

Managing the Disposition of Low-Activity Radioactive Materials

PROGRAM

Forty-First Annual Meeting

March 30-31, 2005

Crystal Forum Crystal City Marriott 1999 Jefferson Davis Highway Arlington, Virginia

> National Council on Radiation Protection and Measurements



Program Summary

Wednesday, March 30, 2005

Opening Session

8:15 a.m. Welcome

Thomas S. Tenforde, President

National Council on Radiation Protection and

Measurements

Second Annual Warren K. Sinclair **Keynote Address**

8:30 a.m. Introduction of the Lecturer

Thomas S. Tenforde

Contemporary Issues in Risk-Informed Decision

Making on Waste Disposition

B. John Garrick **Garrick Consulting**

Managing Low-Activity Radioactive Materials—Challenges and Issues

Ruth E. McBurney and Michael T. Ryan,

Session Co-Chairs

9:15 a.m. Improving the Regulation and Management of Low-

Activity Radioactive Wastes

Michael T. Ryan

Charleston Southern University

Risk-Informed Radioactive Waste Classification and 9:45 a.m.

Reclassification

Allen G. Croff

Oak Ridge National Laboratory, Retired

10:15 a.m. Break

10:45 a.m. **Managing Disposition of Potentially Radioactive**

Scrap Metal

S.Y. Chen

Argonne National Laboratory

International Policies and Practices

Joel O. Lubenau, Session Chair

11:15 a.m. Review of International Standards,

Recommendations and Practices Related to the Management of Low-Activity Radioactive Materials

Gordon Linsley

International Atomic Energy Agency

11:55 a.m. Spanish Protocol for Radiological Surveillance of

Metal Recycling. A Collaboration of Government

and Industry

Juan Pedro Garcia Cadierno

J.I. Serrano Renedo

E. Gil Lopez

Nuclear Safety Council of Spain

12:15 p.m. Lunch

U.S. Experiences in Managing Low-Activity Radioactive Materials

Jill A. Lipoti, Session Chair

1:30 p.m. Current Radioactive Waste Disposal Industry

Conditions and Trends

Steven A. Romano U.S. Ecology

1:50 p.m. Scrap Metals Industry Perspective on Radioactive

Materials

C. Ray Turner

River Metals Recycling, LLC

2:10 p.m. Radioactive Metal Processing Industry Perspective

Al Johnson Duratek

2:30 p.m. Low-Activity Radioactive Materials Management at

the U.S. Department of Energy

Frank Marcinowski, III U.S. Department of Energy

2:50 p.m. Break

3:10 p.m. Nuclear Industry Experience with Safe Disposition

of Radioactive Materials

Ralph L. Andersen Nuclear Energy Institute



Formulating Tomorrow's Public Policy

Susan D. Wiltshire, Session Chair

3:30 p.m. Formulation of Future Nuclear Waste Public Policy

> in America David H. Leroy Leroy Law Offices

3:50 p.m. Low-Activity Waste Management - An Analysis of

Public-Interest Group Positions

H. Keith Florig

Carnegie Mellon University

Policy Development from the Industry Perspective 4:10 p.m.

William P. Dornsife

Waste Management Specialists

4:30 p.m. **Break**

> Twenty-Ninth Lauriston S. Taylor Lecture on Radiation Protection and

Measurements

5:00 p.m. Introduction of the Lecturer

R.J. Michael Fry

Oak Ridge National Laboratory, Retired

Nontargeted Effects of Radiation: Implications for

Low-Dose Exposures

John B. Little

Harvard University School of Public Health

6:00 p.m. Reception in Honor of the Lecturer

Thursday, March 31, 2005

8:00 a.m. A Tribute to the Life and Scientific

Accomplishments of Lauriston S. Taylor

Robert O. Gorson

Thomas Jefferson University, Retired

Business Session 8:30 a.m.

9:30 a.m. Break

Update of Regulatory Efforts and **Round Table Discussion**

Susan M. Langhorst, Session Chair

Overview of U.S. Environmental Protection 10:00 a.m.

Agency's Initiative on Disposition of Low-Activity

Radioactive Waste

Daniel Schultheisz

U.S. Environmental Protection Agency

10:10 a.m. Update of Regulatory Efforts by U.S. Nuclear

Regulatory Commission

Carl J. Paperiello

U.S. Nuclear Regulatory Commission

Implementation of U.S. Department of Energy 10:20 a.m.

Policies, Directives and Guidance for Radiological

Control and Release of Property

Andrew Wallo, III Stephen Domotor Gustavo Vazquez

U.S. Department of Energy

Role of State Regulatory Agencies in the 10:30 a.m.

Disposition of Low-Activity Radioactive Materials

Edgar D. Bailey

Conference of Radiation Control Program Directors, Inc.

10:40 a.m. **Questions and Discussion**

(all participants)

11:35 a.m. Summary

John F. Ahearne, Rapporteur

Sigma Xi

Closing Remarks 12:15 p.m.

Thomas S. Tenforde, *President*

National Council on Radiation Protection and

Measurements



Abstracts of Presentations

Wednesday, March 30, 2005

Opening Session

8:15 a.m. Welcome

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Second Annual Warren K. Sinclair **Keynote Address**

8:30 a.m. Introduction of the Lecturer

Thomas S. Tenforde

Contemporary Issues in Risk-Informed Decision Making on Waste Disposition

B. John Garrick Garrick Consulting

Understanding the risks of nuclear waste management practices is the core issue for societies seeking to reap the full benefit of nuclear science and technology. Knowledge of the risks is not only critical to public health and safety and protection of the environment, but to the very economic viability of a nuclear energy industry and medical and industrial uses of radioactive materials. Because of the very large volume of low-activity radioactive waste in comparison to high-level waste, decisions on the disposition of low-activity waste can end up being an important driver for decisions on the use of nuclear energy and users of radioactive materials in other applications. This is because of the possibility of industry having to provide disposal using technologies that are beyond those necessary to reasonably assure public health and safety and the costs of handling and transporting large quantities of waste material. The options vary from disposing of lowactivity waste in low cost hazardous material sites or industrial waste landfills at multiple and convenient locations, to having to emplace the waste in facilities for much higher hazard radioactive wastes at inconvenient locations. There is even the possibility of having to put

some fraction of low-activity wastes in extremely expensive high-level radioactive waste repositories at one very inconvenient location. The differences in costs are enormous and decisions about the disposition of the waste are critical to future societies. Key issues include the characterization of the waste based on real hazards rather than on waste origins, credible health effects models, consistency of risk analyses for different types of waste, and rules and regulations that allow disposal and management of the wastes commensurate with the actual risks involved. Issues with the application of the risk sciences to support the necessary decision making are (1) the credibility and context of the calculated risks and (2) public understanding and acceptance of the results. The answer to making the right decisions is the application of the risk sciences to the various waste management options in a systematic, transparent and credible way, such that there is consistency across different waste types and, most importantly, public understanding and support.

Managing Low-Activity Radioactive Materials—Challenges and Issues

Ruth E. McBurney and Michael T. Ryan, Session Co-Chairs

9:15 a.m. Improving the Regulation and Management of **Low-Activity Radioactive Wastes**

Michael T. Ryan Charleston Southern University

This paper summarizes the first phase of a study in progress by a committee of the National Academy of Sciences Board on Radioactive Waste Management. The Board initiated the study after observing that statutes and regulations administered by the federal and state agencies that control low-activity radioactive wastes have developed as a patchwork over almost 60 years and usually reflect the enterprise or process that produced the waste rather than the waste's radiological hazard. Inconsistencies in the regulatory patchwork or its application may have led to overly restrictive controls for some low-activity wastes but the relative neglect of others. In the first phase of this study, the committee reviewed current low-activity waste inventories, regulations and management practices. This led the committee to develop five categories that encompass the spectrum of low-activity wastes and serve



to illustrate gaps and inconsistencies in current regulations and management practices. The committee completed its first phase with four findings that will lead into the final phase of the study. This paper is excerpted from the committee's interim report that was issued in October 2003.

9:45 a.m. Risk-Informed Radioactive Waste Classification and Reclassification

Allen G. Croff

Oak Ridge National Laboratory, Retired

Radioactive waste classification systems have been developed to allow wastes having similar hazards to be grouped for purposes of storage, treatment, transportation and/or disposal. As recommended in NCRP Report No. 139, Risk-Based Classification of Radioactive and Hazardous Chemical Wastes, a preferred classification system would be based primarily on the health risks to the public that arise from waste disposal and secondarily on other attributes such as the near-term practicalities of managing a waste. The system should also include provision for case-by-case exceptions based on regulatory judgment.

The current U.S. radioactive waste classification system is not based primarily on risk because the keystone definition-that of high-level waste (HLW)-is based on the source of the waste instead of its inherent characteristics related to risk. Source-based systems can lead to dysfunctional outcomes such as:

- wastes from sources not included in a particular definition being excluded even though the waste poses risks similar to the wastes the source was envisioned to produce. Such exclusion could lead to unacceptable risks although site-specific waste acceptance criteria should prevent this from occurring, or
- wastes being included in the definition because they come from the specified source posing substantially less risk than the source was envisioned to produce because the waste has been substantially altered by decay or processing. Such inclusion could lead to use of unnecessarily expensive treatment or disposal technologies.

Some of these outcomes may have become reality as evidenced by (1) numerous U.S. Department of Energy efforts to reclassify "low-hazard" wastes included in the definition of HLW to allow such wastes to be exempted from requirements for HLW to be managed by disposal in the proposed repository at Yucca Mountain, Nevada and (2) difficulties in finding a disposal destination for "highhazard" wastes included in the low-level waste classification. Such wastes have been the subject of considerable historical and ongoing discussion, litigation and legislation.

A second important feature of the U.S. radioactive waste classification system that is not based primarily on risk is there are no general principles or provisions for exempting materials from being classified as radioactive waste which would then allow management as nonhazardous materials. That is, there is no provision for determining that the radionuclides contained in a material pose a risk sufficiently low so as to allow the material to be managed by disposal as municipal or industrial waste, or by recycle into unrestricted use. Historical attempts of regulatory agencies to establish such provisions were unsuccessful because of public concern about the perceived risk from the residual radionuclide content. However, efforts in this regard have again been initiated and are ongoing although the outcome is still unknown.

This paper will elaborate the current radioactive waste classification in the United States, summarize the current status of issues and risk-informed alternatives related to waste classification and reclassification, and provide observations on potential future direction of efforts to address radioactive waste classification and reclassification issues.

10:15 a.m. Break

10:45 a.m. **Managing Disposition of Potentially Radioactive** Scrap Metal

S.Y. Chen

Argonne National Laboratory

In 2002, the National Council on Radiation Protection and Measurements (NCRP) issued its Report No. 141, Managing Potentially Radioactive Scrap Metal. The report evaluates management policy toward scrap metal generated in regulated facilities that have radiological concerns. This issue has arisen because of the increased number of such facilities that have undergone (or will undergo) the decommissioning process and be dismantled. These facilities include the nuclear facilities owned by the government (nuclear weapons complex), those owned by the nuclear industry (commercial nuclear power plants), and



those owned by other industries that involve the generation of naturally occurring radioactive materials (such as petroleum exploration and extraction). It is estimated that more than ten million metric tons of scrap metal will ultimately be generated in the United States.

Since only a small portion of the scrap metal will have been in contact with or near radioactive materials, the term potentially radioactive scrap metal (PRSM) has been applied, if it cannot be otherwise classified under existing laws or regulations. Effective management of such materials cannot be accomplished today because of the lack of a consistent risk-based policy and systematic regulatory provisions.

One primary method for solving this problem would be to develop a regulatory process that facilitates application of a comprehensive management strategy for disposition of the full range of PRSM. The strategy must address two important factors. First, it must be based on appropriate national and international policies; and second, it must provide an array of viable disposition options. For the latter, two basic approaches have been identified. One approach consists of options that require the disposition to remain within the regulated environment (such as disposal at a licensed low-level radioactive waste facility or recycled for internal use); the other opts for the release of materials outside of the regulatory control (i.e., clearance). Clearance is a concept that helps establish a regulatory process for certifying the eligibility of materials for unrestricted release from an existing regulatory control; much like the existing approaches to controlling gaseous and liquid effluent releases. To this end, appropriate radiological criteria, on the order of a few tens of microsieverts per year to the average member of the critical group, have been established. A specific clearance criterion, set at 10 μSv y⁻¹, would correspond to the negligible individual dose (NID) established in NCRP Report No. 116. At or below the NID level, further optimization may not be warranted. Within the context of clearance, practical disposition options for PRSM would include disposal at a landfill with less rigorous radiological control than for radioactive waste (i.e., either as hazardous or municipal waste), or recycling in the general commerce. Implementation of the clearance process, however, still needs to overcome such issues as public perception and acceptance by the metal industry. Efforts should continue to resolve these issues.

In recent years, regulatory agencies in the United States have made attempts to address the outstanding disposition issues (including clearance of materials) in a more consistent and uniform manner. These efforts include the renewed effort of the U.S. Nuclear Regulatory Commission to promulgate clearance rules for the release of solid materials from licensed facilities; the U.S. Department of Energy's effort on the disposition of scrap metal generated from its facilities and the U.S. Environmental Protection Agency's recent issuance of an Advance Notice of Proposed Rulemaking to address the disposition of low-activity radioactive waste. State regulators have also established release standards for the disposition of technologically enhanced naturally occurring radioactive material under their Suggested State Regulations for the Control of Radiation.

International Policies and Practices

Joel O. Lubenau, Session Chair

11:15 a.m.

Review of International Standards. **Recommendations and Practices Related to the Management of Low-Activity Radioactive Materials**

Gordon Linsley International Atomic Energy Agency

As the decommissioning of nuclear installations gathers pace globally, countries are looking to establish appropriate strategies for the management of materials containing low levels of radionuclides, preferably consistent with international guidance. The subject has been on the agenda of the relevant international organizations for more than two decades and it continues to be an important and sensitive international issue. One of the main reasons for the international interest relates to the potential for trade in such materials between countries.

There are established mechanisms for developing international standards in the areas of nuclear safety, radiation protection, transport, and radioactive waste management. These are organized through the auspices of the International Atomic Energy Agency and involve a leading role for international approving committees made up of representatives of national regulatory authorities. The mechanisms



have been applied to produce various standards relevant to the management of low-level radioactive materials. Of particular interest, in this context, are the recent efforts to develop criteria for the exclusion, exemption and clearance of materials from regulatory control.

Concern over the potential international trade in scrap metal containing very low levels of radionuclides and the associated implications for industry has resulted in advice being developed by a regional international organization, the United Nations Economic Commission for Europe, representing industry concerns.

Recommendations in this area have also been developed by the European Commission (EC) for use within the countries of the European Union. EC has also organized reviews of practices within its member countries for the management of low-activity radioactive materials. These reviews and presentations at international conferences have shown that the approaches being used in countries to manage these materials are not all the same - a reflection of the significant differences in national policies for the management of low-activity materials.

11:55 a.m. Spanish Protocol for Radiological Surveillance of Metal Recycling. A Collaboration of Government

and Industry Juan Pedro Garcia Cadierno

J.I. Serrano Renedo

E. Gil Lopez

Nuclear Safety Council of Spain

Although the use of radiological techniques are subject to controls, radioactive materials have been detected frequently in the metallic scrap in many countries. This fact has motivated the start of a set of measurements to detect and to prevent this kind of event at national and international scales.

The Spanish steel industry is one of the most important in the industrial sectors of the country. It strongly depends on the importation of steel scrap that it is used as raw material. Experience has shown that countries who import great quantities of scrap metal, often promote international initiatives in order to reduce the derived risks of the presence of radioactive material in the scrap.

Until an incident occurred in a Spanish steel factory in 1998, the presence of radioactive material in scrap metal was considered as a potential risk in Spain. This event made evident that the risk is real and its consequences are very important at both environmental and economic levels.

This incident was a direct cause for establishing the Spanish protocol by national authorities. In this sense, the Spanish authorities (Ministry of Industry, Tourism and Trade and the Nuclear Safety Council), the National Company for Radioactive Waste Management, the Association of companies dedicated to scrap recovery (Spanish Federation of Recovery), the Union of Iron and Steel Companies, and the main trade unions signed in 1999 the "Protocol for collaboration on the radiation monitoring of metallic materials."

This protocol has a voluntary commitment. Through a national system of radiological surveillance of metallic scrap and the resulting products obtained from its processing, the duties and rights of all participants are defined. It describes the national control and surveillance system. This system is comprised of a set of legal bases. operations of radiological devices, development of training and education plans for workers, safe management of radioactive materials detected, and the steps to follow by a company in case of radioactive detection in the processing of scrap metal. From November 1999 to December 2003, 302 pieces (sources and contaminated materials) have been detected. The number of subscribing industries is 74 (25 iron and steel companies, 47 recovering industries, and two aluminum melting factories). The main radioactive detections are naturally occurring radioactive materials (NORM) and sources. The main radioactive sources are ²²⁶Ra and ¹³⁷Cs. The origin of these materials are mainly from Spain, European Union (United Kingdom, France and Portugal) and African countries.

