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OPPORTUNITY FOR SURVIVAL
A LOOK AT NUCLEAR MATERIAL SAFEGUARDS

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OPPORTUNITY FOR SURVIVAL
A LOOK AT NUCLEAR MATERIAL SAFEGUARDS

INTRODUCTION

Technological advancements for the good of man have historically been exploited by radical and self-interest groups. Compact forms of potential energy are particularly vulnerable to misuse. The nature of man is such that he must advance even if such advancement means a degree of risk for his own survival. Additional technology must be employed to minimize that risk.

In our growing world, our energy needs are advancing much faster than even our population. Electric power has become vital to the health, comfort, and economic well-being of people around the world. Projected energy requirements for the future suggest that American needs for electricity will increase by at least a factor of four between 1970 and the end of the century.

It has become obvious that deleterious effects to our environment from energy generation is of great concern. Conservation of our fossil-fuel resources (coal, oil, and gas) for other purposes such as raw materials for the production of chemicals, rubber, and plastic is likewise important. It is therefore imperative that we have a clean source of energy which incorporates conservation and economic consideration.

Current technology indicates that we must look to nuclear power for a substantial quantity of our electricity. Nuclear power plants produce power without releasing combustion products to the atmosphere. Economy is realized through essentially eliminating transportation costs. There is also a

substantial unit cost decrease as the capacity increases. Development of more efficient reactors, including "breeder" reactors, will permit maximum use of nuclear fuel resources.

Nuclear power is not without problems. A growing coalition of conservationists, laymen, and legislators are actively questioning the risks of low-level radiation, accident potential, and the handling and storage of highly-radioactive wastes from reprocessing plants. The addition of heat to rivers and bays is also being questioned.

Except for several sensationalistic features in magazines, there has been very little public concern involving the management of nuclear materials. For many years governments owned, measured, and guarded nuclear materials. Even with private ownership, the amounts of material have been small and closely monitored by governments. This, coupled with the notion that only a major nation could gather the resources and technology necessary to build atomic weapons, has resulted in general public complacency.

In the near future, much more nuclear material will be produced. In contrast to today, most of this material will be processed and used in private production and research activities licensed and regulated by governments. With larger quantities of nuclear material being more widely distributed, new technology and refined control procedures will be essential. It is generally conceded that enough information is available in the open literature for a small crew, given the special nuclear material, to produce nuclear weapons in a very short time. Such weapons of mass destruction in the wrong hands could result in chaos beyond description.

The purpose of this paper is to summarize for the Atlantic Richfield Hanford Company the measures being developed to prevent the diversion of nuclear material from uses permitted by law or treaty; and to indicate the vital role which ARHCO

could play in efforts to consummate effective measures while there is still time.

SAFEGUARDS DEFINITION

Safeguards is a collective term that comprises those measures designed to guard against the diversion of material such as source and special nuclear material from uses permitted by law or treaty, and to give timely indication of possible diversion or credible assurance that no diversion has occurred.

A safeguards program consists of three general classes of activity: containment or physical security, surveillance, and material accountability. Containment and surveillance activities provide direct evidence of diversion--material accounting determines indirectly if diversion has taken place over some past period of time.

Prior to 1967, the United States Atomic Energy Commission generally used the term safeguards in reference to safeguarding the public against hazards from a possible accident in a nuclear reactor or other nuclear facility. Currently, *safeguard system* also refers to an antiballistic missile system. In this paper, *safeguards* refers strictly to guarding against diversion of material as defined above.

INTERNATIONAL NUCLEAR SAFEGUARDS

The International Atomic Energy Agency (IAEA) established a Safeguards System in 1961 to comply with the statutory obligation with respect to the activities of member States, that materials and equipment for peaceful uses of nuclear energy not be diverted in such a way as to further any military purpose. The system has been revised and extended periodically

as warranted. Provisions for safeguards have been included in the Treaty on the Nonproliferation of Nuclear Weapons (NPT). The IAEA was selected to apply the treaty safeguards on the basis of its statutory responsibilities. The experience and reputation it has gained in making inspections and applying its safeguards system throughout the world also influenced this decision.

