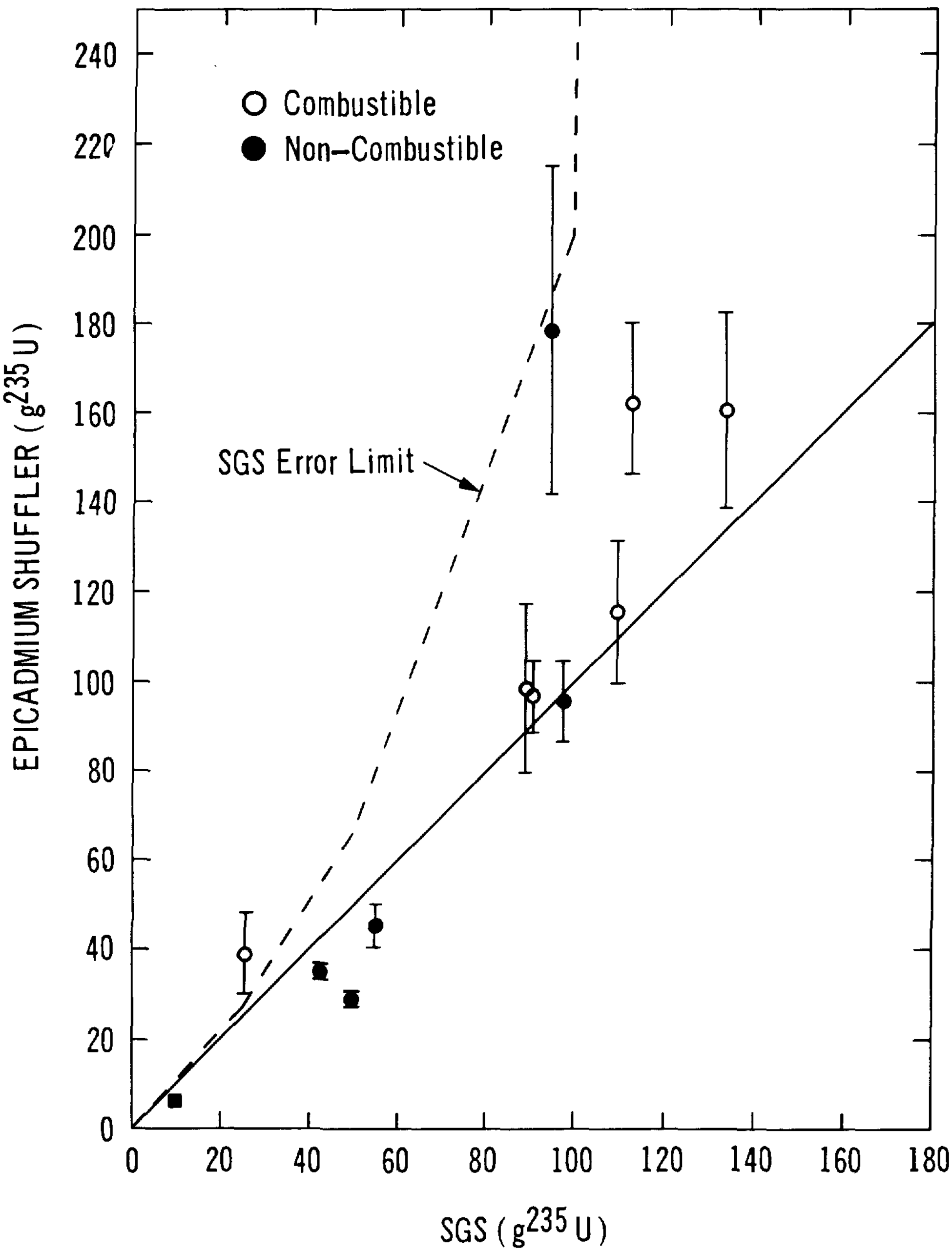

Fig. 4. Epicadmium measurements of enriched uranium in 55-gal drums. Error bars indicate the range for various corrections.

A PHYSICAL INVENTORY VERIFICATION EXERCISE AT A MIXED OXIDE FABRICATION FACILITY

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ABSTRACT

A Physical Inventory Verification (PIV) exercise conducted by safeguards inspectors from the three divisions of Operations of the IAEA was held at the Hanford Engineering Development Laboratory, Richland, U.S.A. in November 1983. The main objectives of the first exercise, which was sponsored by the U.S. Technical Support Programme, were for a group of experienced inspectors to evaluate a set of PIV procedures and a workbook for use at future exercises. In addition, the exercise provided a unique opportunity for inspectors to exchange ideas and experiences on PIV methods used in their respective divisions and contributed towards more standarized procedures. The feasibility of a technique for verifying the in process (glove-box) inventory was also examined and demonstrated. The inspectors were able to use the most up to date equipment available in the Agency and evaluate and discuss their results with experts in measurement techniques and statistics. The paper summarizes the activities performed by the teams, the problems encountered, the results of the measurements and the statistical analyses. Recommendations for improvements for similar exercises in the future are also made.

INTRODUCTION

Eight experienced IAEA inspectors carried out a physical inventory verification (PIV) exercise at Hanford Engineering Development Laboratory, Richland, Washington during the period 8-18 November 1983. The main objective of the exercise was to permit a group of inspectors to perform a PIV under idealized conditions, i.e. without the constraint of time pressure normally present at a PIV. The exercise also set out to achieve the following:

- the evaluation of PIV procedures and a workbook to be used for future exercises
- evaluation of NDA instrumentation and certain new computer programs with which all members of the team were not familiar
- evaluation of procedures for verifying the in-process inventory at a mixed oxide facility
- to stimulate the interchange of ideas between the three Operations Divisions on their respective PIV procedures.