Since the signature of the protocol, four incidents have been detected. All of these were due to the processing of a ¹³⁷Cs source. Three of these were in steel production companies and the other was in a company dedicated to recovery and processing (break up and segregation of the metallic scrap).

12:15 p.m. Lunch



U.S. Experiences in Managing Low-**Activity Radioactive Materials**

Jill A. Lipoti, Session Chair

1:30 p.m. **Current Radioactive Waste Disposal Industry Conditions and Trends**

> Steven A. Romano U.S. Ecology

In 1980, the nation was served by three commercial lowlevel radioactive waste facilities (LLW) in South Carolina, Washington, and Nevada. These sites also accepted low activity radioactive material (LARM) and naturally occurring and accelerator produced radioactive material (NARM). To address what was considered an inequity, the LLW Policy Act was passed that year to encourage formation of interstate compacts to manage LLW on a regional basis. Almost 25 years later, Compacts formed under the subsequently amended Policy Act and ratified by Congress have yet to provide a single new disposal facility.

The nation is consequently now served by a diverse array of industry facilities accepting various categories of radioactive waste. Available facilities include full service Class A, B and C LLW and NARM disposal operations near Richland, Washington and Barnwell, South Carolina; a Class A and mixed waste disposal operation near Tooele, Utah that also accepts LARM and NARM; and certain hazardous waste and uranium and thorium mill tailings waste facilities that accept LARM and/or NARM. The Richland Facility may only accept LLW from 11 western states due to Northwest Compact import restrictions, and is effectively restricted to high activity NARM. While the Barnwell Facility is not yet geographically restricted (it will be in 2008 under current law), that site is at a decided competitive disadvantage to the Tooele, Utah operation for Class A waste and lower activity wastes. The Tooele Disposal Facility dominates the commercial Class A and mixed waste disposal market on the strength of its existing licenses and comparatively low state tipping fees. Significantly, the Toole Facility was privately developed outside of the Compact structure. In a further departure from the Policy Act's vision, the Tooele Facility now faces competition from hazardous waste facilities in Grand View, Idaho and Andrews, Texas that are permitted to accept specified LARM and NARM waste, and from a 11e.(2) mill tailings

disposal facility in Blanding, Utah. The latter facilities accept wastes primarily generated by the federal government.

To expand their existing disposal services, the Andrews, Texas hazardous waste and LARM disposal facility is seeking Class A, B and C and mixed waste disposal authority to serve the Texas Compact, the U.S. Department of Energy, and others. The Tooele, Utah operation initiated and later postponed proceedings to license disposal of Class B and C waste. In addition, other mill tailings disposal facilities are seeking authority and/or contracts to dispose of LARM. With the exception of the Andrews, Texas site, no new Compact facilities are on the drawing Board. The disconnect between present conditions and what Congress contemplated in 1980 has engendered federal rulemaking forays, national level studies, and Congressional inquiries to re-evaluate future access to disposal services. This paper will discuss current and potential future service provision by the commercial disposal industry in this context.

1:50 p.m. **Scrap Metals Industry Perspective on Radioactive Materials**

C. Rav Turner River Metals Recycling, LLC

In February 1983, the metals industry in the United States experienced the first reported/confirmed accidental melting of radioactive materials in a steel mill. It was ⁶⁰Co. Twenty-one years later, the metals industry/worldwide has reported more than 85 accidental meltings of radioactive material, costing an average of \$12 million to decontaminate the mill plus loss of business and community confidence. In one case, the cost of cleanup, including fines, decontamination, loss of business, and disposal, is expected to exceed \$100 million.

It should be obvious that this most competitive industry cannot withstand the extensive cost of this kind of mishap. Thus, the metals industry began to install very sensitive radiation detection systems to prevent accidental melting of radioactive material. The industry has spent hundreds of millions of dollars in the last two decades continually upgrading the detection systems, and still has no system that is 100 percent foolproof.

As a result of the super-sensitive systems, the industry has now uncovered a less serious, but very expensive,



problem that involves naturally occurring radioactive materials (NORM). It is the position of the scrap and steel industry to reject any radioactive material that comes to their facilities. These facilities are not generally equipped to handle the special problems inherent to cleaning a load of scrap metal and removing an unknown hazard. The systems generally do not distinguish between NORM or manmade radioactive materials and just report an alarm countrate at a very low standard deviation above background.

The industry has been asked many times by both state and federal agencies to desensitize their equipment in order to minimize low-level alarms. The issue to us is not one of eliminating low-level nuisance alarms caused by NORM, but one of preventing accidentally melting a discreet source that would require that the mill be shut down for decontamination, again costing millions of dollars. Since the systems are currently not capable of detecting a sealed source 100 percent of the time, it is not worth the risk to desensitize the equipment and chance another meltdown.

More recently, governments have tried to persuade the industry to melt some cleared materials from nuclear facilities that contain low levels of radioactivity. The industry has unequivocally refused to melt that material, partially due to fear of problems with baghouse dust, and partially due to knowledge of the extensive costs of remediation, for which there is no federal nor state aid. The problem with radioactive material in steel mills is not one of cleared material that can scarcely be detected using state-of-theart radiation detectors, but one of losing detection capability of orphaned sources. One fear is that the background levels of specific loads will be increased to the point that detection of orphaned sources that could be in the load might not be detected. This industry, again, is not willing to take that risk. The iron and steel industry, as with any other type of industry, reserves the right to decide what raw material will, or will not, work for them. They have the right to demand absolute purity of the metals they are purchasing. They receive no state or federal support or incentives making it worth their while to melt slightly contaminated materials. There is little or no value to melting recycled metals that contain radioactive materials when there is an abundance of metals that are "pure." The public demand is for "pure" products and, therefore, requires "pure" raw materials in its manufacture. It is like squeezing a loaf of

bread in a supermarket to get the freshest loaf. Consumers have that prerogative and will not soon relinquish it. Neither will the scrap and steel industry.

The problem is not one caused by the U.S. Department of Energy, or the nuclear industry, but one of orphaned sources that have become uncontrolled. Several hundred orphaned sources are still being lost each year, and many are never accounted for until they are melted. The industry must do everything possible to prevent this from happening.

The U.S. Environmental Protection Agency has embarked upon a pilot study at several ports of entry for sea-going vessels that hopes to yield good results in helping to prevent accidental melts. The effort involves installing a detection system inside a grapple used to unload bulk cargoes. The project has yielded valuable data during the last three years and has proven to be a viable system that will hold up against the constant abuse of unloading steel cargoes. Hopefully this will help prevent another accidental melt in the United States.

Steel mills in the United States have similarly installed multiple systems to further assist them in preventing accidental melts. Hopefully, someday we will have the orphaned source problem solved, leaving room for negotiations to address melting "cleared" material. That day has not yet

2:10 p.m. **Radioactive Metal Processing Industry Perspective** Al Johnson

Duratek

The current U.S. economic environment for the disposition of radioactive materials, including very low activity metals, is currently driven by relatively low radioactive disposal costs and readily available disposal space. The recent spike in price and demand for recycled metal commodities provide little economic incentive to the nuclear industry (including waste processors and metal recyclers) to pursue the recycling of potentially contaminated metal. Large nuclear facility decommissioning projects, that typically represent the largest potential source of very low activity metals, receive some of the most favorable radioactive disposal prices in the market. This economic fact, combined with the relatively high perceived risk (both political and economic) of releasing potentially contaminated metals into the U.S. metals recycling market, make the



decision not to recycle suspect metals an easy one for most licensed radioactive facility managers and stakeholders. The potential impact of new U.S. Nuclear Regulatory Commission (NRC) clearance rules on the nuclear industry and on radioactive and nonradioactive metal processors will depend on the nature and specificity of the regulations. However, even with clearly defined clearance limits, the nonradioactive metals processors will likely continue to oppose widespread introduction of radioactive materials into the U.S. scrap metal recycling feed streams.

One alternative to both recycling and radioactive disposal pursued by a growing number of licensed facility managers involves the use of case-specific regulatory exemptions or other licensed processes to assay and clear suspect metals and other waste materials from radiological controls followed by industrial landfill disposal. A description of this type of program will be presented along with corresponding limits for release that provide reasonable risk versus cost-saving benefits over radioactive disposal. For example, over the past year, approximately four million pounds of suspect clean scrap metal (beams, piping, valves, etc.) were segregated from other radioactive waste streams, assayed and disposed at an industrial landfill at one waste processor location in Tennessee.

A second alternative (that is more costly than bulk assay and landfill disposal but competitive with radioactive waste disposal) incorporates the application of Radioactive Metal Melting and Beneficial Reuse Processing. Unlike simple commodity metals "recycling," the "beneficial reuse" model utilizes a dedicated, licensed radioactive metal melting facility that converts radioactively contaminated metal into radioactive products for reuse in directed applications that ensure control of the licensed radioactive material. The history, capabilities and benefit of this type of program will be presented.

Lastly, a proposed concept for a centralized facility for the process and disposition of "very low activity" metals for "directed first use" will be presented for discussion. This proposed disposition process would include the receipt of "potentially clean" materials at a licensed facility equipped as a kind of centralized clearing house for the receipt, assay and disposition of materials that meet a set of predetermined clearance limits. The advantages to this type of approach would include a standardized method to

licensing the assay and clearance process and limits, an economy of scale for reducing the costs of materials disposition, and controlled, verifiable process for the release and directed first use of the materials outside of formal license controls. The economics and challenges of implementing this proposed approach, including discussions of what the radioactive and nonradioactive metals processing industry can do to work together to facilitate the implementation of new NRC clearance rules, will also be discussed.

2:30 p.m. **Low-Activity Radioactive Materials Management at** the U.S. Department of Energy

Frank Marcinowski, III U.S. Department of Energy

The U.S. Department of Energy (DOE) is making significant progress toward accelerated cleanup of its legacy radioactively-contaminated facilities and sites leftover from decades of research and development and nuclear materials and weapons production activities. Sites like Rocky Flats, Fernald, Mound, Brookhaven National Laboratory (BNL), Battelle Columbus Laboratories, and Oak Ridge are working to complete cleanup within the next few years and are faced daily with decisions related to disposition of waste and material. One key to accelerated cleanup is optimizing the disposition of waste. Most of the waste generated in terms of volume has very low levels of radioactive contamination. This waste may take the form of contaminated soil, debris from demolition, or scrap metal and equipment. The cost of disposing of large volumes of waste can be prohibitive, so there is incentive to find innovative ways to disposition wastes.

This paper provides an historical perspective on development of DOE policy regarding release of materials for recycling, reuse or other disposition. The paper describes the current status of policy development in this area, such as development of a draft Programmatic Environmental Impact Statement and monitoring of related rulemaking at the U.S. Nuclear Regulatory Commission. The paper also provides an overview of draft DOE guidance on control and release of property with residual radioactive material.

DOE's accelerated cleanup activities continue, while minute progress is made on environmental analyses, inching ever closer to formal decisions about unrestricted release or clearance of slightly contaminated or suspect



materials. In the absence of formal policy decisions, DOE needs to manage significant quantities of waste and material from cleanup and site closure activities. A number of DOE sites have used the draft guidance, established administrative limits, and disposed, not recycled, slightly contaminated or suspect materials in landfills—in some instances DOE landfills and in some instances commercial landfills. The paper includes a discussion of recent "good practices," such as the application of administrative limits by BNL for cleanup of soils and Peconic River sediment, and a transfer of low-activity waste from the Battelle Columbus West Jefferson Site for bulk survey and release by a commercial contractor. BNL's disposal of this waste in a Subtitle D landfill was fully protective, supported by the State, and avoided an unnecessary \$4.2 million in commercial low-level waste (LLW) disposal fees. At Battelle an estimated 80 percent of the demolition debris and 25 percent of the soil previously planned for disposal at a commercial low-level waste disposal facility, may undergo bulk survey and release. In both cases, the disposition options were fully protective of the environment, and the schedule and cost efficiencies were realized that allowed limited resources to be applied to higher risk activities. At Battelle Columbus, this innovative approach significantly reduced worker safety risks by avoiding the need to crush waste to meet commercial LLW disposal criteria.

2:50 p.m.

Break

3:10 p.m. **Nuclear Industry Experience with Safe Disposition** of Radioactive Materials

Ralph L. Andersen Nuclear Energy Institute

The U.S. Nuclear Regulatory Commission (NRC) currently authorizes seven generic procedures for the safe disposition of licensed radioactive material, including:

- transfer to an authorized recipient
- decay-in-storage
- release in gaseous and liquid effluents
- disposal into the sanitary sewer system
- disposal of certain low-activity wastes as if they were not radioactive
- incineration
- retention as residual radioactivity in conjunction with license termination

NRC also provides a method for licensees to apply to the Commission for case-by-case approval to dispose of specified types and quantities of licensed radioactive material in a manner not generically authorized in NRC regulations. Since 1983, more than 80 such applications have been submitted by licensees and a majority of these have been approved and safely implemented. Applications which have been approved by the Commission have involved low-activity materials and related estimated exposures that represent very small fractions of the applicable dose limits. The accumulation over the past 20 years of case-by-case approvals, and associated analyses of waste streams and exposure pathways, represents a robust and diverse database that can support development of generic standards for the safe disposition of lowactivity materials. This is now of particular relevance because the NRC is pursuing rulemaking on generic standards for the safe disposition of solid radioactive materials.

This paper includes a summary of experience and insights gained from a review of 20 years of licensee applications for approval of specific disposal alternatives. The paper also includes a detailed review of three cases that help illustrate and support approaches that might be considered in generic rulemaking. Recommendations are made regarding how the review process for disposal requests might be made more effective and efficient in the future.

Formulating Tomorrow's Public **Policy**

Susan D. Wiltshire, Session Chair

3:30 p.m. Formulation of Future Nuclear Waste Public Policy in America

David H. Leroy Leroy Law Offices

Government by popularly elected officials serving two-, four- or six-year terms is ill-designed to create and implement policy controlling highly unpopular and longlived nuclear wastes. NIMBY (not in my back yard) is both a sentiment and an acronym known to most voters. NIMTOO (not in my term of office) is the preferred position of many local, state and federal politicians when nuclear issues arise.



Because the formulation of legislation or regulation of a controversial nature requires the building of coalitions, the taking of controversial positions, and potentially risks the alienation of large segments of the populace it is difficult to achieve.

Even when major nuclear waste legislation is implemented by Congress, it can be frustrated by a lack of popular support or noncompliance. Examples are the Nuclear Waste Policy Act of 1982 and the Low Level Radioactive Waste Policy Amendments Act of 1985. The scientific siting process specified by the former was thwarted by state pressures and congressional second thoughts. The latter was violated by popular resistance which effectively vetoed state and regional collaboration.

However, the daily needs of the nation require the ongoing refinement of government radioactive waste operations. This has produced policy by improvisation. Instead of major legislative initiatives or bold bureaucratic breakthroughs, future nuclear waste policy initiatives will be smaller, incremental and accomplished by more informal methods.

The practical tools for such uses are (1) memoranda of understanding between agencies; (2) interpretive guidance letters or rulings applied to existing texts; (3) the licensing of nonthreatening facilities accomplished with local community and public involvement under existing procedures; or (4) narrow, obviously necessary, simple and consensussupported amendments to existing laws or rules.

The next opportunities in America for governmental policy change on nuclear waste issues will occur in the 2005 to 2009 presidential administration. Congress will also have a newly constituted membership. The November 2004 election results will significantly shape the direction and content of those changes, and possibly control whether major radioactive waste issues will be addressed at all.

The basis for such future policies may be the following:

- As to low-level wastes, a report is anticipated for release in Fall 2005 of the National Academy of Sciences Committee on Improving the Regulation and Management of Low-Activity Radioactive Wastes in the United States.
- As to high-level wastes, and the characterization of Yucca Mountain, presidential direction will have

significant impact. The Bush White House issued a policy paper in 2004 titled "Energy for a New Century" calling for advancing next-generation nuclear power technologies, the assurance of long-term waste storage standards, and expanded nuclear generation of electricity in the United States. An editorial in the October 30, 2004, Las Vegas Sun, referring to the presidential election, appeared under the bold headline "Yucca Lives or Dies on Tuesday."

- As to state and regional participation or leadership on low-level waste storage initiatives, threatened private facility access limitations and sharply escalating commercial prices will drive a looming crisis. This creates a new round of public policy needs.
- In sum, the next political cycle in American will incessantly demand that elected officials at all levels face the call of needed solutions for nuclear waste policy. Predictably, they will duck the issues to the maximum extent possible, deferring the decisions as far as possible to successors or future terms of office. Necessity, therefore, will innovate new public policy tools and procedures.

3:50 p.m. Low-Activity Waste Management—An Analysis of **Public-Interest Group Positions**

H. Keith Florig Carnegie Mellon University

The public dialogue over the proper disposition of lowactivity radioactive waste (LARW) includes many stakeholders, each with a different motivation, and each applying different substantive arguments and tactics of persuasion. A number of public-interest nongovernmental organizations (NGOs) have been active in the LARW debate, offering a variety of arguments in opposition to both LARW recycle and the siting of new LARW disposal facilities. This presentation examines the rationales and values underlying these NGO positions on LARW disposition. NGOs are not monolithic. Each focuses on a particular domain (e.g., safety and health, energy policy, economics) of most interest to its base of supporters.