The NPT was negotiated over the course of several years in a number of international forums, with considerable consultation among many governments. The NPT is designed to achieve four objectives, as described by former Secretary of State Dean Rusk: "Commit the nations of the world which do not now have nuclear weapons, not to produce or receive them in the future; assure equally that such nations have the full peaceful benefits of the atom; provide assurance, through international safeguards, that the peaceful nuclear activities of states which have not already developed nuclear weapons will not be diverted to making such weapons; and give recognition to the determination of the parties that the treaty should lead to further progress toward arms control and disarmament."

In order for the Treaty to be in effect, any 40 non-nuclear-weapon States plus the U.K., the U.S.S.R., and the U.S. must have deposited their instruments of ratification. As of May 5, 1970, of the 97 nations which have signed the treaty, 51 have deposited their instruments of ratification. The U.K., the U.S.S.R., and the U.S. are included in this number. The Foreign Relations Committee of the U.S. Senate had recommended that the President arrange for simultaneous deposit by the U.S. and the Soviet Union. This was accomplished. The Treaty came into effect on March 5, 1970. Each non-weapons nation must enter into negotiations with the IAEA within 180 days from March 5. Agreements should be concluded for the application of safeguards within 18 months.

One must realize that the treaty will have a term of not less than 25 years. The decision of a country to forego the option to acquire nuclear weapons [particularly if it has the capability to acquire them by its own efforts] is a serious one.

Why would a non-nuclear country be willing to be a party to the treaty? Many see it as a step toward arms control and disarmament. Among smaller countries where an occasional skirmish is likely to occur, some security is gained if there is assurance that a neighbor is not making nuclear weapons. As a result, economic stability is more likely than when fear is present. Finally, the full peaceful benefits of the atom will be available to them.

The inclusion of Safeguards in the treaty is extremely important from a political point of view. The fact that nations are committed through treaty to allow outsiders to come into their country and inspect their industry is a political first. Also, it is felt that only through protective practices, such as safeguards, will the citizens of a nation allow their government to develop the peaceful potential of nuclear energy.

Only the non-weapons nations are required by the treaty to accept safeguards. The U.S. has offered to permit the IAEA to apply its safeguards to all nuclear activities in the U.S., excluding only those having direct national security significance. The objective of this offer is to assure non-nuclear-weapon States that no commercial disadvantage will result to their industry by virtue of their acceptance of safeguards required by the NPT. The number of facilities which might meet the criteria of the offer total over 200. Since this number would place a burden on the IAEA's resources, it is expected the safeguards would be applied only to a representative number of U.S. activities, at the discretion of the IAEA.

Because the IAEA budget for research and development

is only a small fraction of the worldwide effort on safeguards, it must depend on the results coming from national programs.

UNITED STATES SAFEGUARDS PROGRAM

The United States domestic problem of nuclear safeguards is that of ensuring that significant amounts of nuclear materials do not become lost, strayed, or stolen; and to do so without interfering unnecessarily with free enterprise and at a price the nation can reasonably afford.

For some time the U.S. nuclear industry will at least equal that of all the non-weapon countries combined. Hope for success in international safeguards is considerably dependent upon U.S. efforts to effectively control its own domestic program.

Safeguards responsibility in the U.S. lies principally with the Atomic Energy Commission (AEC). The responsibility for safeguards research and for development of policy was given to its Office of Safeguards and Materials Management (OSMM). The head of the OSMM, General Delmar L. Crowson, reports to the AEC General Manager, who is generally responsible for production, development, and promotion. Since the AEC contractors are part of these activities, the OSMM is also responsible for the application of safeguards to the license-exempt contractors.

The AEC Regulatory Organization is distinctly separate from the General Manager's organization and reports directly to the Commission as evidence of its separation from promotional activities. It is charged with regulation of the private sector on behalf of health, safety, and national security. The Division of Nuclear Materials Safeguards (DNMS) was established in this arm of the AEC to apply safeguards to licensees--the

private sector of the domestic nuclear industry.