This paper describes the equipment used, the organization of the exercise, and the results of the measurements. Details of a calibration exercise held prior to the PIV exercise are also given. Conclusions on the usefulness of the exercise are drawn and recommendations made for future exercises.

CALIBRATION OF EQUIPMENT

During September 1983 a team of IAEA and Los Alamos personnel visited the facility to calibrate three standard high level neutron coincidence (HLNC) detectors intended for use at the exercise. These instruments were calibrated for the following strata:

1. $Pu\ O_2$ powder
2. Mixed Oxide powder
3. Mixed Oxide pellets (containing depleted, natural, and low enriched uranium)
4. Mixed Oxide pellets (containing high enriched uranium)

For each of these strata between 4 and 9 samples were chosen as calibration standards. The weight ranges were selected so as to cover the weight domain of the strata expected at the inventory.

The following curves were derived for the respective strata:

Stratum	Equation of Curve
1	$R = am^b$
2,3	$R = am^b + bm$
4	$R = am^b$

Here R is the response of the detector in CPS, m is the Pu^{240}eff mass and a and b are constants.

The calibration of a special HLNC detector for measuring FBR rods and assemblies and an inventory sample counter (see Table 1) had been performed at the facility earlier.

INSTRUMENTS AND COMPUTER PROGRAMS

Table 1 lists the instruments that were used for the PIV exercise as well as the computer programs available. The first three groups of instruments referred to in the table are members of the high level coincidence group of detectors. All computer programs were written for HP-85 desk top computers. In addition, the Plutonium Isotopic Analysis Unit had its own internal gamma spectrum analysis program.

PIV EXERCISE

1) Team Organization

The participants were subdivided into two teams of 4 inspectors each. Each team comprised representatives from all three Operations Divisions and was headed by a team leader. The intention was that each team would have the opportunity to have access to and perform measurements on all the strata available.

In practice the teams could stratify the inventory, draw up sampling plans and select samples for measurement independently. However, for practical reasons, the two teams combined measurements and results for the fuel assemblies, fuel rods, and "in process" strata.

2) Set-up of Equipment and Calibration

A period of two days was set aside for each team to set up its equipment and do a calibration check on five samples of two of the available strata. This enabled the participants to test the calibration of the equipment and gain experience in the use of the computer programs (see Table 1). This phase of the exercise was particularly useful because it allowed inspectors to gain experience of calibration procedures as well as in the use of the related curve fitting programs.

3) Verification of the Inventory

Four days were set aside for the teams to do verification of the inventory. This activity comprised examination of records, records and reports comparison, and physical verification of the inventory.

For the examination of records and records and reports comparison activities the teams were supplied with the following documents:

- Copies of the operator's accounting ledger for the period covering the month preceding the inventory to the date of closing of the material balance period
- source documents (shipping documents, documents showing calculation for discards, retained waste, etc.) for this period
- copies of the operator's accounting ledger for the period 1-30 June 1983
- copy of the operator's inventory change report as received by the Agency for the period 1 June 1983 to 30 June 1983

In practice, each team was sub-divided into two groups. The first group performed the examination of records and operator's source documents as well as the comparison between the operator's accounting records for the month of June 1983 and reports submitted to the Agency for that month. During this time the second group of each team went to the facility and established the population of items from the operator's records by item counting.

When this activity had been completed, the two teams met to decide on their respective verification strategies and calculate sample plans. Both teams came to approximately the same stratification (see Table 3). One team decided that, in view of the extra time available, they would use a goal quantity of four kg of plutonium in the calculation of the sample sizes as compared with the usual Agency practice of 8 kg. In their case this resulted in larger sample sizes.

The next phase of the exercise was to select the samples from the population and perform NDA measurements on them. This was originally scheduled for 3 days but took considerably longer mainly because of problems encountered by both teams with the equipment as well as with its calibration. Both teams ensured the integrity of the selected samples during the measurements by placing seals on the storage cabinets at times when inspectors were not present.

This phase of the exercise also included a simulation of the verification of the in-process inventory. In the field this usually causes a considerable amount of trouble since all material is located in glove boxes. On this occasion the facility provided a list of in-process items and the inspectors were allowed to select some items from these for measurement. These items were then placed inside a glove box and the tare and net weights for the items found by weighing on a balance located inside the glove box to a precision of 1 g. Samples of the pellets taken from these items were then weighed to a precision of 1 mg and bagged out of the glove box and placed in the inventory sample counter for measurement. The amount of Pu (inspector) was then calculated combining these results.

Both teams were also able to verify FBR (Fast Breeder Reactor) fuel assemblies and FBR rods present at the facility. A stratum of 4 assemblies was set aside for the exercise and inspectors were able to verify all these using the newly constructed Universal Fast Breeder Counter (see Table 1)

4) Analysis of Results

A period of three days was set aside for analysis of the inspectors' results and for a wrap-up discussion. During this period both teams had time to analyse their results and had the opportunity to gain experience in one way analysis of variance techniques for the results for one of the HLNCC detectors. The analysis of the results followed standard Agency procedures of checks for outliers, paired comparison of operator-inspector values and extrapolation of these to the stratum and inventory. An analysis of variance technique was applied to estimate the systematic error for the standard HLNCC detectors and apply the result in checking the sample measurement results for gross defects. During this time a statistician from HEDL was available and he provided invaluable assistance to the inspectors in the analysis of their results.

RESULTS

Calibrations

Although the Californium normalization runs indicated that both detectors were operating satisfactorily, the results of the calibration test runs showed unacceptably large differences from the September results particularly for one IAEA detector. Since the results were taken using the same standards as the September calibration, this implied an error in the calibration constants found in the original calibration.