NGOs tend to frame LARW decisions more broadly than do industry proponents or government regulators. NGO objections to proposed recycling and disposal initiatives are made on ethical, institutional, technical and broader energy-policy grounds. Fairness is a major theme, which



includes both procedural and distributional components. Procedural fairness concerns stem from historical and current contexts. The legacy of decision making on defense and nondefense activities involving radioactive materials is one of less-than-open processes. Thus, existing stockpiles of LARW are deemed to have been generated by politically illegitimate activities. Fairness concerns about current processes for deciding LARW policies include the imbalance in financial resources between proponents and opponents of LARW recycling and disposal siting, conflicts of interest for various parties with a duty to be objective, and continuing problems with openness and public participation (e.g., future generations are not present to weigh in on LARW disposal decisions).

Distributional fairness seeks to assure balanced distribution of risks and benefits of a policy. Recycle is criticized because the benefits would accrue to owners of radioactive scrap, while the risks are born entirely by consumers of products with recycle content. Another distributional fairness issue concerns the possibility of unforeseen worst case scenarios in which hot particles leak through recycle and remanufacturing screening procedures, exposing some members of the public to doses higher than imagined.

Concerned NGOs are skeptical of technical arguments that waste repositories can be made secure from leakage or disturbance, especially over century time scales, and that recycling programs can avoid slipups or be free of corruption, given the large sums of money at stake. These doubts are based on the observation that the history of technological risk management is full of examples in which unexpected events occurred that were outside of the design bases used to create protection systems.

4:10 p.m. Policy Development from the Industry **Perspective**

William P. Dornsife Waste Management Specialists

The major burden for the implementation of any option for disposition of low-activity radioactive waste will fall to the industries that generate the waste and provide waste management services. There are a number of critical issues that need to be considered and addressed before a comprehensive and sound program can be implemented.

Perhaps the most important issue confronting industry is the public concern and opposition that will likely occur to almost any proposed solution. This will likely be manifested by strong public opposition to the implementation of any practical solutions or by refusing to use any products that could be impacted by the solutions. This public concern could then lead to the more serious political opposition that could result in laws or regulations being implemented to prevent any solution from being implemented. This can only be countered by developing and providing factual and independent information on the potential health and safety risks and economic benefits. There is a need for a comprehensive study that evaluates all health and safety risks (including nonradiological) and economic benefits from a life-cycle standpoint for all of the alternatives for disposition of low-activity material.

Another important issue is the multiple and sometimes conflicting government agency jurisdiction, regulation and policy that now exist and will likely continue in the implementation of new options. Examples of current and future problems include:

- new U.S. Department of Transportation regulations that have exempt concentrations that may be lower than current exempt licensing levels or new proposed disposition levels;
- pre-78 11(e)(2) being regulated differently than other mill tailings; lack of national NORM (naturally occurring radioactive materials) standards with states having NORM regulations that are inconsistent or conflicting;
- implementation usually occurs at the state level with more stringent requirements;
- and low-level radioactive waste (LLRW) compact jurisdictional issues over the material. This overly burdensome regulatory structure may lead to industry hesitation to participate in the proposed solutions.

Since there is a system currently in place for disposition of some low-activity radioactive materials, albeit not consistent or entirely risk based, there is industry concern that new proposals may jeopardize the existing system. The question becomes, why not use the existing exemptions but make them easier to implement and more risk based? The other related concern is how to transition to a new system, since the current system must remain in place to continue to provide the limited solutions.



There are conflicts between the interests of various industry groups. There are strong industry interest groups that inhibit wider solutions for certain categories of waste because current regulations favor them or because some solutions are viewed to cause economic harm. For waste management service providers there is a concern about the potential market to justify investment or liability risks and the ability to receive the necessary permits or approvals required. There are liability and other risks for generators using low-activity radioactive waste disposition options, such as their exposure to additional regulatory oversight and the marketability of their products.

There are a number of difficult implementation issues that directly affect industry. For the generating facility there are issues relating to the control and transfer of materials leaving licensed facilities. For the waste management industry additional monitoring, design, and long-term care for disposal facilities will need to be considered. Worker exposure monitoring and control will need to be addressed at unlicensed facilities.

Taking all of this into consideration, the only real option that most industry stakeholders may be able to agree with may be land disposal in acceptable facilities, which may only be Resource Conservation and Recovery Act Subtitle C or mill tailings disposal facilities that also have a license to deal with the transfer, acceptance, worker exposure, and release issues.

4:30 p.m. Break

Twenty-Ninth Lauriston S. Taylor Lecture on Radiation Protection and Measurements

5:00 p.m. **Introduction of the Lecturer**

R.J. Michael Fry

Oak Ridge National Laboratory, Retired

Nontargeted Effects of Radiation: Implications for Low-Dose Exposures

John B. Little

Harvard University School of Public Health

6:00 p.m. Reception in Honor of the Lecturer

Thursday, March 31, 2005

8:00 a.m. A Tribute to the Life and Scientific

Accomplishments of Lauriston S. Taylor

Robert O. Gorson

Thomas Jefferson University, Retired

8:30 a.m. **Business Session**

9:30 a.m. Break

Update of Regulatory Efforts and Round Table Discussion

Susan M. Langhorst, Session Chair

10:00 a.m. Overview of U.S. Environmental Protection Agency's Initiative on Disposition of Low-Activity **Radioactive Waste**

Daniel Schultheisz

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) issued an Advance Notice of Proposed Rulemaking (ANPR) (68 FR 65120, November 18, 2003) to request public comment on options to promote a more consistent framework for the disposal of radioactive waste with low concentrations of radioactivity ("low-activity"). Radioactive waste disposal in the United States is marked by a fragmented regulatory system, with requirements that often focus on the origin or statutory definition of the waste, rather than the hazard of the material in question. Thus, some wastes that are inconsistently regulated, if regulated at all for their radiological properties, can sometimes present higher risks to the public than wastes that are more tightly controlled. The current system provides limited disposal options and can sometimes result in inefficient use of resources, inconsistent regulation, and potentially unaddressed risks.

It may be possible to enhance public protection by moving toward a system that provides disposal options appropriate for the hazard presented by the waste in question. EPA's ANPR focuses on the potential use, with appropriate conditions, of Resource Conservation and Recovery Act Subtitle C (RCRA-C) hazardous waste landfills for disposal of "low-activity" wastes. EPA envisions that the RCRA disposal technology would be offered as a new disposal option for these wastes.



The public comment period for EPA's ANPR generated more than 1,500 public comments. EPA continues to analyze the comments and to interact with stakeholders to determine the most appropriate action to address these issues.

Update of Regulatory Efforts by U.S. Nuclear 10:10 a.m. **Regulatory Commission**

Carl J. Paperiello

U.S. Nuclear Regulatory Commission

On June 30, 1999, the U.S. Nuclear Regulatory Commission (NRC) published in the Federal Register an "Issues Paper" concerning regulations covering releases of solid material containing very low levels of radioactive material from nuclear facilities. The paper noted that unlike liquid and gaseous material there were no specific criteria in the NRC regulations in Title 10, Code of Federal Regulations, Part 20, governing the releases of solid material from licensed facilities. The notice solicited comments on the issues raised in the paper and announced a series of public meetings on the issues raised in the paper. After holding these and other meetings and receiving comments from stakeholders NRC directed the staff on August 18, 2000, to defer rulemaking, to request the National Academy of Sciences (NAS) to study the issues involved, establish a technical base for future action, and to stay informed of international efforts in this area.

In 2002, NAS published the results of its study in The Disposal Dilemma, Controlling the Release of Solid Materials from Nuclear Regulatory Commission-Licensed Facilities. The staff published a number of research reports supporting the technical bases for potential rulemaking. NUREG-1640, Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities, was published in four volumes presenting scenarios and doses from the release of specific solid material from licensed facilities. NUREG-1725, Human Interaction with Soil: An Information Search, discussed scenarios for the potential interaction of people with soil that might possibly be released from a nuclear facility. NUREG-1761, Radiological Survey for Controlling Releases of Materials, identifies survey practices needed to analyze solid material to quantify potential radioactivity. In addition, the staff issued several reports summarizing comments from stakeholders. In 2004, the International Atomic Energy Agency approved Safety Guide No. RS-G-1.7, Application of the Concepts

of Exclusion, Exemption, and Clearance. This safety guide establishes international clearance concentration guidance for solid material at doses comparable to those suggested by the NAS report.

Currently, NRC staff is continuing to analyze rulemaking approaches with regard to alternatives that result in (1) retaining the current process by allowing unrestricted use through measurement guidelines, or (2) modifying NRC regulations to: (a) restrict release to only certain authorized paths such as restricting material to EPA regulated landfills, conditional use (e.g., roadbeds, reuse of tools), and allowing case-by-case requests; (b) at only licensed low-level waste disposal facilities; or (c) allow release with no limitation on pathways if a radiation survey verifies that levels are acceptable ("clearance"). The current status of activities, including all NRC documents and stakeholder comments, can be found at the NRC web site (www.nrc.gov).

10:20 a.m.

Implementation of U.S. Department of Energy Policies, Directives and Guidance for Radiological **Control and Release of Property**

Andrew Wallo, III Stephen Domotor Gustavo Vazquez U.S. Department of Energy

This presentation will describe U.S. Department of Energy (DOE) directives, recent policies, and guidance relating to the management of property containing or potentially containing residual radioactive material. Although DOE general property management requirements will be addressed, the focus of the presentation will be on personal property which includes waste, scrap and equipment. Examples of authorized limits approved and implemented for disposal of waste containing residual radioactive material will be presented. The status of and plans for future directives or changes will be discussed in the context of intra- and interagency activities.

10:30 a.m.

Role of State Regulatory Agencies in the **Disposition of Low-Activity Radioactive Materials**

Edgar D. Bailey

Conference of Radiation Control Program Directors, Inc.

Since the opening of the first disposal site for commercially generated low-level radioactive waste (LLRW) at Beatty, Nevada, in September 1962, the states have been



explicably involved in the process. The states have been involved as landowners, regulators, environmental monitors, and sometimes promoters of the sites and the persons operating the sites. Although some of the LLRW disposal sites were originally licensed by the U.S. Atomic Energy Commission and U.S. Nuclear Regulatory Commission (NRC), we have now evolved to the point where all of the operating and all of the closed sites are located in NRC Agreement States and are under the regulation of the Agreement States.

In recent years due to the ever-increasing costs of LLRW disposal and the availability of LLRW disposal sites there has been a continued effort to establish national criteria for radioactively contaminated wastes that do not need to be sent to a LLRW disposal site in order to adequately protect the health of the public and the environment. NRC has unsuccessfully tried to establish de minimus levels of radioactive materials and levels that were "below regulatory concern." The adoption of either of these proposed regulations would have gone a long way in addressing this need. Both of these proposals failed because of concerns from the general public, Congress, and the states.

NRC did adopt a decontamination and decommissioning rule (D&D) which provides a site-specific dose-based standard for the levels of radioactive contamination that may be left in place when a site/facility is released for unrestricted use. Many felt that this would establish radioactivity levels that did not have to be disposed of as LLRW. However, the D&D regulation did not set national standards for the radioactivity levels because it was site specific (and therefore the actual concentrations could vary from site to site), and because the states were permitted to establish regulations that required a lower calculated dose than the NRC regulations.

Concerns have arisen in some states over the contaminated soil and other materials left behind once a site or facility is released for unrestricted use. In California, for example, a Governor's Executive Order has prohibited the disposal of these so-called "decommissioned wastes" at municipal landfills.

Both the NRC and the U.S. Environmental Protection Agency (EPA) have rulemaking processes underway in an attempt to address these issues, NRC through a

rulemaking effort on "clearance" levels and EPA through an Advanced Notice of Proposed Rulemaking.

For either of these efforts to have a significant positive impact on the disposal of very-low-activity wastes, there will have to be acceptance and implementation by the states. Since both LLRW and solid waste disposal sites are in large part regulated by the states as Agreement States and as states with delegated authority from EPA to regulate solid waste, state involvement in the processes will be crucial and ultimately decide whether or not these efforts will be successful.

10:40 a.m. **Questions and Discussion**

(all participants)

11:35 a.m. Summary

John F. Ahearne, Rapporteur Sigma Xi

12:15 p.m. **Closing Remarks**

Thomas S. Tenforde, President National Council on Radiation Protection and Measurements



The Program Committee

S.Y. Chen, *Chair* Argonne National Laboratory

William P. Dornsife Waste Control Specialists

Susan M. Langhorst Washington University, St. Louis

Jill A. Lipoti New Jersey Department of Environmental Protection

Joel O. Lubenau

Ruth E. McBurney Texas Department of Health

Dade W. Moeller Dade Moeller and Associates, Inc.

Carl J. Paperiello U.S. Nuclear Regulatory Commission

Michael T. Ryan Charleston Southern University

Susan D. Wiltshire JK Research Associates, Inc.

Registration

Wednesday, March 30, 2005 7:30 a.m. – 5:00 p.m.

Thursday, March 31, 2005 7:30 a.m. – 12:00 noon

There is no registration fee.

2006 Annual Meeting

April 2-4, 2006 in Arlington, Virginia

These organizations have supported the work of the National Council on Radiation Protection and Measurements during the period of January 1, 2004 to December 31, 2004.

Contracts

Bechtel BWXT Idaho, LLC **Defense Threat Reduction Agency** Food and Drug Administration U.S. Navy U.S. Nuclear Regulatory Commission University of Pittsburgh

Contributors

American Academy of Health Physics American Association of Physicists in Medicine American College of Medical Physics American College of Radiology Foundation American Industrial Hygiene Association American Nuclear Society American Osteopathic College of Radiology American Roentgen Ray Society American Society of Radiologic Technologists American Society for Therapeutic Radiology and Oncology Council on Radionuclides and Radiopharmaceuticals Health Physics Society Landauer, Inc. Radiological Society of North America Society of Nuclear Medicine

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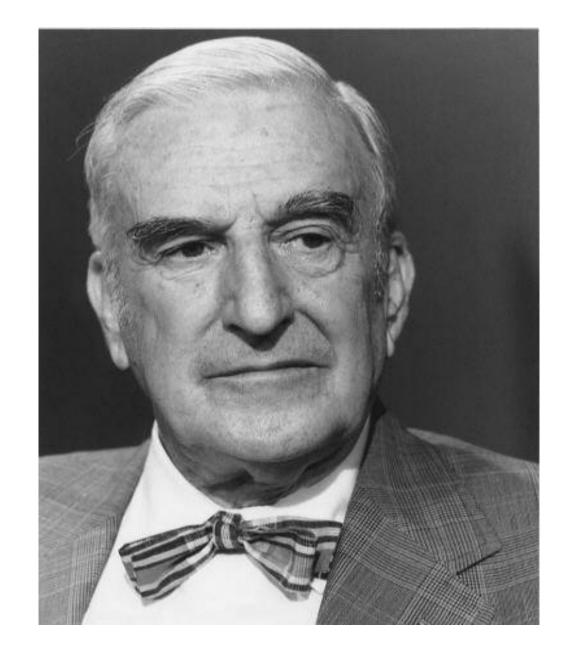
Grants

Defense Threat Reduction Agency Department of Homeland Security National Aeronautics and Space Administration National Cancer Institute National Institute of Standards and Technology U.S. Department of Energy U.S. Nuclear Regulatory Commission



Forty-First Annual Meeting

Managing the Disposition of Low-Activity
Radioactive Materials



Lauriston Sale Taylor
June 1, 1902 – November 26, 2004
NCRP President from 1964 to 1977



Lauriston Taylor's International Leadership in Radiation Protection and Measurements

- 1929-1946: Founder and Chairman of U.S. Advisory Committee on X-Ray and Radium Protection
- 1946-1964: Founder and Chairman of National Committee on Radiation Protection
- 1964-1977: First President of National Council on Radiation Protection and Measurements



Lauriston Taylor's International Leadership in Radiation Protection and Measurements (continued)

- Secretary of (1934-1950) and Chairman (1953-1969) of International Commission on Radiation Units and Measurements
- Member (1928-1969) and Secretary (1937-1950) of International Commission on Radiological Protection
- President of Health Physics Society (1958-1959)



Tribute to Lauriston Taylor

Presented on behalf of NCRP by

Robert O. Gorson

8:00 – 8:30 a.m., Thursday, March 31



Reports Published in 2004

No. 146 Approaches to Risk Management in Remediation of Radioactively Contaminated Sites (Chair: D.J. Strom)

No. 147 Structural Shielding Design for Medical X-Ray Imaging Facilities (Co-Chairs: B.R. Archer and J.E. Gray)



Reports Published in 2004

No. 148 Radiation Protection in Veterinary Medicine (Chair: K.R. Kase)

No. 149 A Guide to Mammography and Other Breast Imaging Procedures (Chair: L.N. Rothenberg)



Statement Published in 2004

No. 10 Recent Applications of the NCRP
Public Dose Limit Recommendation for
Ionizing Radiation (Chair: R.J. Vetter)



Proceedings of 39th Annual Meeting

- 2003 Annual Meeting, "Radiation Protection at the Beginning of the 21st Century A Look Forward" (Chair: J.E. Till) Health Physics 87(3), 249-319 (2004)
- 27th Lauriston S. Taylor Lecture by Charles B. Meinhold, "The Evolution of Radiation Protection From Erythema to Genetic Risks to Risks of Cancer to ...?" Health Physics 87(3), 240-248 (2004)



Publication of Report by Scientific Committee 1-10

Residential Radon Exposure and Lung Cancer Risk: Commentary on Cohen's County-Based Study [published in Health Physics 87(6), 656-658 (2004)] (Chair: Clark Heath)

Warren K. Sinclair Annual Keynote Lecture





Second Annual Warren K. Sinclair Keynote Lecture

Contemporary Issues in Risk-Informed Decision Making on Waste Disposition

Dr. B. John Garrick

PLG, Inc., Bethesda, Maryland

President, Chairman and CEO (retired)

CONTEMPORARY ISSUES IN RISK-INFORMED DECISION MAKING ON THE DISPOSTION OF RADIOACTIVE WASTE

by Dr. B. John Garrick

Presented at the Annual Meeting of the National Council on Radiation Protection and Measurements

Arlington, Virginia March 30-31, 2005

Quantitative Definition of Risk

What can go wrong?
How likely is it?
What are the consequences?