General Crowson, in addition to being head of the OSMM, directly advises the Commission on safeguards policy matters.

RESEARCH, DEVELOPMENT, AND SPECIAL STUDIES

The areas of study are broad, and the organizations involved are many. In the U.S., the major research and development program as administered by the OSMM is in two parts-- systems studies and development of measurement techniques. Contracts are issued to various organizations to perform the tasks. A Technical Support Organization has been established at Brookhaven National Laboratory to review the research and development program and to perform field exercises. Other significant aspects of safeguards procedure which are being carefully studied include transportation, physical security of plants, use of inspectors, computerized data processing, materials accounting, and auditing.

The AEC contractors [which include the Atlantic Richfield Hanford Company] have been instrumental in formulating many of the procedures and techniques involved in nuclear materials management. They are currently involved in most of the above areas of study and will provide a proving ground for new innovations and demonstration units. Also actively involved are private industry along with the Atomic Industrial Forum (AIF); U.S. Arms Control and Disarmament Agency; equipment manufacturers; and the transportation industry.

A very effective professional society, the Institute of Nuclear Materials Management, exists for the purpose of advancing Nuclear Materials Management in all its aspects. Their promotion of research, establishment of standards, and dissemination of knowledge are vital factors in efforts to build an effective program.

SYSTEMS STUDIES

A significant portion of the research and development budget is being devoted to systems studies. In this instance, systems studies are those analytical studies performed for the definition of goals, the determination of ways by which these goals might be achieved, estimation of the effectiveness of these methods, determination of the strategies for implementing the methods, and estimation of costs.

As applied to safeguards, the studies are designed to help better understand where losses occur in the nuclear fuel cycle, what their causes are, and what their reasonable magnitudes ought to be. They will help identify those portions of the nuclear fuel cycle where diversions are most likely to be difficult to detect because of the other loss mechanisms which work in those particular areas.

Systems studies contracts are with the Pacific Northwest Laboratory of Battelle Memorial Institute and the National Bureau of Standards.

MEASUREMENT TECHNIQUES

Measurement techniques involve the development of:

- a. Surveillance instrumentation which will indicate and record the status of nuclear materials in vulnerable points in the fuel cycle.
- b. Instrumentation for non-destructive analysis of the nuclear material content of fabricated components and non-homogeneous scrap.
- c. Improved methods of destructive analysis.

Major research and development efforts are currently being centered on non-destructive analysis. This is a most important element in accountability because it holds promise of more

accurately and quickly measuring quantities of materials which are contained in otherwise unmeasurable forms or measurable within wide uncertainty ranges.

Non-destructive radioassay methods are generally divided into two main categories: (1) passive assay, and (2) active interrogation [by irradiation of the sample]. Passive assay methods involve observation of naturally-occurring neutron and gamma radiations from fissile species. Active interrogation involves the use of an external source of highly-penetrating neutrons or electrons to induce fissions in the sample material. Quantitative assay is based on detailed observations of one or more types of emissions following fission--notably delayed neutrons and gamma rays and/or prompt neutron and gamma rays.

The Los Alamos Scientific Laboratory (LASL) is utilizing, as interrogating sources, neutron generators which provide a copious source of neutrons of well-defined energy which can be varied. As an alternative, a ^{252}Cf spontaneous fission source offers a practical, maintenance-free neutron source in extremely compact form. Gulf General Atomic (GGA) has developed electron accelerator approaches for active interrogation. Both LASL and GGA have developed Mobile Non-Destructive Assay Laboratories which are being evaluated for industrial use.

Passive gamma ray assay techniques are useful when materials allow penetrability and when samples do not have a high fission product radiation level. The development of the Ge(Li) detector has considerably enhanced possibilities in this field. Significant improvements in coincidence counting instrumentation has permitted wider application of passive neutron counting techniques for the assay of plutonium.