Examination of Records

This activity was performed and both teams found the discrepancies that existed in the operator's accounting records. A small error was detected in the comparison of the Operator's records with the corresponding report to the Agency.

Measurement Results

A detailed description of the measurements results for the strata selected by both teams is beyond the scope of this paper. A summary of the main conclusions is only presented here.

One team was able to detect a deliberate discrepancy (equivalent to an average overstatement of about 5%) in the Pu O_2 powder (greater than 500 g Pu) stratum using the HLNCC results (mean difference 3.09 ± 1.09%). This was confirmed by weighing of 4 randomly selected items from the population which gave an average operator-inspector difference of 2.7% ± 0.99%. This rather low result is mainly due to the fact that one of these items had the 'correct' amount of material. (The operator's diversion strategy in this case was to overstate the weights in most, but not all of the items in the stratum).

Measurements on the MOX powder stratum gave widely varying and inconclusive results depending on the enrichment of the uranium present. This resulted in significantly different results being found for the measurements of the items containing enriched uranium indicating a problem in the calibration of the detectors for the stratum. The same was true to a lesser extent for the results of MOX (HEU) pellets.

The results for the Pu measurements on the remaining strata were satisfactory and indicated no significant difference between the operator's statement and the inspectors' measurements. However, further study of the calibration curves for the instruments is indicated in all cases. It was not possible to measure the enrichment of the stratum of High Enriched uranium due to in-homogenity of the samples and lack of suitable hardware.

Table 2 shows a summary of the measurements results for the strata selected by one team.* In determining an estimate of the systematic error, using the one way analysis of variance technique, only strata numbered 2, 4, 6, 7, 8 were used. Stratum 1 which contained the deliberate discrepancy was eliminated from the analysis as were 9 and 10 because a different type of HLNC detector was used for these. Stratum 5 was eliminated because of calibration problems mentioned earlier.

A comparison made between two algorithms for analysing gamma spectra to yield Pu isotopics (PUISOD an the PIAU) using 4 samples of PuO_2 powder, gave inconclusive results. However, one of the methods appeared to give isotopic analysis closer to the operator's values than the other.

Equipment

There was an unacceptably high rate of equipment failure. One HLNCC was found to be unstable and two 8 K Ciceros became inoperative during the exercise.

CONCLUSIONS AND RECOMMENDATIONS

The exercise is considered by all participants to have been highly successful. Although the procedures used were, to a large extent, laid down by the workbook, one of the most positive aspects of the exercise was that it gave the opportunity for the participants to exchange ideas and information on approaches used in their respective operations divisions.

The technique for verifying the in-process inventory was successfully demonstrated although one of the balances requested for weighing the samples was not available. It was unfortunately

*Footnote: In the following exercise in 1984 (reports under preparation) equipment was recalibrated and a substantial improvement in measurement results was noted (Random and systematic errors of around 1.5% and 0.6% respectively).

not possible (owing to the static state of the inventory) to demonstrate or investigate techniques for an "active" (with the process lines in operation) inventory verification. It is unlikely that this will be practicable because the areas of the facility currently available for the exercise are insufficient for this purpose.

Although equipment breakdown/malfunction is by no means unusual in the field, the performance of the equipment on this occasion is not considered satisfactory. There was insufficient preparation of the equipment for the measurement of Uranium content, a technique which is by now well established. In particular it was found that the calibration of the HLNC detectors was not satisfactory and on remeasurement, gave unacceptably large differences from the standards.

For four samples it was found that algorithms used for the PUISOD and PIAU programs for isotopic content were not in agreement. Using the data of measurements on four samples the former program showed better results than the latter. It appears that, for the present, the operator's data for isotopics should continue to be used in the HLNC analysis programs.

The time available for the exercise is considered to be sufficient to perform the work well and without the stress usually present at an actual PIV (because of time constraints). Most of the strata were rather small and only large enough for the minimum sample size of 3 samples to be taken.

The error propagation techniques used are in relatively common use in the Agency and caused relatively few problems. However, not all participants were confident in the use of the analysis of variance techniques used and in its interpretation.

The exercise successfully demonstrated the detection of a discrepancy of about 5%. It would have more clearly done so if the uncertainties in the calibrations had been lower.

The first draft of the workbook was satisfactory. However, it was found that some sections, particularly some of the computer program and statistical analysis sections, needed further amplification and correction.

The following recommendations were made:

1. That the exercise be repeated once more mainly with experienced inspectors to finalize the procedures, subject to the reservations below. Should the problems encountered in the first exercise be overcome, the exercise would then be highly instructive and should be repeated a number of times until all inspectors who are likely to perform inspections at similar facilities have benefited from it.

2. (a) Before a further exercise is scheduled, the calibration curves for the HLNCC's, both corrected and uncorrected for multiplication, should be reanalysed using the original (raw) data. Complete recalibration of the instruments is to be indicated.

   (b) Depending on the outcome of the reanalysis, serious consideration should be given to obtaining a set of fully characterized standards at the facility. This would involve complete isotopic analysis of a selected number of items to be used as standards and kept at the facility for future exercises.

   (c) Consideration should be given to providing separate calibration curves for the strata containing HEU.

3. An Agency co-ordinator should be appointed who will co-ordinate the exercise as before. However, the co-ordinator should not be a member of one of the teams, but should be present at the exercise to ensure continuity, standardization and timeliness of the activities.

4. Consideration should be given to using the calorimeter currently under development to gain experience on and evaluate its usefulness in a PIV.

5. A decision should be made as to which of the two algorithms used for gamma isotopics is to be applied for the exercise.

6. Consideration should be given to providing a computer program of the type similar to INSPECT suitable for use on the HP85 or similar machine for the evaluation of MUF. This would require a certain amount of additional data from the facility to simulate beginning inventory, inventory changes and measurement errors for an entire material balance period. It would, however, provide the participants with a complete picture of the evaluation of MUF for the material balance period for which they had performed the PIV.