An Answer $\langle s_i, L_i, x_i \rangle$ Set of Answers $\{\langle s_i, L_i, x_i \rangle\}$ Complete Set $\{\langle s_i, L_i, X_i \rangle\}_c$

$$R = \{ \langle s_i, L_i, x_i \rangle \}_c$$

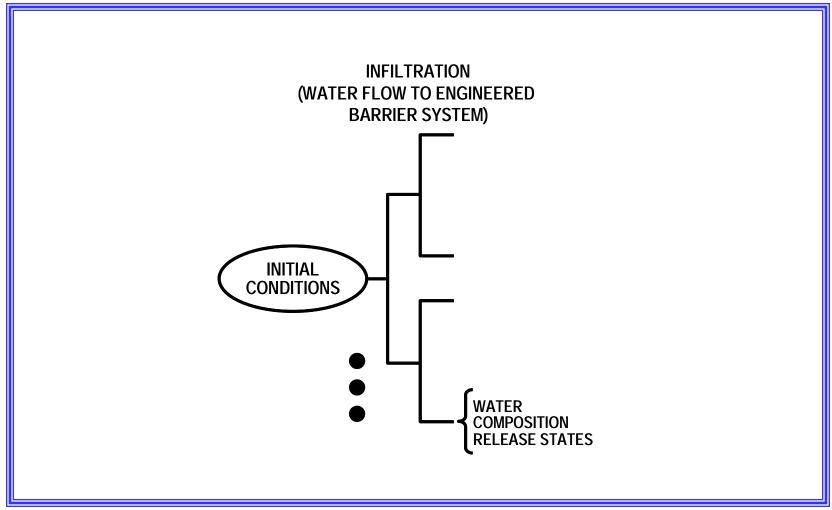
Include s_0 = "As-Planned" Scenario

Initial Conditions

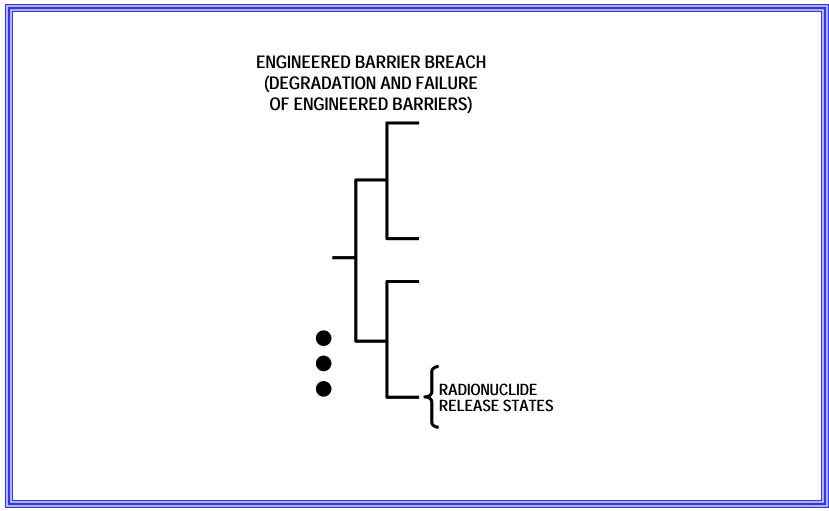
INITIAL CONDITIONS

- 1. NONDISRUPTIVE CASE
 - a) CLIMATE CHANGES
 - b) WATER FLOW RATES AND DURATION
- 2. DISRUPTIVE EVENTS
 - a) EARTHQUAKES
 - b) VOLCANIC ERUPTIONS
 - c) EXTREME FLOODING/ EROSION
 - d) METEORITES
 - e) HUMAN INTRUSIONS
 - f) OTHER

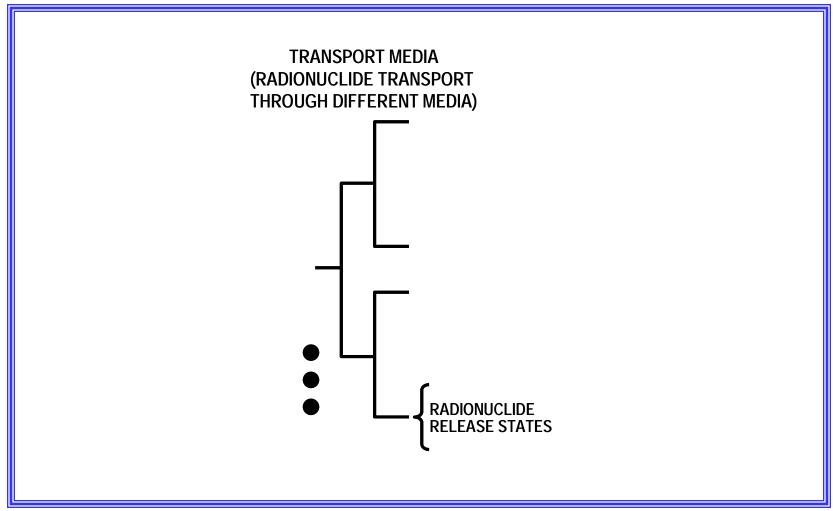
Infiltration Model



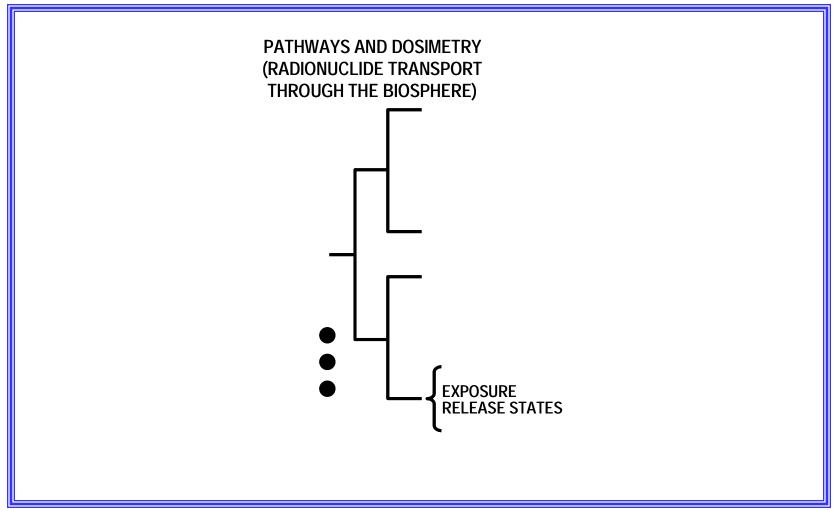
Engineered Barrier Model



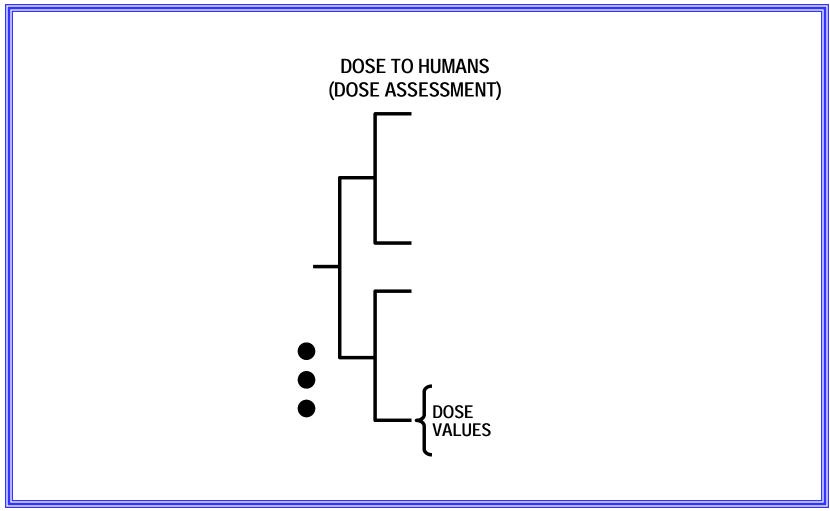
Transport Media Model



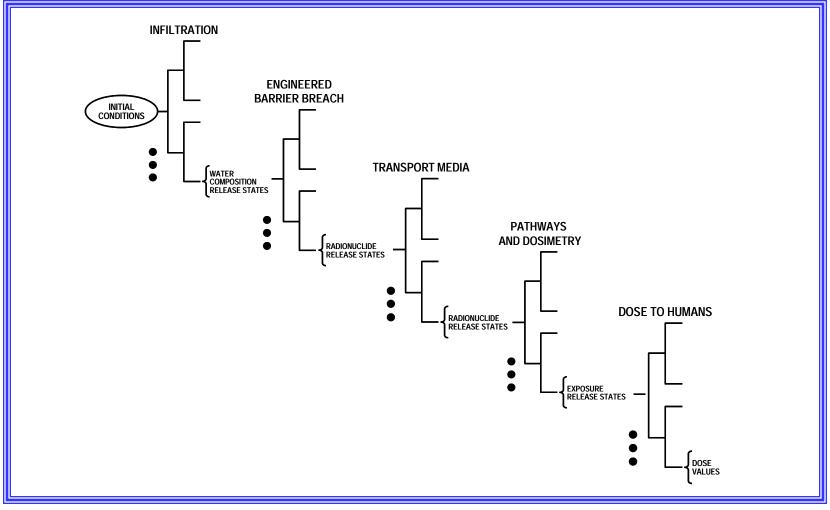
Pathways and Dosimetry Model



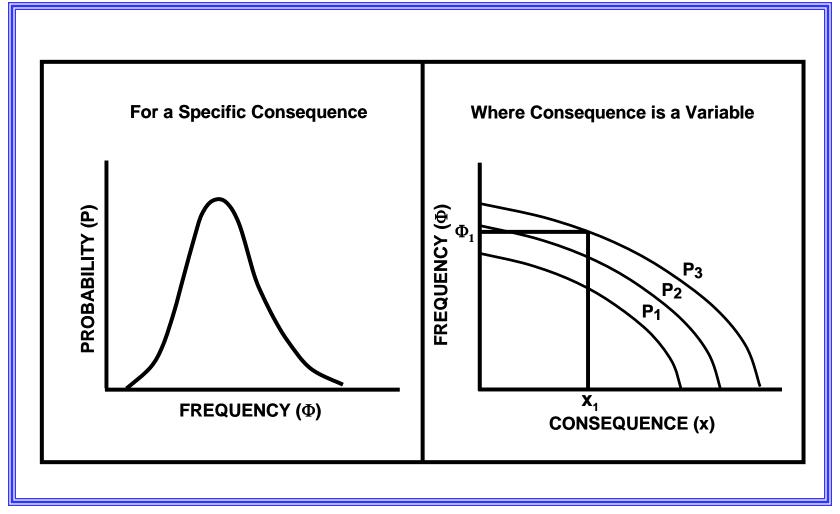
Dose to Humans Model



A Conceptual Model for A Probabilistic Performance Assessment



Form of the Results for A Probabilistic Performance Assessment



NCRP 2005

B. John Garrick

Attributes of the "Set of Triplets" Approach to PPA

It is a logical extension of the large PRA experience base of the nuclear power and other industries and is rooted in principles that are applicable to any kind of risk

A "probability of frequency" based risk metric is consistent with past practices in PRA while making uncertainty an explicit part of the results

Fine structure scenarios greatly accommodate the issue of importance ranking as the importance of any one scenario to overall risk becomes clearly visible

The analysis approach is based on Bayesian inference, which is anchored to the fundamental rules of logic

Improving the Regulation and Management of Low-Activity Radioactive Wastes

John R. Wiley David H. Leroy Michael T. Ryan

National Council on Radiation Protection and Measurements March, 2005



Outline of Talk

- Reasons for the Study
- Task and Committee Members
- Approach
- Low-Activity Waste Categories
- Committee Findings
- Closing Remarks and Phase II

Reasons for the Study

This project was initiated by the National Academies' Board on Radioactive Waste Management, which observed that statutes and regulations controlling low-activity radioactive wastes (LAW) have evolved as A patchwork over the past 60 years.

- Wastes from some origins may be over-regulated relative to their radiological hazards, increasing costs and other burdens on the generators and potentially increasing worker risks.
- Radiological hazards of other LAW may be greater than generally perceived.

Statement of Task

- Using available information from public domain sources, provide a summary of the sources, forms, quantities, and hazards of low-activity waste in the United States;
- Review and summarize current policies and practices for regulating and managing lowactivity waste, including treatment and disposal practices; and
- 3) Provide an assessment of technical and policy options for improving practices for regulating and managing this waste to enhance technical soundness, ensure continued protection of public and environmental health, and increase cost effectiveness.

Committee Members and Expertise

David H. Leroy, Chairman

Michael T. Ryan, Vice-Chair

Leroy Law Office

Charleston Southern University

Nuclear Regulatory

Commission

(retired)

| Waste Management | <u>Health Risk</u> <u>E</u> | Invironmental Policy |
|----------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------|
| Edward L. Albenesius Savannah River Site (retired) | Gail Charnley Health Risk Strategies | Perry H. Charley Diné College |
| Wm. Howard Arnold Westinghouse Electric (retired) | Sharon M. Friedman Lehigh University | Sanford Cohen SC&A, Inc. |
| Maurice C. Fuerstenau University of Nevada | Michael T. Ryan, Vice-Chair | Ann Rappaport Tufts University |
| Kimberly W. Thomas Los Alamos National Laboratory | Law and Regulation François Besnus Institute de Radioprotection et de Sûreté Nucléaire | Geoscience D. Kip Solomon University of Utah |
| Economics James Hamilton Duke University | F. Stanley Echols Echols Consulting Group | BRWM Liaison Robert M. Bernero |

David H. Leroy, Chair

Approach

This interim report addressed the first two parts of the task statement in order to provide a factual basis for the final report.

Public domain inventory data were summarized from the:

- DOE central internet database (CID);
- Manifest information management system (MIMS);
- •US National Report for the International Safety Convention (DOE/EM-0654, May, 2003).

Approach (2)

The committee organized the summary information into five categories, which we believe are inclusive of LAW from all sources (DOE, nuclear utilities, other industries, medicine, research, mineral recovery).

The categories focus on the physical and radiological characteristics of the wastes, rather than their origins. We chose this approach to emphasize inconsistencies, gaps, and suggest ways to improve the current LAW regulatory/management system.

Low-activity Waste Categories 1-3

Three categories include wastes that are defined and regulated as low-level wastes. They are subject to the same statutory definition and controls (AEA, NWPA, LLWPA), but have very different physical and radiological characteristics.

- 1. Wastes that fit comfortably in USNRC classes A, B, C.
 - Typical "Barnwell" commercial waste
 - DOE "burial ground" waste
- 2. Slightly radioactive solid materials from decommissioning and cleanup. These push the low end of USNRC class A. They produce very low or essentially non-detectable levels of radiation and arise in large volumes.
- 3. **Discrete sources (sealed sources).** These can push the upper end of USNRC class C (GTCC). Some produce high levels of radiation but their volumes are small.

Categories 4-5

Two categories include wastes that have similar physical and radiological properties (large volumes; U or Th series isotopes) but are subject to different regulations.

4. Uranium and thorium mining and processing wastes (AEA)

Post Uranium Mill Tailings Radiation Control Act (UMTRCA) 1978 wastes require disposal in a licensed radwaste facility.

Pre-UMTRCA wastes (mostly AEC "FUSRAP" wastes) have other disposal options.

5. NORM AND TENORM wastes (non-AEA)

- Uneven control by state agencies
- Little public perception of radiation hazard
- Conference of Radiation Control Program Directors (CRCPD) model regulation proposed.