Calorimetry is a non-destructive method which holds much promise for quantitative accuracy when the isotopic (radio-active) composition of the material is known. By the use of

twin calorimeters, the total power output of a sample may be measured. Knowing the percent fraction of each radioisotope present and the power per unit mass of each radioisotope, the mass of the desired isotope can then be calculated. A German firm, ALKEM, working with $\text{PuO}_2\text{-UO}_2$ mixtures [heat outputs 0.08 to 2.5 watts] reports that the accuracy of a calorimetric measurement is ± 0.1 to 0.3 percent. This means that the accuracy of the method is dependent upon the accuracy of the isotopic analysis which may be ± 0.6 percent.

TRANSPORTATION

Safeguarding materials during transportation is at least as important a problem as safeguarding materials while in a processing plant. In fact, it could well be the most important from the standpoint of ultimate vulnerability. On the plus side, however, the loss or theft would probably be known.

Heading the list of problems, in the opinion of knowledgeable people in the transportation field, is that the transportation industry is so thoroughly infiltrated by organized crime that any cargo which they decided to obtain will be obtained.

A number of incidents have occurred which indicate that care appropriate to the value and nature of the material has been absent. The following incident as reported by Samuel Edlow, who is in charge of Traffic Management of Nuclear Materials, is typical: "Shipment of March, 1969. Three containers of strategic material, gross weight 850 pounds, left Goodyear on Wednesday, reached Columbus, were taken to Dayton, where they were loaded aboard air freighter for St. Louis for onforwarding to consignee by special truck. Two containers were delivered on Thursday. The third container appeared to be irretrievably lost, but was eventually found nine days later in Boston under a load of shoes. And how was it found - a

shoe store was tracing a lost consignment of shoes and - they found the shoes - with the strategic material underneath."

Experience has shown that transportation people have little concept of the monetary value of nuclear materials. The fact that it is radioactive and the less the contact the better, is paramount over the fact that it may be valued at many times the same weight of gold.

Consideration is being given to various methods of protecting shipments such as visual and audio alarms; pre-routing with progress checks; and vehicle disabling mechanisms.

Associated with but not limited to transportation is the philosophy that if nuclear materials were stolen, the recovery of the material warrants a higher priority than apprehension and prosecution of the thief. This departure from normal law enforcement practice is in the interest of national and international security. Early detection of theft or loss is vital since the best opportunity for recovery would be immediately thereafter.

PHYSICAL SECURITY

Sound physical practices not only contribute to safeguards but may contribute to plant economics. Physical security procedures which are not designed in such a way to minimize diversion possibilities could have a serious financial impact on the plant operators since theft of material will represent a loss of dollars. Damage to the reputation of the company may also prove costly.

Industry faces a personnel problem which has not been of major concern in government installations due to the high security clearance requirements. Also what has been common practice at Hanford [such as an active patrol, perimeter fence, area fence within the perimeter, and exclusion areas

within the area] may not be as positive at private facilities. New techniques need to be developed to accomplish the same purpose.

An example of recent development work in the security field is a lock which is designed to control the movement of personnel and material into and out of a facility. It is a self-contained unit which has alpha and gamma alarms along with automatic door locks. As little as one gram of plutonium carried on a person and shielded by 10 mm of lead can be detected.

INSPECTORS

The safeguards inspector is recognized as an essential element of any safeguards system.

Of concern has been the level of inspection required to effectively and economically serve the purpose. The number of inspectors, rules of procedure, resident and/or non-resident, sensing and recording devices have all been factors involved in the complex subject.

Much study has been given to the concept of resident inspection. Studies to date indicate that full accountability on an independent basis by resident inspectors would involve such a large complement of people that the possibility cannot realistically be anticipated. However, it is known that the mere presence of a resident inspector, even though all shifts are not covered, may contribute to the deterrence of diversion efforts, strengthen physical protection, and enhance the effectiveness of plant procedures. Thus resident inspection covers both the accountability and the physical protection objectives.