7. A statistician should be available at least during the last three days of the exercises to assist the teams in the evaluation of their results. The presence of a least 2 LANL staff members for the entire exercise is highly desirable.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to their colleagues who participated in the exercise: Miss K. Morimoto and Messrs. J. Griggs, P. Karasuddhi, K. Schaerf, M. Danker and T. Ishikawa. They are particularly indebted to Messrs. R. Augustson, D. Reilly and P. Rinard of

Los Alamos National Laboratory and Messrs. W. de Merschmann, J. Merrill, D. Engle, J. Brunke, B. Woehle, A. Mah and Ms. M. Serice of HEDL for the invaluable part they played in making the exercise a success.

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3. Krick, M., Los Alamos National Laboratories, Private Communication, 1983.

TABLE 1

EQUIPMENT AVAILABLE

Standard Hexagonal High Level Neutron Coincidence Detector (HLNC)	3
Universal Fast Breeder Counter (UFBC)	1
Inventory Sample Counter (INVS)	1
8K CICERO Multichannel Analyser	2
4K SILENA Multichannel Analyser	1
Plutonium Isotopic Analyser Unit (PIAU)	2
High Resolution Gamma Detectors	3

COMPUTER PROGRAMMES ON HP85

CAL2	Collection and Analysis of HLNC Detector Calibration Data (ref.3)
DEM3.2	Curve Fitting (Demings Method) (ref.2)
WKHEDL	Collection and Analysis of HLNC Detector Data (ref.3)
PUISOD	Gamma Isotopic Analysis (ref.2)
ONEAOV	One Way Analysis of Variance (ref.2)

TABLE 2 SUMMARY OF RESULTS

Stratum No.	Description	Total Mass g Pu	No. Items	N_a	N_v	Stratum Op-Insp.* Diff.(g)	Random Error	Syst. Error	Comments
1	PuO_2 Powder >500 g	19279.7	23	13	(4)	527.9	191.7	-	Defect detected N_v items were weighted not including analysis of variance
2	PuO_2 Powder <500g	3769.5	22	8	4	116.38	(1.09%) 40.94	(2%) 74.94	Note 1
3	HEU Powder	14763.6(u)	15	6	3	-	-	-	Measurements not successful
4	MOX Scrap	2415.9	9	4	4	71.03	(3.3%) 80.46	(2%) 78.03	Note 1
5	MOX Powder	2410.2	10	8	4	71.76	(5.34%) 128.6	-	Calibration problems, not included in anal of variance
6	MOX Pellets (LEU)	8458.6	19	4	4	364.14	(1.3%) 112.67	(2%) 168.16	Note 1
7	MOX Pellets (HEU)	4415.6	19	5	4	99.68	(1.6%) 68.78	(2%) 87.78	Note 1
8	In-Process	3488.9	18	4	4	- 61.14	(2.1%) 72.64	(2%) 69.36	Note 1
9	FBR Rods	11720.2	4	4	4	-562.34	(0.7%) 85.40	(2.6%) 304.72	Systematic error estimated
10	FBR Assemblies	32619.6	4	4	4	-190.01	(0.7%) 229.64	(2.6%) 848.11	

*Operator-Inspector

NOTE 1: Systematic error estimated at 2% from analysis of variance.

MATERIAL CONTROL AND ACCOUNTABILITY PROCEDURES FOR A PROSPECTIVE NUCLEAR WASTE REPOSITORY AT THE NEVADA TEST SITE*

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ABSTRACT

We developed preliminary material control and accountability (MC&A) procedures for the prospective Nevada Nuclear Waste Storage Investigations Project (NNWSI) geologic repository. Preliminary safeguards studies for repositories have been completed in the past, but specific MC&A guidance has yet to be developed for these facilities.(1), (2) We therefore consulted Nuclear Regulatory Commission (NRC), Department of Energy (DOE), and International Atomic Energy Agency (IAEA) guidance and practices for nuclear facilities that are most similar in size and mission. In general, existing material control and accountability procedures are readily transferable and reasonable in a geologic repository setting. The only exception is the physical inventory of nuclear material. We suggest that permanent seals be placed over waste emplacement borehole locations and used in lieu of physical inventories.

Introduction

This work was performed in support of the repository conceptual design for the Nevada Nuclear Waste Storage Investigations Project (NNWSI). The prospective NNWSI geologic repository has certain features which, in combination, make it unique from a material control and accountability perspective:

1. The ability to retrieve all the spent fuel and other high level waste (HLW) is to be designed and built into the repository.

2. The construction and operation of the repository by DOE will be licensed by NRC.

3. Large amounts of plutonium and U-235 dispersed in spent fuel and other HLW will be emplaced in underground boreholes. (See Table I.)

4. IAEA safeguards may be applied.

5. The repository surface facilities will probably be located within the boundaries of the Nevada Test Site (NTS.) (See Figure I.)

Discussion

We now examine the impacts of the above features on the development of material control and accountability procedures for a repository at the NTS.

Retrievability has the greatest impact on repository MC&A procedures. If the spent fuel and other HLW were emplaced with no hope of later retrieval, then accountability would end when the repository is decommissioned. A simplified accounting system would still be required for operational purposes to track the status of the waste canisters and underground emplacement boreholes. Retrievability is, however, a planned contingency to "protect public health and safety in the event the site or design proves unsuitable."(3) The retrievability option must be maintained for up to fifty years after the first waste canister is emplaced.(3) Retrieval of spent fuel for reprocessing can be ordered anytime within the fifty year period.(4)

Although the repository will be licensed by the NRC, the Commission permits the DOE to develop and then certify its own safeguards for the repository. Article 60.21(b)(3) of 10CFR60 states:(3)

> A certification that DOE will provide at the geologic repository operations area such safeguards as it requires at comparable surface facilities (of DOE) to promote the common defense and security.