Findings

FINDING 1:

Current statutes and regulations for low-activity radioactive wastes provide adequate authority for protection of workers and the public.

- The current system is working; no crisis
- Uneven application of authority
- The patchwork approach may become less workable in the future.

Findings Con't

FINDING 2:

The current system of managing and regulating low-activity waste is complex. It was developed under a patchwork system that has evolved based on the origins of the waste.

- Clear message from information-gathering meetings: A more consistent, simpler, performance-based, risk-informed approach is needed.
- Consistent with message from studies by other organizations (NCRP-139).

Findings Con't

FINDINGS 3 AND 4:

Certain categories of low-activity wastes have not received consistent regulatory oversight and management.

Current regulations for low-activity wastes are not based on a systematic consideration of risks.

- NORM/TENORM state regulation
- Uranium/thorium wastes pre- and post-UMTRCA
- Decommissioning waste (SRSM) Versus NORM/TENORM
- Waste shipments versus local disposal

Closing Remarks (1)

The committee concluded that there is adequate statutory and institutional authority to ensure safe management of low-activity wastes, but the current patchwork of regulations is complex and inconsistent—which has led to instances of inefficient management practices and possibly in some cases increased risk overall. Existing authorities have not been exercised consistently for some wastes. The system is likely to grow less efficient if the patchwork approach to regulation continues in the future.

Closing Remarks (2)

The task of this interim report was to develop an overview of current regulatory and management practices for low-activity waste, and thus set the stage for the committee's final report, which will assess policy and technical options for improving the current practices. The assessments will include risk-informed options, and the committee strongly believes that issues of public trust and risk perception will be important considerations in the final report.

Future Directions

- Continue present ad hoc system add regulatory patches as needed.
- Greater recognition and use of international regulations and standards.
- Move from the present origin-based to a more risk-informed system

Risk-Informed Radioactive Waste Classification and Reclassification

Allen G. Croff
Oak Ridge National Laboratory
(retired)

2005 Annual Meeting of the NCRP

March 30-31, 2005

Outline

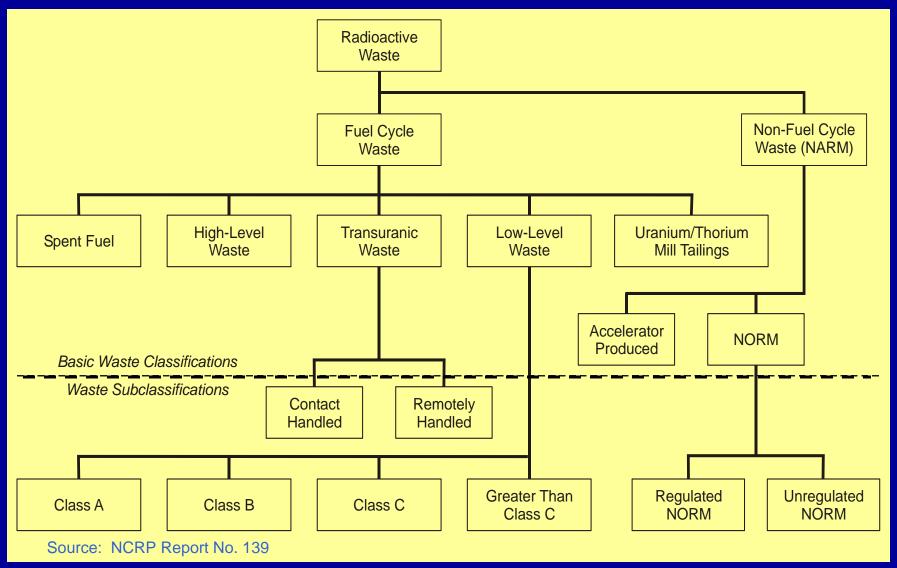
- Definitions and purpose
- Existing waste classification systems
- Risk basis of waste classification systems
- Need for risk-informed waste classification
- Future directions

Definitions and Purpose

Definitions

- Waste: Material having no further value that must be safely managed at a cost
- Waste class: Group of wastes having similar attributes
- Waste definition: Concise explanation of the attributes bounding a waste class
- Purpose of waste classification
 - Group similar wastes for subsequent management
 - Allow for planning before disposition path is known

U.S. Waste Classification System



IAEA Waste Classification System

- Used in many countries to varying degrees
- Uses familiar labels (HLW, LLW)
- Substantially different than U.S. system
 - Independent of waste source
 - More quantitative
 - Does not distinguish between fuel cycle and non-fuel-cycle waste
 - Includes an exempt waste classification

Risk Basis of Systems

- Definitions
 - Risk Based: Risk is sole consideration
 - Risk Informed: Risk balanced against other factors
- U.S. waste classification system is qualitatively/indirectly risk informed for wastes generated and managed similar to the ideal
- U.S. has many wastes differing from the ideal
 - HLW
 - LLW
 - Exempt waste
 - Non-fuel cycle

Risk Basis of Systems (cont'd)

- IAEA waste classification system is risk informed
- Proposed U.S. waste classification systems
 - Many proposed to alleviate shortcomings
 - NCRP Report No. 139
 - Generally risk informed and similar to IAEA waste classification system
 - None seriously considered for adoption so far

Need for Risk-Informed System

 HLW: Absence of lower boundary greatly increases cost and occupational risk of remediation

LLW: Greater-than-Class C LLW has no disposal destination

 Very-Low-Activity Waste: Lack of exempt waste class leads to increased cost and risk

Future Directions

HLW

- Recent legislation provides basis to reclassify on a (risk-informed?) case-by-case basis
- No apparent inclination to revise HLW definition

LLW

- Anticipate EIS process to explore disposal options
- No apparent inclination to revise LLW definition
- Very-Low-Activity Waste
 - Ongoing effort to establish case-by-case clearance criteria
 - No apparent inclination for an exempt waste class

Future Directions (cont'd)

- Fuel Cycle vs Non-Fuel Cycle Wastes
 - Growing interest by states in having one waste classification system

Definition of HLW

- HLW is
- (A) highly radioactive material from fuel reprocessing, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and
- (B) other highly radioactive material that NRC, consistent with existing law, determines by rule requires permanent isolation

IAEA Waste Classification System

| Class | Waste characteristics | Disposal options |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Exempt waste | Concentrations of radionuclides at or below levels corresponding to annual dose to members of the public from waste disposal of 10 µSv | No radiological restrictions |
| Low- and intermediate- level waste Short-lived | Concentrations of radionuclides above exempt levels and thermal power density less than about 2 kW m ⁻³ | |
| waste ^a | Concentrations of long-lived, alpha-emitting radionuclides restricted to 4 kBq g ⁻¹ in individual waste packages and average of 0.4 kBq g ⁻¹ over all waste packages | Near-surface disposal system or geologic repository ^b |
| Long-lived waste | Concentrations of long-lived, alpha-emitting radionuclides that exceed restrictions for short-lived waste | Geologic repository |
| High-level waste | level waste Thermal power density greater than about 2 kW m ⁻³ and concentrations of long-lived, alpha-emitting radionuclides that exceed restrictions for short-lived waste | |
| Waste that contains long- lived, naturally occurring radionuclides ^c Contains uranium, thorium, or radium; generated in mining and milling of ores or similar activities, or decommissioning of nuclear facilities ^d | | No radiological restrictions or systems similar to those for short- lived waste ^e |

^aDistinction between short-lived and long-lived radionuclides is half-life of about 30 y.

^bRange of disposal options may be acceptable, due to variety of radionuclides and wide range of concentrations that may be present.

^cWaste is not part of basic waste classification system, but large volumes of waste that contains long-lived, naturally occurring radionuclides are given additional consideration.

^dWaste from decommissioning also may contain man-made radionuclides.

^eDisposal option would depend on results of safety assessments for particular wastes.



Managing the Disposition of Potentially Radioactive Scrap Metal

NCRP Annual Symposium Crystal City, Arlington, VA March 30–31, 2005

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Environmental Assessment Division

Argonne National Laboratory



A U.S. Department of Energy Office of Science Laboratory Operated by The University of Chicago





Operations of Several Programs of National Interest Involving Radioactive Materials Have Led to Residual Contamination

National Programs of Interest

- Nuclear Weapons Programs for National Security Needs (DOE/DOD)
- ☐ Civilian Nuclear Power Operations for National Energy Needs (nuclear utilities)
- □ Industrial Operations Involving Naturally Occurring Radioactive Materials (NORM) – for Various Societal Needs (industries producing natural resources such as petroleum)

Potential Contamination

- Real Property (sites, buildings, etc.)
- Non-Real Property (scrap metal, concrete, etc.)
- Wastes (radioactive, chemical, mixed)





Why Scrap Metal?

- ☐ An ideal candidate for a disposition study (well-defined, comprehensive information, extensively studied)
- Metal is a commodity (recyclable) and disposal options could be unjustifiably costly (economic issues)
- Involves some controversial issues regarding release (public perception)
- ☐ The metal industry has ongoing problems dealing with radioactive contamination issues *(orphan source melting)*
- ☐ Many studies on the release of solid materials focus on metal (IAEA, ANSI/HPS, EC, DOE, NRC)





Considerable Amounts of Metals with Radiological Concerns Will Be Generated

| | | Mass (1,000 metric tons) by metal type | | | | |
|--------------------------------|----------|----------------------------------------|-------|--------------|-----------------|--------------------|
| Source | Aluminum | Copper | Lead | Nickel | Carbon Steel | Stainless Steel |
| Commercial nuclear power plant | 12-287 | 11-643 | 3-730 | 0-17 | 536-3,210 | 135-199 |
| DOE nuclear weapons facilities | 27-44 | 7-56 | 1 | 38-57 | 192-1,068 | 12-174 |
| Military | _ | _ | _ | _ | _ | 160 |
| R&D reactors | _ | _ | _ | - | 2 | 2 |
| NARM related activities | - | - | - | _ | 3,000 | _ |
| Total U.S. | 39-331 | 18-699 | 4-731 | 38-74 | 3,730-7,280 | 309-535 |

Grand Total = 4,138-9,650 MT

Source: NCRP Report No. 141 (2002).





Much of the Metal Is Merely Suspect Contamination

| | Percentage distribution of scrap metals for a reference PWR | | | erence PWR |
|-----------------------|-------------------------------------------------------------|---------------------------------------|-----------------------------------|------------|
| Metal Type | Suspect Radioactive | Suface- contaminated- removable | Suface- contaminated- fixed | Activated |
| Aluminum | 80 | 15 | 0 | 5 |
| Copper | 98 | 2 | 0 | <1 |
| Lead | 100 | 0 | 0 | 0 |
| Carbon steel and iron | 70-80 | 10-20 | 0 | 10-15 |
| Stainless steel | 0 | 50 | 15 | 35 |

Based on a reference PWR with a 1,000 MW(e) power rating. Estimated metal inventory is 33,000 (Nieves et al. 1995).

Suspect: No or insignificant radioactive content (e.g., secondary or support systems)
Surface-removable: Readily removable by decon technologies (e.g., steam generators; turbines)

Surface-fixed: Not readily removable by decon technologies (e.g., radwaste systems)

Activated: Activation by neutrons; mostly volume contamination (e.g., reactor vessels)



Office of Science U.S. Department of Energy

Managing "Potentially" Radioactive Scrap Metal (PRSM)

- PRSM includes all suspect or contaminated metals within a facility if they cannot be otherwise classified under current laws
- Managing disposition requires the availability of viable options with a comprehensive strategy





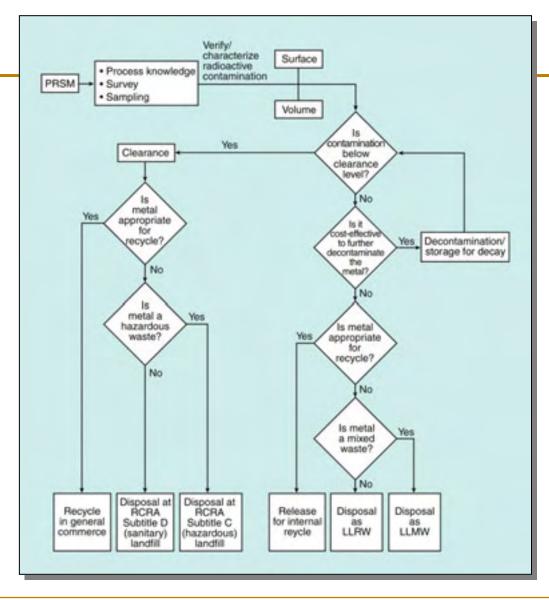
Various Disposition Options Have Been Identified and Explored with Varying Degrees of Success

| Disposition Remains within Radiological Control |
|-------------------------------------------------------------------------------------------------------|
| ☐ Within-industry recycling <i>(limited capacity)</i> |
| ☐ On-site storage ("hold and release") <i>(limited capacity)</i> |
| ☐ Disposal at LLRW burial facility (most likely option, per 10 CFR 61 or DOE Order 435.1 regulations) |
| Disposition Outside of Radiological Control |
| ☐ Disposal at RCRA Subtitle C (hazardous waste) landfill (case-by-case) |
| ☐ Disposal at RCRA Subtitle D (sanitary waste) landfill (case-by-case) |
| ☐ Recycling in public domain (clearance) <i>(case-by-case)</i> |
| |





The Goal Is to
Develop a
Comprehensive,
Risk-Informed
Disposition
Management
Approach







However, Defining "Non-Radioactive" Is An Exceedingly Difficult Proposition

A History Filled with Failed Regulatory Attempts NRC's attempt to establish "Below Regulatory Concern (BRC)" Policy in the early 1990s was unsuccessful because of public opposition □ DOE's discovery of trace amounts of radioactivity in waste led to the "No-Rad Added" Policy in 1993 □ DOE announced a self-imposed *moratorium* in 2000 on the recycling of scrap metal in general commerce Significant Cost Implications to Generators Expensive disposal option at low-level waste disposal facilities (on the order of several billion dollars; NAS 2002) Lack of release policy and standards impedes *cleanup* activities across the DOE complex and NRC-licensed facilities

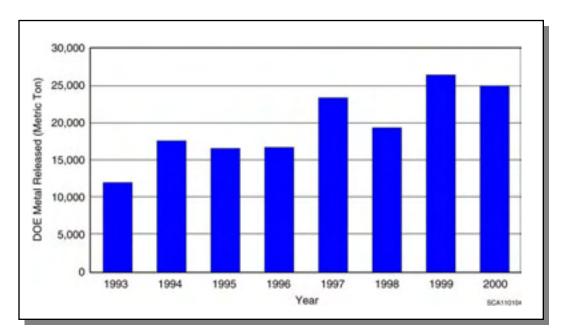




Current and Past Approaches Have Been Conducted in an Ad Hoc Manner

Currently Available Regulatory Provisions Lack a Systematic Approach for a Widespread Application

- NRC 10 CFR 20.2002 Provision (Method for Obtaining Approval of Proposed Disposal Procedures)
- DOE Authorized Release Approach (Order 5400.5 – Radiation Protection of the Public and the Environment)
- Release with Potential Surface Radioactivity Only
 - DOE Order 5400.5
 - □ NRC Regulatory Guide 1.86 (1974)







Clearance Is a Process That Resembles the Controlled Release of Effluents

"Clearance – A regulatory process to certify the removal of solid materials from an existing regulated environment for the purpose of unrestricted release" (NCRP Report 141)

| Release Media | Release Mechanism | Existing Law | Pollutant Control | Dose Constraint (μSv/yr) |
|------------------|----------------------|--------------------------------------------|------------------------|-----------------------------|
| Solid Materials | Clearance | None (ongoing rule by NRC) | Material contamination | To be determined |
| Air | Effluent | Clean Air Act (40 CFR 61) | Air contamination | 100 |
| Water | Effluent | Safe Drinking Water Act (40 CFR 141) | Water contamination | 40 |

^{*}Dose levels are for maximally exposed individuals.