One of the most controversial subjects concerning inspections has been the rules of procedure. It is recognized that every inspector is an individual; and, consequently, the

manner and extent to which he carries out his duties depends on his temperament, motivation, and other personal attributes. Because of this element of human variation, some have stated that the individuality of the inspectors must be suppressed by stipulating vigorous rules of procedure and specifying precisely what the inspector must or must not do. Others who have had personal experiences with safeguards inspections in many countries and in different situations feel that serious disputes could arise simply because of inflexibility. They feel that an inspector must be free to develop a value system which he can apply to the evaluation of masses of data and information. The result of this selection process will be an accurate summary of the important facts.

It is apparent that a balance between human inspectors and instrumented safeguards systems must be achieved. There are cost and maintenance considerations which limit the number of data sensors that can be installed, as well as economic and practical limits to the number and quality of inspectors. The role of the inspector will be particularly sensitive and important in the ultimate success or failure of the Non-Proliferation Treaty.

ACCOUNTABILITY PROCEDURES

Historically, accountability procedures have been utilized to keep track of materials and to periodically quantify the material balance status of facilities. In safeguards efforts, accountability procedures will continue to play an important role and can perhaps be referred to as the cornerstone for safeguards activities. In order to keep pace with nuclear growth in private industry, research and development efforts must be directed toward improvement in accountability systems.

The timeliness with which accountability procedures will allow one to see indicators suggesting the possibility of

diversion is extremely important. In today's world of high-speed transportation, speed in recognition of problems is essential.

COMPUTERIZED DATA PROCESSING

The Atomic Energy Commission Management Information System (MIS) is being designed as a single integrated system consisting of many interrelated computer-based subsystems. Nuclear Materials Control is one subsystem of an identified twenty-seven.

The system is intended to provide specified information on a current, accurate, and complete basis. Periodic source data will enter the system one time only (to the extent practical) and be used by a variety of subsystems. A manager will be able, on demand, to receive required information without the routing of voluminous reports.

To become a functional subsystem of the MIS, current reporting and control systems for nuclear material accounting records are being integrated into the computer system at AEC Headquarters. The basic reporting and control systems are now maintained on an operational status through a network of computers within the AEC.

It is obvious that the availability of current information in the MIS system is dependent upon the speed at which data are gathered, analyzed, and reported by individual custodians of nuclear materials. Installations are striving to approach fully-automated material control systems.

The Atlantic Richfield Hanford Company has utilized computer processing for much of their static inventory control records. Progress has been evident involving computerization of the calculations for physical inventory and transfer measurement uncertainties. Analytical laboratory work has

been expedited and simplified by using a computer to issue analysis cards, calculate results from laboratory measurements, and assess the feasibility of the results.

MATERIAL ACCOUNTING AND STATISTICS

Material accounting records are subject to errors beyond the usual financial accounting experience since all material measurements are subject to some error.

Because material accounting procedures cannot distinguish material losses from measurement errors, statistical procedures must be employed to objectively determine the probable cause for the imbalance. The imbalance is usually referred to as Material Unaccounted For (MUF).

When dealing with a materials measurement situation, the true or actual value cannot be determined because of measurement limitation. Measurements provide estimates of the true value. The average of the measured values is generally referred to as the accepted value, or the known value. The difference between the true and the accepted value is a result of measurement error.

Measurement error can be classified in two categories: systematic [sometimes referred to as *fixed*) errors, and random errors. A systematic error has the same magnitude and algebraic sign when a measurement is made several times. When systematic errors are identifiable, it may be possible to minimize them by means such as standardized procedure, data adjustment, or calibration of equipment. Random errors are errors which are either positive or negative--with an equal probability of being either--and their occurrence can never be eliminated. For statistical purposes, misreading a measurement, improperly recording the data, and arithmetic mistakes are not considered experimental errors, however statistical

procedures help to identify these mistakes.

Thus, statistical methods are employed to determine the uncertainty of each measurement involved in material balance calculation. From these measurement uncertainties, the measurement uncertainty of MUF may be calculated.

The safeguards capabilities of material balance accounting to detect diversion can be equated in terms of the probability of detecting a loss of material in MUF when diversion actually occurs. The probability of detecting material losses is dependent on the size of the loss, the measurement uncertainty of MUF, and the risk assumed for mistaking measurement errors for material losses.