Geologic repositories are a recent development from a safeguards perspective, and specific DOE guidance on the material accountability and control of high level nuclear waste in such facilities has yet to be developed. We

* This work was supported by the U.S. Department of Energy (DOE) under contract DE-AC04-DP00789.

** A U.S. DOE facility.

therefore consulted guidance presently available for high level nuclear waste in facilities that are most similar in size and mission. The guidance which we feel is most appropriate is for the transfer and storage of spent fuel contained in 10CFR72, "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation."(5) We feel that the MC&A procedures contained in 10CFR72, when modified for repository use, are also appropriate for the Defense High Level Waste (DHLW). Spent fuel together with DHLW, if selected for disposal in a commercial waste repository, will make up the bulk of the high level waste stored at the repository (Table I).(6) 10CFR72 requires that records be kept showing the receipt, inventory (including location), disposal, acquisition, and transfer of all spent fuel in storage. For a repository, only those records showing the receipt and inventory (including location) of all nuclear waste in handling and storage should be required. Whenever spent fuel or other HLW is received, we recommend a "Nuclear Material Transaction Report" (DOE/NRC Form 741) be prepared and filed with copies sent to the DOE and to the originator. For transactions involving waste management sites ("V" Reporting Identification Symbols), data for the "V" side of the form need not be reported. We also recommend the use of Form 741 as the documentation to track each waste package as it is packaged for disposal and finally emplaced underground. The Form 741 would be marked "memo transfer only" when used to track waste movements within the repository. Records of spent fuel and other HLW should be kept in duplicate, and the duplicate set of records should be kept at a separate location sufficiently removed from the originals to prevent the destruction of both sets by a single event. Records should be kept until a final decision is made to retrieve the waste or leave it permanently entombed.

Each waste canister should be uniquely numbered and its contents recorded. In the case of spent fuel waste canisters, six PWR spent fuel assemblies or eighteen BWR spent fuel assemblies may be associated with each waste canister because spent fuel assemblies may be consolidated at the repository prior to emplacement underground (see Table I).(6) Because all fuel assemblies are already numbered, these serial numbers could then be easily associated with a given waste canister number. For DHLW shipments, no consolidation is planned and so only one shipment would be associated with each waste canister. At the present time, we do not know if DHLW shipments will be uniquely numbered before such shipments are sent to the repository. If they are numbered, then that number would be associated with the waste canister number. If they are not numbered, then a description of the contents of the shipment could be associated with a unique waste canister number.

Once packaged and uniquely numbered, the waste canisters would be sent underground for emplacement. Current emplacement schemes call for multiple canisters to be placed in 600' to 700' long horizontal boreholes or for single waste canisters to be placed in 30' deep vertical boreholes. To complete accountability and control of the nuclear waste, these boreholes would also be uniquely numbered so that the contents of each borehole might be accurately known. Thus, one or more canister numbers would be associated with each borehole number, depending on whether the boreholes are horizontal or vertical. As discussed earlier, this numbering procedure would be useful not only for waste retrieval, but would also assist repository operations by providing information on the status of waste canisters and boreholes (e.g., which boreholes were filled and how many more canisters could be placed in an unfilled borehole).

The United States currently has a list of nuclear installations eligible for IAEA safeguards under the US/IAEA Safeguards Agreement. This list has been filed by the Secretary of State with the NRC, and the Commission administers the implementation of the Agreement through 10CFR75, "Safeguards on Nuclear Material Implementation of US/IAEA Agreement."(7) Should the U.S. Government decide to place the repository in Nevada on the eligible list, several additional material control and accountability procedures detailed in 10CFR75 would be imposed. A Material Balance Area (MBA), in which the quantities of nuclear material moving in and out of the area can be accurately determined and verified, would be established within the repository waste receiving and packaging facilities. In these facilities, spent fuel and the other HLW forms are unloaded from their shipping containers and packaged in canisters for emplacement underground. Because IAEA safeguards on nuclear material are normally terminated when such material becomes "practically irrecoverable," the only waste form of interest to the IAEA would be the unreprocessed spent fuel.(8)

IAEA practice calls for the physical inventory of nuclear material for control and accounting purposes. Whether such a practice could be implemented in a repository setting is highly questionable. Although the retrieval of all spent fuel and other HLW is a planned contingency, repeated retrievals of each highly radioactive canister for a physical inventory would place an unacceptable burden on repository operations. As an alternative, we would suggest welding permanent seals over the shield plug after a given borehole has been filled with waste. A physical inventory of each plug could then be taken to insure that the seals had not been broken. An IAEA repository inspector could witness the initial placing of the seals and perform a seal "inventory." These seals, rather than the material within each borehole, could then be "inventoried." A precedent for such seals already exists in IAEA practice for stockpiled source material in sealed storage facilities.[9]

An initial inventory report using DOE/NRC Form 742, "Material Balance Report" would be prepared upon the implementation of IAEA safeguards. This form would show the quantities of nuclear material at the repository as of the initial inventory reporting date. Form 742 would also be submitted as a Material Balance Report every time an onsite inventory was taken by IAEA inspectors. Subsequent changes to the inventory would be submitted on DOE/NRC Form 741 as discussed above. 10CFR75 states that all records dealing with nuclear materials be retained for at least five years.[7]

The final and most important part of any MC&A system is the people who actually administer it. If the repository is located on the NTS, then we would recommend that all repository management and security be DOE "Q" cleared so that they may interact with the rest of NTS. Other repository operations and construction personnel could be "L" cleared or granted "name approval" access. "Q" clearances would not be required if the repository were located outside of the NTS.