SCH305A

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Clearance Has A Specific Focus on the Release of Materials, Compared to Exemption

Clearance

- An <u>a posteriori</u> process to certify release <u>from within an</u> <u>existing</u> regulatory control (a narrow, specific focus)
 - ... which is different from Exemption
- An <u>a priori</u> process to <u>bypass</u> regulatory control (representing a broader context)

Examples of Exemption

- 10 CFR Part 30 for *byproduct materials* (such as timepieces containing H-3 or Pm-147, or smoke detectors containing Am-241)
- ☐ 10 CFR Part 40 for source materials (such as gas mantles containing thorium or glassware containing uranium)





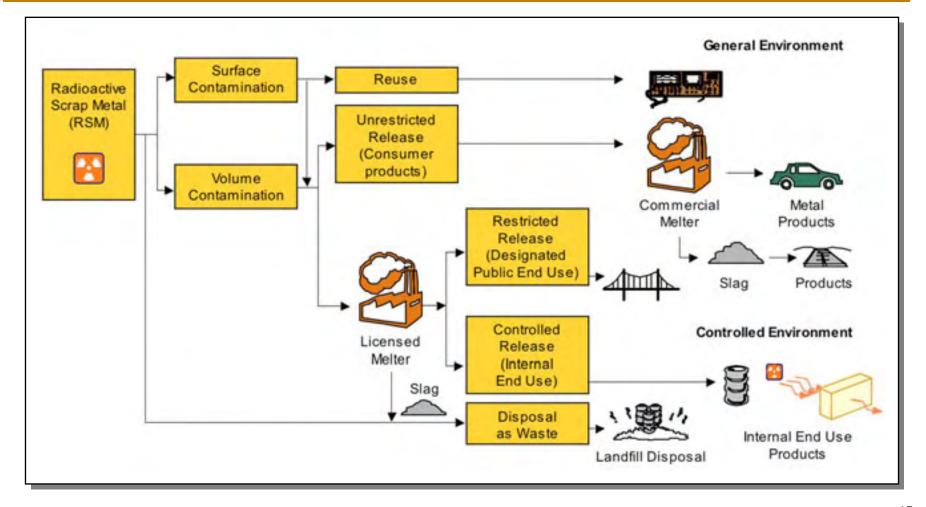
Stringent Criteria Are Needed for Setting Clearance Standards

- A few tens of μSv per year to an average member of the critical group would be an appropriate dose criterion for setting clearance standards (NCRP Report 141)
- An annual effective dose of 10 μSv is considered a
 - □ Negligible Individual Dose (IND) (NCRP Report 116)
 - ☐ Trivial dose (or <u>de minimis</u> dose level) (IAEA Safety Series No. 89)
 - □ Lowest level of dose constraint (ICRP Report 82)
- ☐ The IND corresponds to an estimated annual individual risk level of 5×10^{-7} latent cancer fatalities (NCRP Report 141)
- ☐ The IND is a dose level below which efforts to reduce radiation exposure to the individual are unwarranted (NCRP Report 141)





On the Basis of the Dose Criterion, Clearance Standards Are Developed by Assessing Impacts from Potential Scenarios







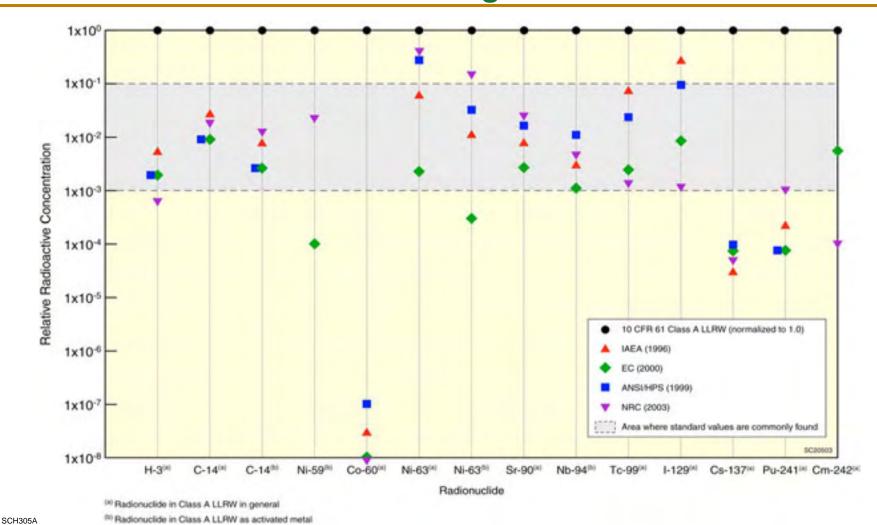
Considerable Efforts Have Been Devoted to Developing Clearance Standards

- Recent activities to develop clearance methods and standards have been conducted on the basis of 10 µSv/yr
 - □ European Commission (EC, Radiation Protection 122, Part II; 2000)
 - □ IAEA-TECDOC-855 (1996), Safety Guide (No. RS-G-1.7; 2004)
 - □ American National Standards Institute/Health Physics Society (ANSI/HPS N-13.12; 1999)
- ☐ The NRC also published a study to support its clearance rulemaking (NUREG-1640; 2003) without specifying a dose criterion





The Derived Clearance Levels Are on the Order of a Few Percentages of the Upper Concentration Levels in the Class A LLRW of 10 CFR 61 Regulations







Remaining Issues

- International Trade
 - Uniform and consistent policy and standards
- Residual Liability
 - Metal industry's concerns (metal purity, trade perception, defense against orphan source contamination)
 - □ Government-industry collaboration (e.g., Spanish Protocols)
- □ Risk Communication
 - □ Use of concept and terminology (e.g., definition of clearance, "contamination")
 - Public perception (fear of radiation and contamination)
- □ Relationship to Detection-Based Initiatives (e.g., steel mills, homeland security)





Harmonizing the Dose- (or Risk-Based) Clearance Approach with the Detection-Based Interception Approach

Sensitive Radiation Detectors Have Already Been Deployed by Metal Industries to Screen Out Radioactive Metals...



Truck passing through monitors





... How Does It Affect Clearance Implementation?

(Source: NCRP 2002)





The NCRP Report Concludes with Five Major Findings...

- □ The management and disposition of large amounts of potentially radioactive scrap metal generated in the U.S. will require a comprehensive and multifaceted approach
- National guidance on pollution prevention forms a sound basis for management of PRSM
- ☐ The current regulatory system focuses *only on waste management*
- ☐ Establishment of *consistent national/international policies* and *standards* is an urgent need
- ☐ Concerns of the *metal industry and the public* must be adequately addressed

Additionally, Implementation of the Management Policy Should Proceed with a Graded Approach



A Phased Approach in Order?

NCRP Report 141:

- "NCRP recommends that the development of internal recycling activities take precedence over clearance"
- "As part of the phased approach....proposed regulations may initially prohibit the recycling of PRSM into consumer products..."
- ☐ "It is also possible to designate metal products for more acceptable uses (such as underground sewage systems) where direct contact of PRSM...can be minimized or avoided"
- □ "Only if the regulatory system proves to be practical and safety is assured....would lessening of these restrictions (toward full institution of a clearance process) be considered"





A Path Forward...

- ☐ Interacting with regulators (i.e., NRC, EPA, DOE) to formulate an acceptable <u>risk-informed national policy</u>
- Meaningful engagement with stakeholders via a national dialogue:
 - Series of reports and recommendations from national organizations (NAS and NCRP) form an initial national consensus
 - Collaboration with metal industry (e.g., Spanish Protocols)
 - Coordination of international/national efforts
- ☐ Formulating a graded approach
 - Prioritize and promote internal recycling
 - Explore designated use of recycled metals to address public sensitivity





International standards related to the classification and deregulation of radioactive waste

Gordon Linsley
Consultant in Radiation and Waste Safety

Contents

- 1. IAEA Safety Standards
 - General aspects
 - Waste categorization
- 2. The development of international clearance recommendations
- 3. UN/ECE Metal Recycle Report
- 4. Review of European clearance practices

IAEA Safety Standards

The International Atomic Energy Agency (IAEA)

- International governmental forum for scientific and technical co-operation in the peaceful use of nuclear technology
- Established as an autonomous organization under the UN in 1957 following President Eisenhower's proposal in his "Atoms for Peace" speech in 1953
- 140 Member States
- Headquarters in Vienna, Austria
- Staff of more than 2000 professional and support staff

IAEA SAFETY FUNCTIONS

to facilitate and service international conventions and other undertakings

to establish international safety standards

to provide for the application of international standards

STANDARDS PREPARATION PROCESS



Some relevant IAEA Safety Standards

- International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, (1996)
- Classification of Radioactive Waste, Safety Series No.111-G-1.1, (1994)
- Application of the Concepts of Exclusion, Exemption and Clearance, Safety Standards Series, Safety Guide, RS-G-1.7 (2004)

IAEA Waste Classification

- 1970s-80s several earlier international schemes
- IAEA Safety Guide 111-G-1.1 (1994) was the first to be:
 - based on consideration of risk and suitability for disposal,
 and
 - quantitative
- It was related mainly to the needs of the nuclear industry

IAEA Waste Classification Scheme (1994)

- HLW geological disposal,
- LILW (long-lived) geological disposal,
- LILW (short-lived) near surface disposal
- Exempt waste no disposal needed (on radiological grounds)

• N.B. There is no international *low activity* radioactive waste category

Proposed revision

• An outcome of the International Symposium on Low Activity Radioactive Waste Disposal, December 2004, Cordoba, Spain:

A recommendation for the revision of the existing international classification scheme to include:

- very low level waste,
- U-mining and milling waste,
- NORM,
- disused sealed sources

A very low-level waste category

- Proposed by some countries in connection with decommissioning waste
- Motivation less costly disposal and, possibly, avoiding nuclear regulation
- VLLW repositories have fewer engineered barriers
- Intended for waste activity concentrations typically 10 or 100 x clearance levels

Development of international clearance recommendations

Defining the scope of Radiation Protection Regulations

General

It is necessary to define what radiation protection regulations apply to and what they do not

National Perspective

An established definition can facilitate the reuse and recycling of valuable materials and avoid costly regulated disposals

• International Perspective

Defining the scope of international regulations can facilitate trade and transboundary movement

An old problem

- In the early days simple, rule of thumb solutions
- In the UK Radioactive Substances Act (1960) radioactive material was defined as being any material with naturally occurring radionuclide concentrations of greater than 0.00001 μCi/g (0.4 Bq/g)
- Later extended to all radionuclides

But different "rule of thumb" judgements!

- IAEA Basic Safety Standards for Radiation Protection (1967 edition)(the BSS)
- 5.1.1.3 "If...doses of radiation incurred will be trivial, the competent authority should waive the requirements of ...for such operations and items as the following:
- (ii) operations which do not involve the use of radioactive substances at concentrations exceeding 0.002 µCi/g or ... solid natural radioactive substances at concentrations exceeding 0.01 µCi/g"

A proper technical basis

- As time went on, an improved technical basis for defining the boundary to regulations was sought
- This became possible when the ICRP established a linkage between dose and risk (ICRP Publication 26 (1977))

Towards international criteria for defining "de minimis"

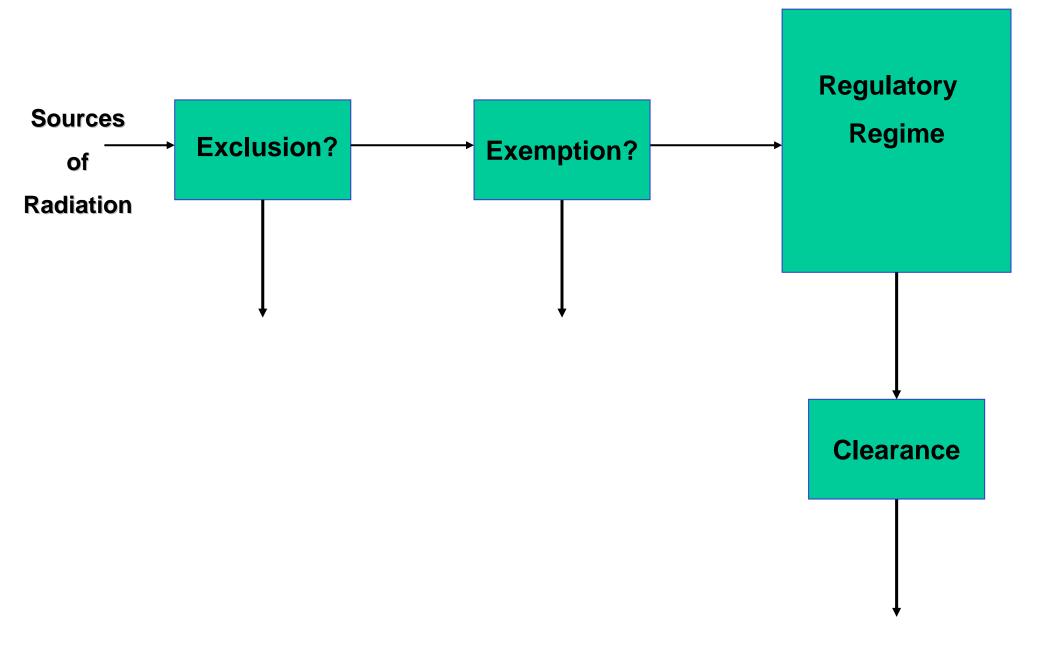
- In the early 1980s individual dose criteria in the range 1-10 mrem/y were proposed in international meetings as a basis for "de minimis" levels
- In 1988, in a series of meetings of high level international experts in radiological protection sponsored by IAEA and NEA, an important policy was agreed.

IAEA Safety Series No. 89 (1988)

- Basic radiological criteria for exemption of a source or practice:
 - trivial annual individual effective dose (1 mrem)
 - trivial collective dose (100 man.rem/year of practice)
 - inherently safe source

The international BSS (1996)

- Established a mechanism for defining the scope of regulations :
 - exclusion exposures not amenable to control
 - exemption control not necessary on basis of triviality (based on SS No. 89)
 - clearance release of material already within regulatory control (- same basis as exemption)
- establishes generic exemption levels
 - in terms of activity and activity concentration
- but leaves responsibility for establishing clearance levels to national authorities



Exclusion, Exemption and Clearance in the BSS

Exemption levels

- International Basic Safety Standards (BSS)
 - contains a table of exemption values total activity
 and activity concentrations but only for moderate
 amounts of the order of 1 tonne
- European Basic Safety Standards Directive
 - contains the same values

Clearance levels

- In the 1990s there was considerable interest from most countries in having internationally endorsed clearance levels
- Various IAEA publications were issued
- However, <u>none were endorsed</u> by relevant Safety Standards Committees there was no international consensus

Clearance discussions

- Types of clearance
 - Conditional clearance
 - for specific materials, e.g, steel, concrete,
 - for specific routes e.g., recycle, landfill disposal
 - Unrestricted clearance
 - no restrictions on materials or routes

International clearance levels

- They are "unrestricted" clearance levels
 - because any conditions applying to the clearance would be difficult to regulate beyond national boundaries

2001 IAEA General Conference Resolution on Commodities

- The General Conference requested the Secretariat "to develop.....radiological criteria for long-lived radionuclides in commodities, particularly foodstuffs and wood...."
- Seen as a new impetus to have levels which define the scope of regulations

Issue of Safety Guide in 2004

- Approved in 2004 by RASSC and WASSC and then by CSS after prolonged and difficult discussions
- Title: "Application of the Concepts of Exclusion, Exemption and Clearance" (IAEA, RS-G-1.7)
- The Safety Guide contains a table of levels, and is supported by a methodology document (Safety Report Series No.44)

New IAEA Safety Guide

- Some of the main points in committees' discussions:
 - Desire to retain the concepts of the BSS no new concepts
 - The idea of international levels defining the scope of regulations was generally accepted - provided that national regulators have the power to override
 - Difficulty in agreeing the values for naturally occurring nuclides
 - The values are close to those recommended for general clearance by EC with some exceptions

Safety Guide values

- Naturally occurring radionuclides
 - K- 40, 10 Bq/g, all others, 1 Bq/g
- Artificial radionuclides
 - nuclide specific, ranging from 0.1 to 10,000 Bq/g
- Examples:

```
Co-60, Cs-137, Am-241 – 0.1Bq/g
C-14, Sr-90, – 1Bq/g
Fe-55, P-32 – 1000Bq/g
```

Application of the values (i)

- Application extends to large amounts of material
- It is usually unnecessary to regulate below the values in the Safety Guide but Regulatory Bodies should retain the authority to investigate certain situations
 - Example: use of some building materials containing natural radionuclides

Application of the values (ii)

- Application to trade
 - In principle no need for further action when levels are below those of the Safety Guide
 - Confirmation of the levels should be determined at the first point of entry into trade
 - To avoid unnecessary hindrances to trade, States should co-ordinate their regulatory strategies

Application of the values (iii)

Graded approach

- When values exceed the levels in the Safety Guide, an approach <u>commensurate</u> with the associated risks should be applied
- For example, if exceeded by no more than about 10 times, the Regulatory Body may decide that the optimum regulatory option is still not to apply regulatory requirements

Application of the values (iv)

- Graded approach (continued)
 - Even when the Regulatory Body has decided that regulatory controls should be applied, a graded approach can still be applied,
 - for example, the BSS prescribes the progressively more demanding regulatory options of:
 - notification,
 - registration
 - licensing

Recommendation of IAEA 2004 Cordoba Symposium

- The Symposium welcomed the new Safety Guide as a step towards international coherence.
- However, it requested further guidance on its application and on methods for verification of compliance with the clearance levels.