Measurement uncertainties determine the minimum thresholds for detecting material losses. The probability of detecting the loss of an absolute quantity of material increases as measurement uncertainties decrease.

POSSIBLE CONTRIBUTIONS
BY ATLANTIC RICHFIELD HANFORD COMPANY

Efforts toward developing an effective safeguards program involve not only research and development, but also the effective application of known technology by resourceful humans.

The opportunity at ARHCO to demonstrate effective safeguards, which would have international application, is as great and probably greater than at any other site. Atlantic Richfield Hanford Company has the basic materials and problems, staff expertise, and direct association with those in the field doing much of the research and development.

Current thinking indicates that considerable pressure will be forthcoming in which AEC contractors will be expected to strive for safeguards goals similar to those desired of private industry.

There is opportunity for ARHCO to spearhead a program which would make Hanford a model of an effectively-safeguarded facility. Since safeguards covers a broad and diverse field, a committee may be useful in determining a plan of action and defining specific areas where emphasis should be placed. Such a program could, in cooperation with the Commission and AEC contractors, involve the entire cycle of nuclear materials at Hanford; be limited to ARHCO; or be designated for a specific facility.

By leading out and demonstrating effective safeguards, ARHCO action could have a national and world-wide impact, as well as fulfill requirements which will probably be forthcoming.

LOCAL RESEARCH AND DEVELOPMENT

Possible Research and Development programs fall into two categories: (1) programs for which ARHCO has a real need, with *need* being defined as that which will eventually be expected of AEC contractors; and (2) programs involving concepts and instrumentation which will contribute to safeguards technology but would not necessarily be utilized at ARHCO.

Examples of items in the first category are:

- Measurement of nuclear materials in scrap. This need not only involves safeguards, but pertains to processing and criticality control. Development and practical demonstration of a passive system for non-destructive assay would provide a utilitarian approach even though active interrogation systems are being developed elsewhere on a contract basis.
- Method development and techniques to measure the input of nuclear materials into a processing plant. Techniques include calibration, weighing, volume, and bias control. Process control would benefit from such improved

measurements.

- Additional quality control programs to include testing of weighing, volume, and other non-destructive measurements.
- A program to optimize sampling techniques. This includes handling and storage, obtaining representative samples, and treatment of solids.
- Refine the measurements of nuclear materials in product form. This should include the effects of environment on the ability to measure plutonium oxide; and the effect of time and environment on the measurement of plutonium nitrate solution.
- Investigate the possibilities for utilizing precision calorimetry.
- Strive to identify and eliminate all sources of unmeasured losses.

The ultimate goal is to close all material balance areas with measurements. This means that a material balance area's measurement system should be self-sufficient. There should not be complete dependence on measurements from other balance areas.

The second category could include the following:

- Development of monitors in storage areas which would reveal the substitution of nuclear material with dummies.
- Application of space technology to detect the movement of nuclear materials from buildings or plants.
- Develop fool-proof means of verifying the volume of solution in a process tank.
- Develop and demonstrate monitoring devices at possible

exits from process streams. This would include waste exits.

- Investigate possible use of tracers in process solutions which along with in-line instrumentation would allow inspectors to detect diversion attempts.
- Perfect fuel element identification and verification.

WASTE MINIMIZATION

Analysis of nuclear materials in waste will always involve a high uncertainty relative to other points of analysis. The lower the values where the uncertainty is the greatest, the better the position from a safeguards point of view. Thus, one means of minimizing uncertainty values is to minimize wastes through process improvement.

Current trends seem to indicate that strong efforts toward process improvement and waste recycling should be considered. From both a safeguards and environmental point of view, economic concern may have to be compromised.

LOCAL ACCOUNTABILITY

A demonstrated excellence in *rapid* accounting of material in a nuclear reprocessing plant could draw considerable international attention. Efforts should be made to speed up the gathering of source data. Current performance could be expedited by additional computerization and further application of statistics.

By-difference accounting for scrap should eventually be eliminated with the availability of reliable measurements. Confidence in these measurements could be gained by comparing recovery data for scrap processed on a segregated basis.