Summary and Conclusions

Our review of current NRC, DOE, and IAEA guidance and practice for nuclear material control and accountability indicates that this guidance and practice are readily transferable and reasonable in a geologic repository setting. The only exception is the physical inventory of the nuclear material. The use of seals in lieu of such a requirement is an alternative which permits compliance with the spirit of current practice. We therefore suggest that the use of this alternative for geologic repositories be considered. Finally, we feel that it is now appropriate to consider promulgating specific MC&A guidelines for repository environments.

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7. 10 Code of Federal Regulations Part 75 "Safeguards on Nuclear Material-Implementation of US/IAEA Agreement."

8. Information Circular 153 "The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons," Paragraph 35, International Atomic Energy Agency, Vienna.

9. Information Circular 66, Revision 2, "The Agency's Safeguards System" Paragraph 61, International Atomic Energy Agency, Vienna.

TABLE I

QUANTITIES OF SNM IN DESIGN BASIS
NUCLEAR WASTE FORMS FOR THE PROSPECTIVE NNWSI REPOSITORY[a]

	DHLW	PWR SF	BWR SF
SF Assemblies/Pkg[b]	---	6	18
Nominal Receival Rate (Pkg/Yr)	500	600	400
Peak Receival Rate (Pkg/Yr)	750	794	545
U-235 (kg/Pkg)	0.027	22.4	24.8
Pu-239 (kg/Pkg)	0.130	13.9	15.9
U-235 (kg/Fuel Assembly)	--	3.7	1.4
Pu-239 (kg/Fuel Assembly)	--	2.3	0.9
Package Weight (lb)	5380	9900	12300
Package O.D. (in)	24	19.7	22.4
Package Length (in)	118	177.2	177.2
Thermal Power (watts)	510	3200	3060
Contact Gamma Dose Rate (mrem/hr)	6.6×10^6	1.9×10^7	1.5×10^7

Legend:

DHLW = Defense High-Level Waste
PWR = Pressurized Water Reactor
BWR = Boiling Water Reactor
SF = Spent Fuel (Not Reprocessed)

NOTES

a. All numbers shown are average values.

b. Fuel rods may be removed from assemblies at the repository and consolidated in cylindrical containers.