UN/ECE report on recycling of metal scrap

UN Economic Commission for Europe

- One of 5 regional commissions of the UN
- Primary goal to encourage greater economic cooperation among its Member States
- It focuses on economic analysis, trade, industry and enterprise development, statistics etc.
- It has 55 Member States
- Over 70 international professional organizations and NGOs take part in UN/ECE activities

UNECE report on recycling of metal scrap

- UNECE held meetings of representatives of the steel industry, governments and international organizations on issues related to radioactively contaminated scrap (1999 – 2003)
- Main driver metal and scrap recycling industry concern over potential adverse effects on customer confidence and costs from contamination

Makes recommendations for improvement of the system

- Related to three main routes of radioactivity introduction into steel:
- A discrete radioactive sources
- B uncontrolled radioactively contaminated material
- C material with a very low level of radioactivity, released in accordance with a national regulatory framework

C – release in accordance with a regulatory framework

- Recognizes that there is no significant radiological hazard from properly regulated releases – but, there is a perception of hazard
- Seller should inform the customer of the regulatory framework under which the metal has been released – to allow prior informed approval

Review of European clearance practice



Review of the application of the clearance concept in Europe

• Sources:

- Recent international conferences and workshops
 - Berlin (IAEA), 2002, Rome (NEA), 2004, Cordoba (IAEA), 2004
- Review by European Commission (2003)

Clearance in Europe (1)

- Clearance or a similar regulatory mechanism exists in almost all countries
- The extent of its usage varies; influencing factors are:
 - (i) public opinion (negative)
 - (ii) national reuse/recycle policy (positive)
- Limited experience exists at the industrial scale
 - expected to change as decommissioning starts

Clearance in Europe (2)

- As yet, there is no uniformity in clearance application
 - Not yet a legal EU obligation
 - Various clearance levels are in use, covering a wide range of values – some historic, some conditional and some unrestricted
- Almost all values are mass activity few surface values
- The need for harmonization is recognized

European Summary Implementation of the clearance concept

| Country | 1 mrem/y Criteria | General Clearance Levels | Case by Case Clearance |
|-------------|-------------------|-----------------------------|---------------------------|
| Belgium | ✓ | ✓ | |
| Denmark | ✓ | | ✓ |
| Germany | ✓ | ✓ | |
| Greece | ✓ | | |
| Spain | ✓ | ✓ | ✓ |
| France | ✓ | | ✓ |
| Ireland | _ | | ✓ |
| Italy | ✓ | ✓ | ✓ |
| Luxembourg | ✓ | ✓ | |
| Netherlands | ✓ | ✓ | |
| Austria | ✓ | | |
| Portugal | _ | | |
| Finland | ✓ | ✓ | |
| Sweden | ✓ | ✓ | |
| UK | x | ✓ | ✓ |

Clearance in Europe (3)

- Experience of clearance and metal recycle
 - Austria, UK, Spain, Germany, Sweden,
 Greece, Finland, Italy, France, Denmark
- Problems with acceptance of cleared metals
 - Denmark, Spain, Italy, Luxembourg, Finland,
 UK
- Agreements between supplier and receiver required – Austria, Germany, Denmark

Germany

- Clearance policy
- Clearance provisions included in legislation of July 2001
- General clearance levels (nuclide specific)
 - Solids (activity concentrations and surface contamination values), liquids, building rubble, soil areas, buildings for reuse
- Specific clearance (conditional clearance)
 - Disposal, incineration, demolition, scrap metal recycle
- Prescribed methods for demonstrating compliance

France

- Clearance policy
- Legislation does not include general clearance levels
- Use of a "zoning" system at nuclear installations to identify materials for subsequent release or control backed up by measurement checks
- Disposal arrangements
- LLW repository and a VLLW repository

Spain

- Clearance policy
- Provision for clearance of materials from decommissioning is included in a Royal Decree of 1999
- Decommissioning of Vandellos 1 NPP is seen as an example of implementation of the policy
- 3 types of clearance unconditional, generic conditional (e.g. metal scrap and concrete debris recycling), and specific conditional (case by case)
- Prescribed methods for demonstrating compliance
- Disposal arrangements
- LLW repository and planned VLLW repository

United Kingdom

- Clearance policy
- Provision for exemption in legislation (the term clearance is not used)
- Retained historic levels generic level of 0.4 Bq/g (0.00001µCi/g) for solids after recent review
- Conditional exemptions (18 separate exemption orders)
- Disposal arrangements
- One LLW repository seeking additional capacity

Conclusions

- There is an increased international interest in low activity waste management prompted by decommissioning activities
- A new international waste categorization scheme is to be developed – to include previously neglected waste types
- At long last, a consensus has been reached on international clearance levels
- Further international guidance on the regulatory application of clearance and compliance with clearance levels is being developed



2005 Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP)

March 30-31, 2005

Arlington (Virginia), USA

The Spanish Protocol for radiological surveillance of metal recycling

Juan P. García Cadierno Consejo de Seguridad Nuclear (SPAIN)



Introduction

- The importance of the Spanish iron and steel industry
- The appearance of sources in scrap is increasing in the last years
- International initiatives: UE, IAEA, UNECE, BIR, ICO, Interpol
- Experience shows the needing for a national system
- The Spanish system includes legal, technical, training, etc. activities



Background

- Before 1998
 - There was general concern but no systematic action
 - Some steelyards had portal monitors
 - The CSN implemented information initiatives
- Acerinox event occurred in 1998
- After 1998
 - Recovery actions
 - Preventive actions: Implementation of a national system



Group of Expert work

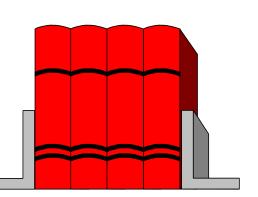


- Study of the international situation
 - Lack of international standards
 - EC and IAEA partial recommendations
 - The Italian case
- Participation in international initiatives
 - EC Groups of Experts
 - IAEA Conferences and Guidance drafting
- Developing of national regulation



Spanish regulations

- There were no specific standards
- Current regulation
 - Law 14/1999
 - New functions for the CSN
 - Possibility of financing through RWM Fund
 - Development of Law 14/1999
 - The Protocol as an intermediate step
 - The basis for regulation in the future
 - CSN Safety Guide 10.12. Radiological control in scrap recovery and recycling activities
- New EU Directive 2003/122/EURATOM:
 - Control of high activity sealed radioactive sources and orphan sources
 - Spain: good position from current regulations and protocol to endorse the Directive requirements





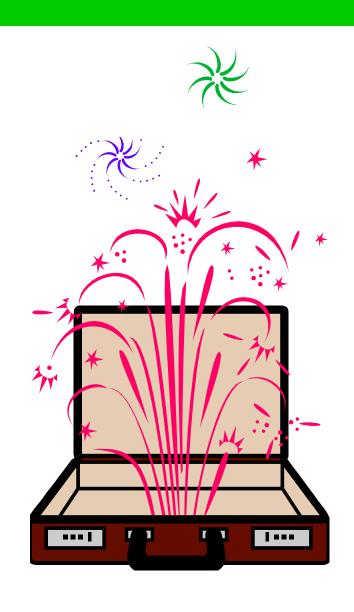
The Protocol for the national surveillance of scraps

- The Protocol is a voluntary commitment subscribed by the industry and the administration aimed at establishing a national system for the preservation of risks arising from the presence of radioactive materials in scraps and in the products resulting from its processing.
- The signing parties: Ministries of Industry, Tourism and Trade, CSN, ENRESA, Spanish Federation of Recovery Industries, Associations of Iron and Steel Companies, Trade Unions
- Promotion of signature: Associations of lead, copper and aluminium
- Periodic meetings:
 - Supervision of applications
 - Analysis of trends



The Technical Appendix content

- Objective
- Scope
- Definitions
- Register of subscribing companies
- Commitment by the parties
- Action in the event of detection
- Special actions
- Financing



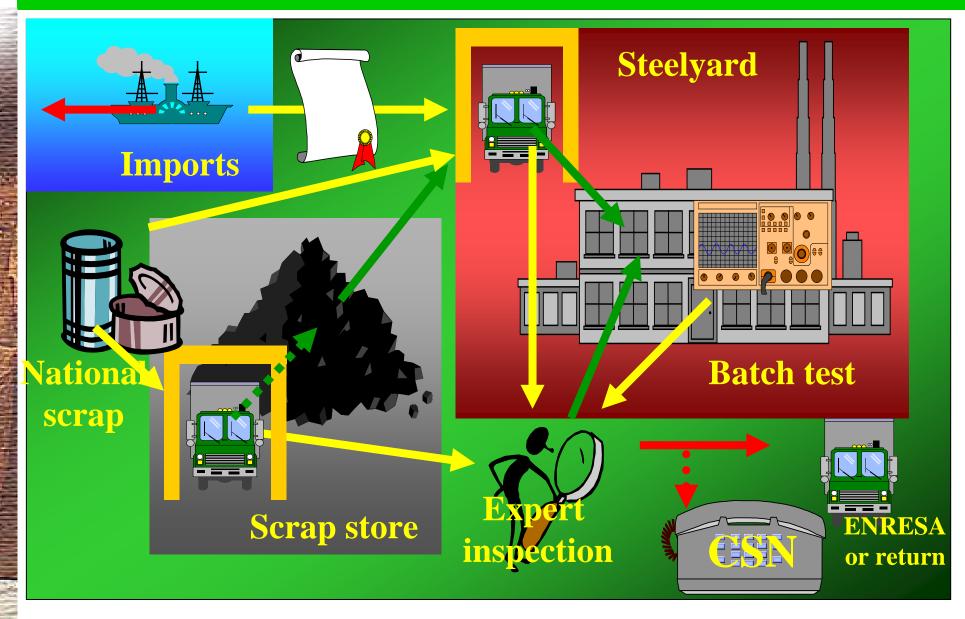


Implementation procedure

- Signature of the Protocol
- Creation of Protocol Register
- Metal recycling companies register its own facilities in the Protocol Register
- Registration is voluntary and free
- MIN inscribes facilities and inform to owner and CSN
- Commitments start automatically

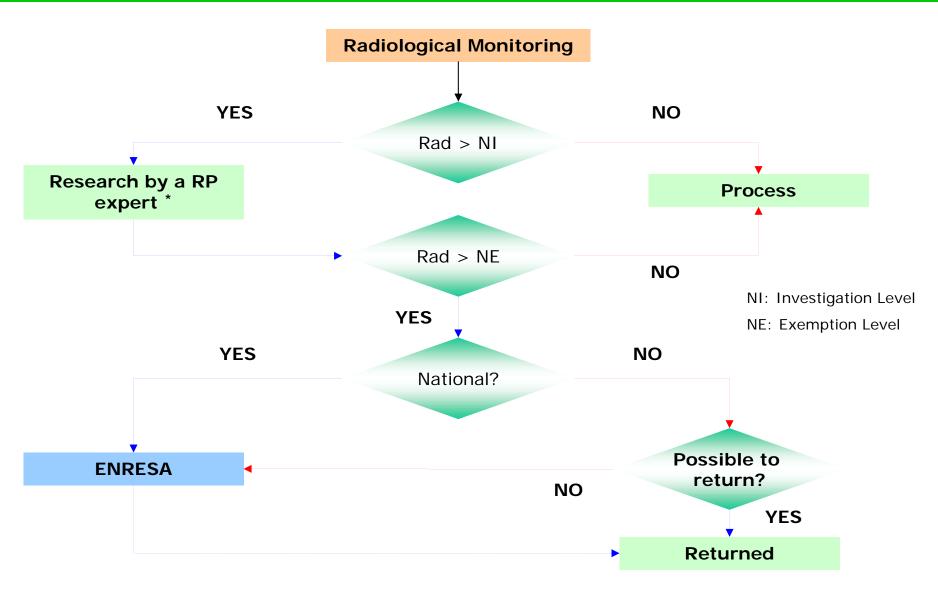


Actions





Process Diagram in the detection



(*) In the context of the Protocol, a RP expert is a person who has received training in Radiation Protection



Scale of levels in ¹³⁷Cs (Actions)

CONCENTRATION (Bq/g)

| 1000 | Significant radiological risk |
|------|-------------------------------|
| 100 | Required Radiation Protection |
| 10 | Regulatory Exemption Level |
| 1 | Protocol action level |
| 0.1 | Protocol investigation level |
| 0.01 | Normal values |

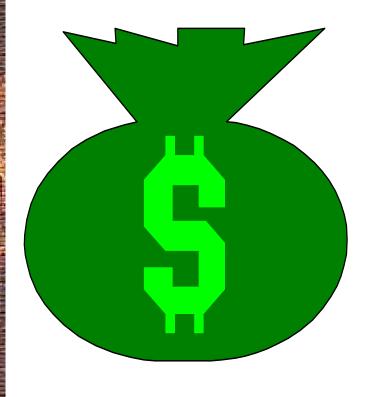


Special actions

- If generalised contamination is detected at the facility, CSN shall be informed immediately
- CSN will assess the information and inform to the Ministry
 - CSN monitors urgent actions: protection of workers and public
- Ministry will require the necessary recovery and waste management actions previous CSN proposal



Financing



- All costs will be charged to the subscribing companies
- They may pass them on to their suppliers
- The management of Spanish sources detected may be financed through application to the RWM Fund
- Specific taxes to finance CSN activities

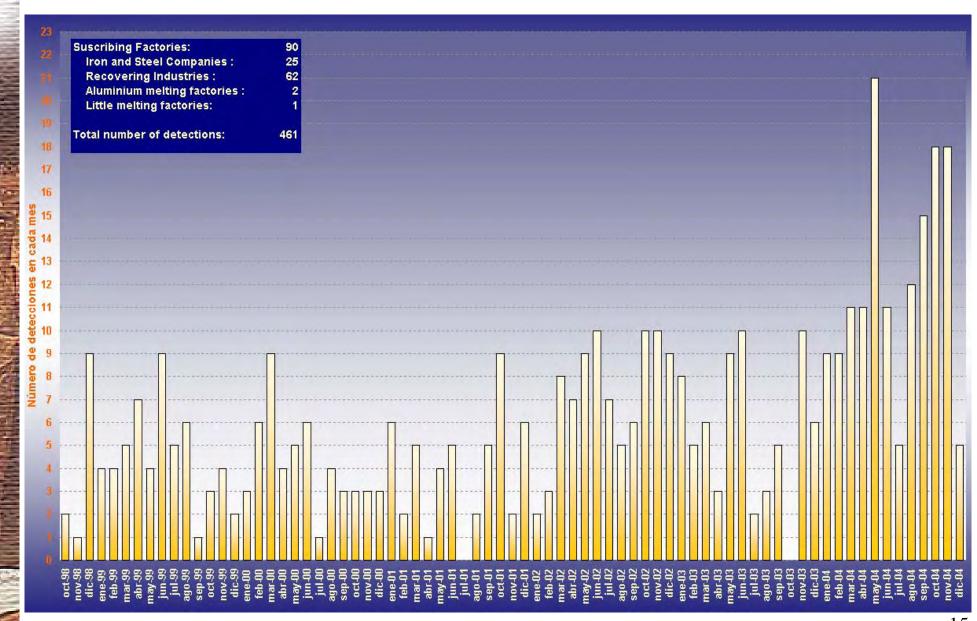


Training and information

- Information
 - Objective: To show the Protocol among workers of the metal recycling sector
 - Target: All recycling sector workers
- Radiation Protection basis
 - Objective: To familiarise with radiation risk and radiological protection basis
 - Target: Management, risk prevention, engineers, Trade Unions leaders of the recycling sector
- Radiation protection implementation
 - Objective: To train in the use of radiation detectors and radiation protection equipment
 - Target: Radiation Protection experts intervening under the Protocol provisions

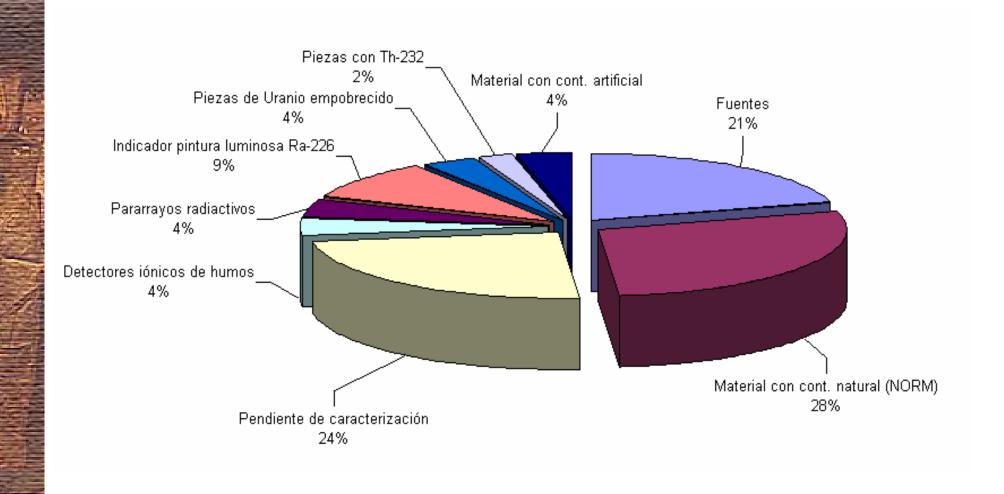


Implementation of the Protocol (1)