LABORATORIES

Specific areas within the experience of the author where immediate consideration can be focused are discussed. This is not a critique of the current status of ARHCO laboratory practices. Rather, it is a collection of what is considered to be vital factors in demonstrating that an effective safeguards program is possible.

Analytical Laboratories

The analytical laboratory is the key between the physical material in various forms, and material accountability. Two specific items are vital: (1) results must be provided with known, valid uncertainties; and (2) speed of performing analyses without sacrifice of quality is essential. It is obvious that the more precise an analytical result is, the better; however, from a safeguards standpoint, this concern is secondary to knowing what the uncertainty is. Speed in the detection of a possible diversion cannot be emphasized too strongly.

The following areas may be directly concerned with the ability of the analytical laboratory to satisfactorily meet the above goals:

- A process control-oriented laboratory may not give the necessary emphasis to material balance samples [*i.e.*, there is pressure to place process control samples first even though a particular sample may not be vital at the time].
- Work attitude should be such that expediting sample analyses should not be dependent upon work-breaks at precise times. Basic morale and insufficient appreciation of job importance could be factors.
- Technical personnel should be asked and be willing to learn the business by performing routine analyses on

a routine basis. A potential supervisor or lead chemist may never learn the intricacies and problems involved in any other way. Lack of this experience leads to unmerited reliance on non-technical personnel.

- Technical manpower should be utilized to assure quality and timely results where needed. There may be tendencies for control chemists to place emphasis on more interesting development work rather than accept and adapt proven methods.
- Establish the attitude that laboratory standards and referee programs are means of determining valid uncertainty information and that they are not designed to determine the worth of the individual or the reputation of the laboratory. Reducing the tendency to take *extra* care when running standards should increase the validity of uncertainty values.

Standards Laboratory

A standards laboratory performs two distinct functions for modern nuclear analytical laboratories: (1) it provides standardized solutions for analytical methods and standards for instrument calibration; and (2) it provides standards which simulate process solutions and thus allows determination and statement of the uncertainty associated with a given result.

Non-technical personnel can become very proficient in preparing standardized solutions and routine standards once the methods have been set up by technical personnel. The function of simulating process solutions, particularly when dealing with nuclear processes, is quite different--being dynamic in nature. The plant process is continually changing due to process improvements and variety of material being processed. There is a constant demand for technical competence

in providing the analytical laboratory with truly representative standards. It is not practical, nor is it necessary to exactly simulate process material; however, considerable technical dexterity is required to include the necessary components.

There is a tendency to technically understaff a standards laboratory, particularly if it is merely part of an analytical control laboratory. Technical personnel are relied upon for supervisory coordination with vital non-routine standards preparation left to non-technical personnel.

A standards laboratory can be a prime factor in establishing a "blind standards" program. Analytical laboratory personnel perform differently when they know they are analyzing a standard. Submission of standards on the same plane as process solutions is a valuable tool in determining valid uncertainties.

CONCLUSIONS

There are continual innovations at Atlantic Richfield Hanford Company which can benefit the national and international safeguards programs. Diligent efforts should be made to publish and present appropriate contributions.

Man has developed a compact form of energy which must be guarded wisely. To quote R. A. Schneider, who has been active nationally in safeguards systems studies, "Nuclear material safeguards will never die. It may sleep at times, but the smallest incident at home or on the international scene will put a *pressure* on those handling nuclear materials beyond all previous political pressures regarding reactor safety and environmental discharges."

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J. W. Jordan, R. A. Schneider, L. H. Taylor, R. E. Tomlinson, and L. F. Wirfs are very much appreciated.

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2. *Proceedings of the Tenth Annual Meeting of the Institute of Nuclear Materials Management*. (1969)
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The number of reports involving safeguards has become so large that it is possible to list only a few of the more comprehensive. Reference 1 is a good source for specific

reference.

Reports containing the proceedings of the Institute of Nuclear Materials Management Meetings are excellent for comprehensive coverage.

Popular magazine articles are included as examples of sensationalized, but interesting, coverage.