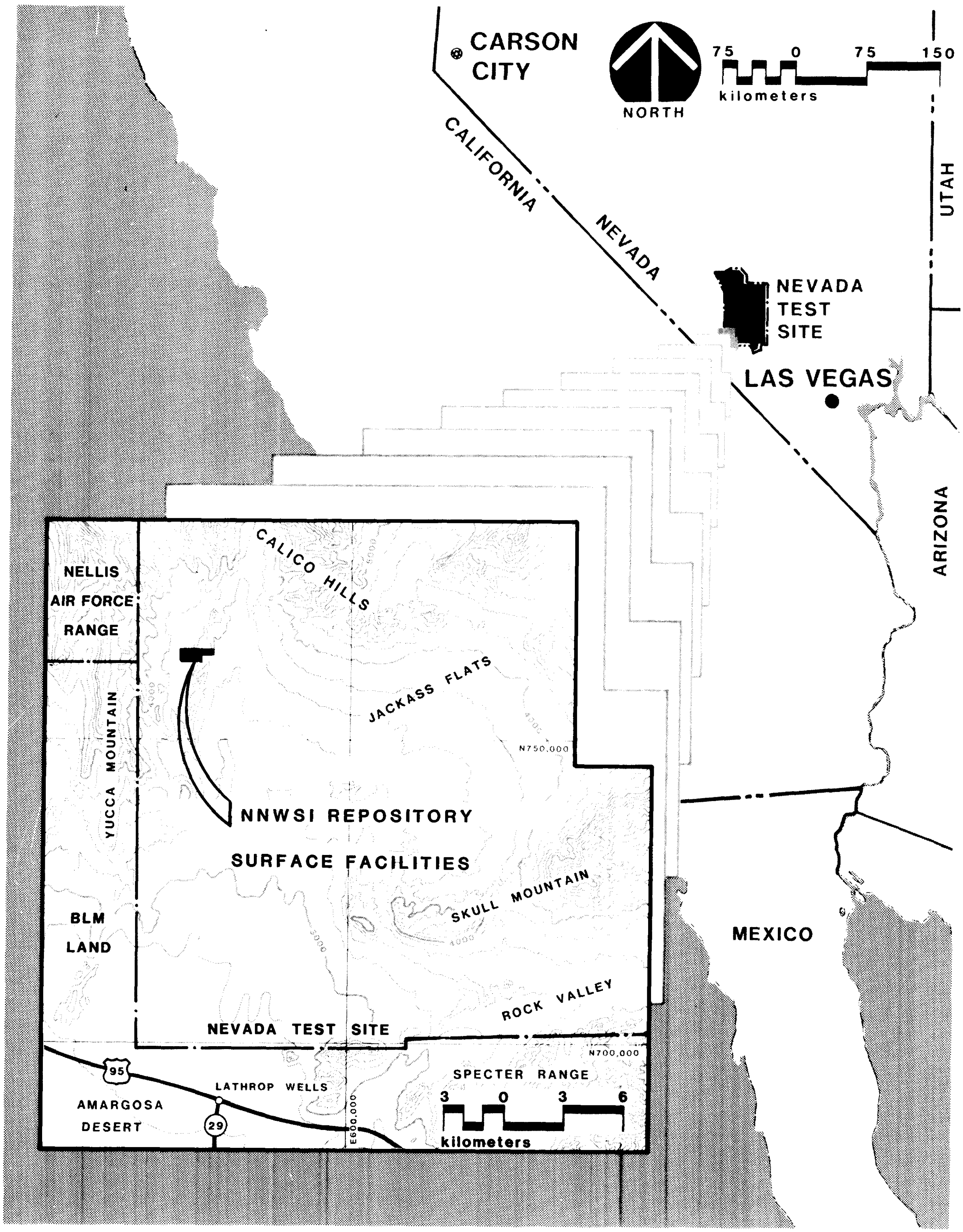

FIGURE 1

NNWSI REPOSITORY LOCATION

RECOMMENDATIONS FOR PHYSICAL PROTECTION LEVELS FOR THE PROSPECTIVE NUCLEAR WASTE REPOSITORY AT THE NEVADA TEST SITE*

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ABSTRACT

We developed a preliminary physical protection system (PPS) for the prospective Nevada Nuclear Waste Storage Investigations Project (NNWSI) geologic repository. We consulted Nuclear Regulatory Commission (NRC) and Department of Energy (DOE) regulations and practices for nuclear facilities that are similar in size and mission and found no specific guidance for a geologic repository. It is not surprising that the guidelines do not address repositories because there are currently no such facilities, and specific regulations have not yet been promulgated. An implied NRC acceptance of DOE safeguards for the repository (10CFR60.21) led us to a design that followed DOE Order 5632.2. Due to the characteristics of the repository nuclear material, we recommend protecting this material at a level comparable to a Category IIIA quantity of Special Nuclear Material (SNM). This level of protection is adequate for protecting the "dispersed nuclear material" likely to be contained in the prospective repository.

Introduction

The prospective NNWSI geologic repository has certain features which, in combination, make it unique from a safeguards perspective:

1. The construction and operation of the repository by DOE will be licensed by NRC.

2. Large amounts of plutonium and U-235 dispersed in spent fuel and other high level waste (HLW) will be emplaced in underground boreholes (see Table I).(1)

3. The repository surface facilities will be located within the boundaries of the Nevada Test Site (NTS). The repository location is remote: the nearest metropolitan area, Las Vegas, is approximately 100 miles away (Figure 1).

Discussion

We will now examine the impact of the above features on the repository safeguards system and how they lead us to recommend protecting the HLW and spent fuel at a level equivalent to that provided for a Category IIIA quantity of SNM.

First, we consulted the licensing application section of 10CFR60(2) and found that if the repository is operated by the DOE, a certification must be made by the DOE to NRC that the

> ". . .DOE will provide at the geologic repository operations area such safeguards as it requires at comparable surface facilities (of DOE) to promote the common defense and security."

We inferred from this guideline that the NRC will accept a physical protection system (PPS) designed by the DOE for the prospective NNWSI repository provided that the PPS is consistent with safeguards at a comparable DOE surface facility.

We therefore consulted DOE Order 5632.2(3) for specific DOE guidance. In general, the level of physical protection required under DOE guideline 5632.2 is a function of the SNM classification. Very high and expensive levels of protection are required for Categories I and II quantities of SNM (Table II), while fairly low and inexpensive levels of protection are specified for Category IIIA material. Even though the total amount of SNM at the prospective Nevada repository exceeds the amount required for a Category I quantity, the protection level afforded the waste material can be reduced. A reduction in the SNM classification is permitted by the DOE if the SNM is not readily separable from the rest of the waste material, and the combination of the SNM and other radioactive material delivers an external radiation dose in excess of 100

* This work was supported by the U.S. Department of Energy (DOE) under contract DE-AC04-DP00789.

** A U.S. DOE facility

rem/hour at one meter from any accessible surface without intervening shielding. Table I indicates that the waste material to be handled at the repository satisfies the criteria for a reduction in physical protection. However, no specific DOE guidelines are presently available to help determine the extent of downgrading allowed.

Because a reduction in classification is allowed, we recommend protecting the repository nuclear material as if it were a Category IIIA or lower quantity of SNM. We feel this recommendation is reasonable because of (1) the existing precedent set at the Engine Maintenance and Disassembly Facility (E-MAD), (2) the low attractiveness of the waste for theft, and (3) the low probability of producing a significant radiological release to the public from an act of sabotage.

The E-MAD facility is located on the NTS and is currently involved in experiments with spent fuel which support the NNWSI project. The existing safeguards at E-MAD are comparable to those that would be used to protect a Category IIIA amount of SNM.

Theft is presently considered to be a non-viable adversarial objective due to the dispersed form of the SNM, the heavy weight of the waste canisters (5,000 to 12,000 lb), the technical problems associated with reprocessing spent fuel, and the highly radioactive nature of the unshielded material. It is, however, prudent to assume that adversarial capabilities will become more sophisticated over the next twenty years when the repository likely will be in operation. Thus, physical protection requirements should be reviewed in the future to ensure that theft remains a non-viable objective.

Although radiological sabotage remains a threat, preliminary calculations performed at Sandia National Laboratories for "worst case" attacks at the surface facilities of the repository indicate that the public health consequences of such incidents would be minimal[4]. Due to the remoteness of the site, the dose rate to the general public produced by an attack on a spent fuel shipping cask at the repository entrance would be well within the limits prescribed by 10CFR60 (0.5 rem whole body/incident) for radiological releases from operational accidents.[5] If an act of sabotage were committed underground, the radiological consequences to the public would also be minimal because the ventilation shafts to the surface will be equipped with appropriate filters[6] and because radionuclide release to the accessible environment by ground water transport must be within limits which assure public safety.

As a final recommendation, we believe that the spent fuel and other HLW stored at a repository should be designated as "dispersed nuclear material" in DOE safeguards guidance. Such a designation would distinguish the repository materials from SNM.

Summary and Conclusions

The physical characteristics of the nuclear material to be stored at the prospective NNWSI repository and the remoteness of the site convince us that the level of physical protection required at the repository should be equivalent to or less than that required for a Category IIIA quantity of SNM. Such a PPS design would be effective, inexpensive to install, and easy to maintain. In addition, we feel that it is now appropriate to consider promulgating specific guidelines to promote consistent, effective, and appropriate safeguards designs in repository environments.

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TABLE I

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Legend:

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SF = Spent Fuel (Not Reprocessed)

NOTES

a. All numbers shown are average values.

b. Fuel rods may be removed from assemblies at the repository and consolidated in cylindrical containers.

TABLE II

DOE GUIDELINES FOR PHYSICAL PROTECTION OF SNM

Category	Amount of SNM	Formula Used to Determine Category	Typical Elements of Physical Protection System	Protection Level	Cost
I	5000 gm or more	gm = gm U-235 + 2.5 (gm U-233 + gm Plutonium)	Material access areas. Protected area with the following features: isolation zone, hardened alarm station, secondary alarm station, detection/assessment, capability, SNM vaults or secured rooms, less than 5 min. guard force response time to point of alarm. Escorted transport with Q-cleared employees.	high	high
II	1000 to 4999 gm	gm = gm U-235 + 2.5(gm U-233 + gm Plutonium)	Protected area (requirements can be reduced subject to detailed justification). Less than 10 min. guard force response time to point of alarm. Escorted transport with Q-cleared employees.	medium to high	medium to high
IIIA	350 to 999 gm	gm = gm U-235 + gm U-233 + gm Plutonium (Plutonium and/or U-233 content less than 400 gm)	SNM stored in locked room when unattended. Patrols at intervals of less than 2 hours. Less than 10 min. guard force response time to the point of alarm. Limited access to the SNM.	low	low

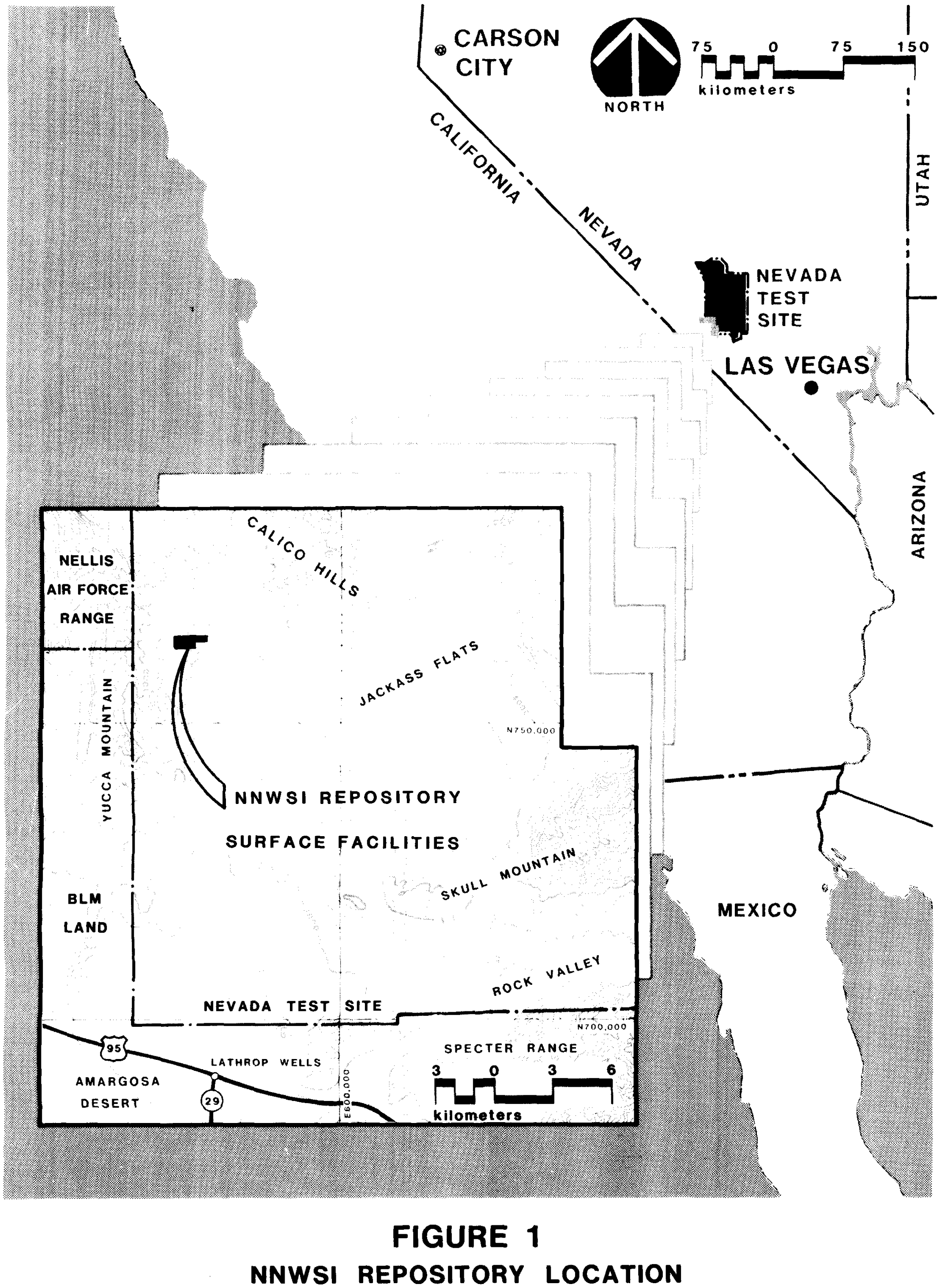

FIGURE 1
NNWSI REPOSITORY LOCATION