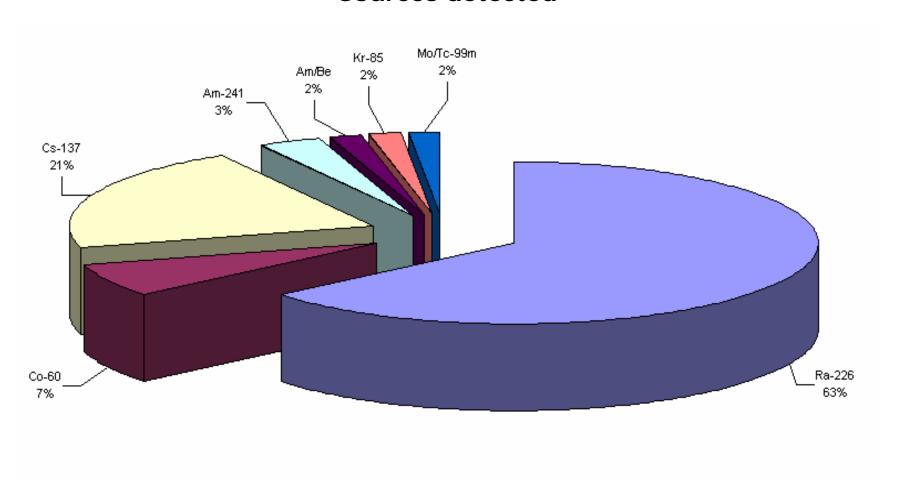
Implementation of the Protocol (2)





Implementation of the Protocol (3)

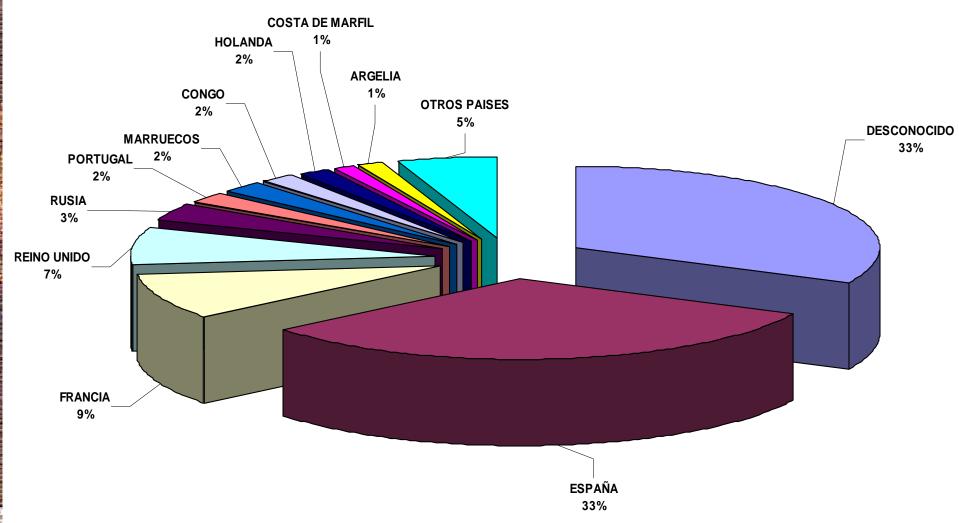
Sources detected





Implementation of the Protocol (4)

Detections by countries





ACERINOX Incident Consequences and Lessons Learned

CONSEQUENCES

- Three facilities were contaminated due to the melting of a source of Cs-137.
- One of them still has a radiological surveillance program (shallow and underground water measures with a frequency once per year).
- The radiological measurements to the workers showed 5 cases with a light contamination over 376. The most exposure worked received 8% of the annual dose limit established in the Radioprotection Act (1 mSv/year)
- The estimated source activity was 120 Ci.
- The main problems were the economic costs of the decontamination (about 26 mil. €) and the contaminated material was sent to the Low Level Waste Repository.

LEASSONS LEARNED

• The melting of radioactive source in steel facilities can be very expensive. Due to this, the Spanish protocol over the radiological surveillance in the scrap was made.



SIDERURGICA SEVILLANA Incident Consequences and Lessons Learned

CONSEQUENCES

- The radiological measurements made in the steel and slag show that these products were not contaminated by the source of Cs-137. (The only contaminated product was the dust)
- 135 tm of inert material was sent to an industrial disposal, and 283 tm was returned to the facility. (the material was a mix of radioactive inactive materials and industrial wastes)
- 553 tm of radioactive waste was generated in the decontamination activities. The total volume was 372 m³ and the estimated source activity was 2.7 Ci

LESSONS LEARNED

- The incident shows that a gamma detector sited in collector of the dust is very useful to alert in a prompt manner about the melting of a Cs-137 source of relative importance
- A bad performance of the radioactive results lead to the managers do not carry out the steps of the protocol in these cases (section 6.1).
- The delay to start corrective actions of the protocol (stop the facility, communicate immediately to CSN, to avoid the exit of products from the facility) lead to contaminate other facility.



DGR Incident Consequences and Lessons Learned

CONSEQUENCES

- About 100 m³ of iron scrap was contaminated by the fragmentation of a Cs-137 source.
- The estimated activity of the source was 210 mCi.
- This incident did not contaminate other facilities due to the products was passed through the portal detector. This step lets to stop the exit of the products if the results are well understood.

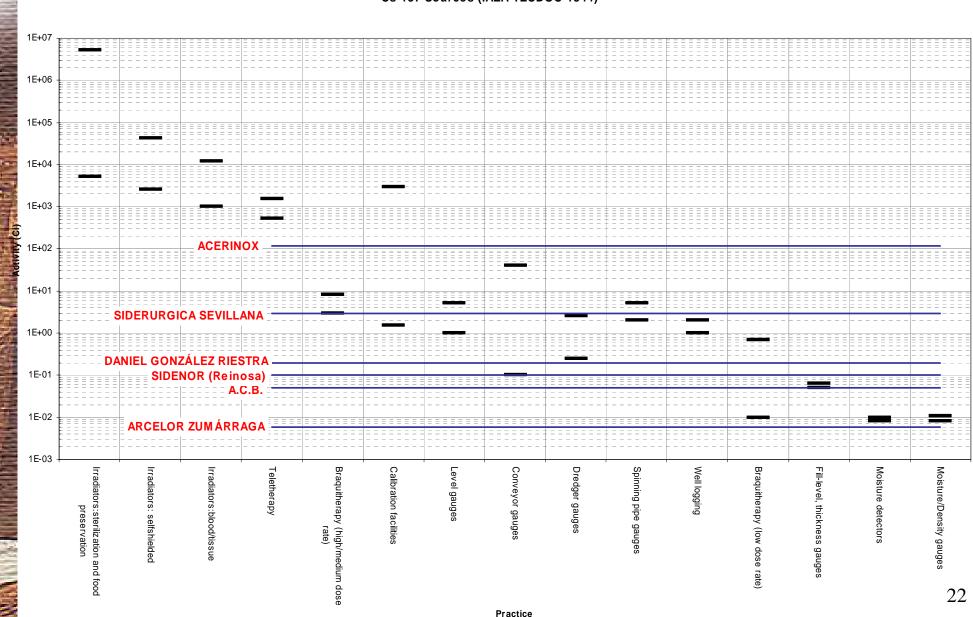
LEASONS LEARNED

- The people of the recycling industry must be made aware of what's happening in case of a break or fragment a radioactive source.
- Training on the steps to do in case of a detection in a recycling process of a radioactive source.
- The facilities dedicated to fragment the scrap must have portal detector at the entrance.
- The portal detectors must be operated by trained operators.



Categorization of Sources IAEA-TECDOC-1344

Cs-137 Sources (IAEA-TECDOC-1344)



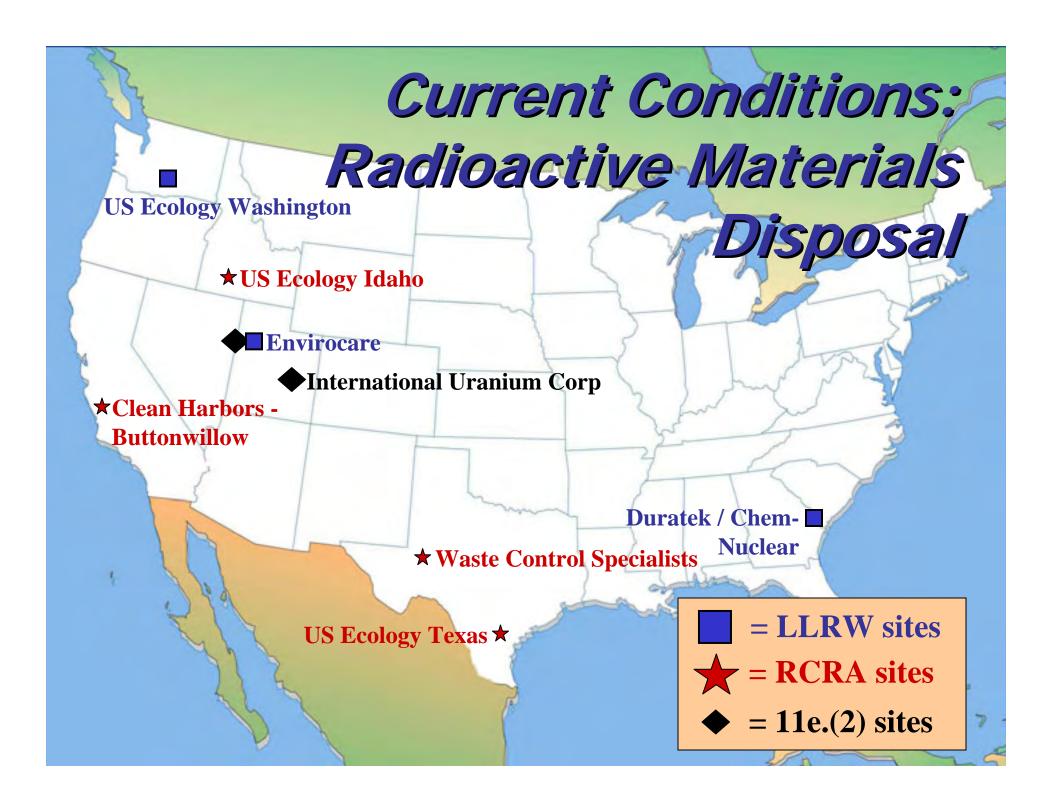
Current Radioactive Waste Disposal Industry Conditions & Trends

Stephen A. Romano, President and CEO



Background

- Low-Level Radioactive Waste Policy Act as Amended & interstate Compacts approved by Congress restrict free market conditions
- No new Compact disposal sites have yet resulted from Policy Act. Significant restrictions apply to two existing Compact disposal facilities
- The marketplace is providing new options not envisioned by the Policy Act



Full Service LLRW: Richland, WA (US Ecology)

- □ A, B & C Low-Level
 Radioactive Waste:
 Northwest & Rocky Mountain
 Compacts only
- Rate regulated: 2004 average cost \$111 / cubic foot
- □ Radium 226 sources (to 1.2 curies) & other high activity NORM waste: All 50 states



Full Service LLRW: Barnwell, SC (Chem-Nuclear)

- A, B & C LLRW and NORM waste nationwide
- High state fees greatly limit waste receipts
- State law closes site to out of region waste after 2008



Class A LLRW: Toelle, UT (Envirocare)

- Class A LLRW (including mixed) nationwide, except Northwest Compact
- Recent State law prohibits B&C waste
- Also accepts large volumes of US DOE waste

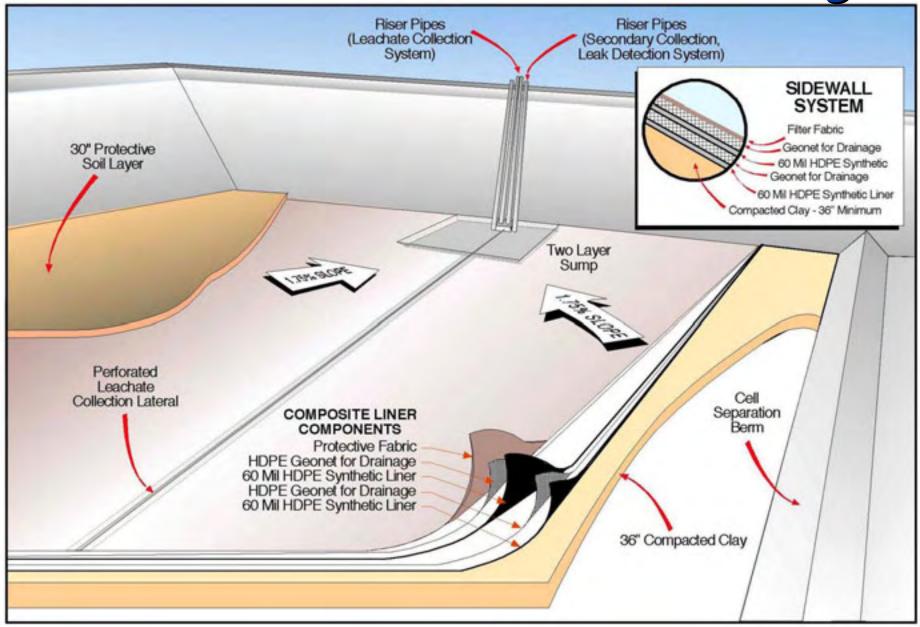


"Hybrid" RCRA Site: Grand View, ID (US Ecology)

- Unimportant quantities of source material
- NORM / TENORM <2000 pCi/g
- Accelerator produced (<= 3 year half life)
- Exempt devices & items, byproduct material



Idaho Hazardous Waste Cell Design



Other RCRA "Hybrid" Sites

Buttonwillow

★Clean Harbors -

Waste Control Specialists ★

US Ecology Texas ★

- Robstown, TX (US Ecology)
- Buttonwillow, CA (Clean Harbors)
- Andrews, TX (Waste Control Specialists):
 Applying for full service
 LLRW license projected to open @ 2008

11e.(2) Sites

- Toelle, UT (Envirocare
- Blanding, UT (International Uranium)
- Proposed: Andrews, TX (Waste Control Specialists)





Key National Issues

- Will Class B & C LLRW outside the Atlantic, Northwest & Rocky Mountain Compacts have home after 2008?
- Will Texas issue WCS a Class A, B & C license? Will non-Compact states gain access?
- Will use of RCRA disposal facilities & 11(e).2 mill tailings facilities expand?
- Will EPA and/or NRC issue rules facilitating or restricting RCRA and/or 11e.(2) option?
- Will Congress legislate additional options (e.g. USDOE sites) or alter Compact system?

National Council on Radiation Protection and Measurements (NCRP) 41st Annual Meeting "Managing the Disposition of Low-Activity Radioactive Materials"

Presented at
Crystal City Marriott,
Crystal City, VA

By

Ray Turner

March 30-31, 2005

Radioactive Materials Effects Scrap and Steel Industry

- More than 80 meltings worldwide
- Most recently in 2004 (USA and China)
 - Yes, it still happens!
- Deaths and Injuries are occurring
- Multi-million dollar decontamination efforts

Recycling Industry

- Notable Orphan Source Accidents Thailand, 2000:
- Disused Co-60 teletherapy unit not stored securely.
- Machine dismantled, source falls out when further disassembled at scrap recycling yard.
- 10 people severely exposed, 3 die.
- "Rogue source" suggested when physicians see patients with similar signs and symptoms at local hospital and notify authorities.

Recycling Industry

Brazil, 1987:

- Disused Cs-137 teletherapy source dismantled, source breached, causing exposures, contamination.
- 4 people died; 249 others exposed.
- Widespread contamination of portion of city; cleanup costly.
- Economic consequences for region.

Economic Consequences

- Goiania, Brazil, 1987: Treatment and care of the victims estimated at US\$ 750,000.
- > 125,000 individuals voluntarily monitored.
- > 8,000 residents certified "non-contaminated."
- Hotels refused registrations; airlines, buses refused travel; vehicles stoned, etc.

Yusko/Lubenau

Economic Consequences

- Agriculture value dropped 50%;
- Prices for textiles, finished products fell 40%, stayed depressed for over 1 month;
- Sales loss estimated as US\$ 7,000,000;
- Clean-up cost > US\$ 7,000,000;
 - (In an area where labor cost is very low)
- Housing prices fell; tourism dropped; etc.

Economic Consequences

Spain, 1998:

- Cs-137 source mixed with recycled metal not detected. Source melted in steel mill.
- "Radioactive cloud" drifts away from national monitors, floats over Mediterranean
- Detected in Italy, France, Switzerland, etc.
- "8000 x background" and "worst since Chernobyl" causes international crisis.

Yusko/Lubenau

Radioactive Materials Detections in the United States

- Thousands of sources have eluded detection at processing facilities, ending up at steel mills
- More than 40 meltings have occurred
- Average decontamination costs \$12 million+
- Loss of production, confidence, and business
- Thousands of tons of radioactive waste buried

Where does cesium go?

 "Conventional wisdom" says it all goes to the baghouse (boiling point far below iron melting temperature)."

Where does cesium go?

- Heat exchangers ~18%
- Plenums & dampers -14%
- Emission control systems (ducts) ~12%
- Evacuation duct 8%
- Baghouse walls ~5%
- Spark arrestor ~2%
- Filter bags ~42%

Zero Tolerance

- 100% of US mills/processors have adopted a zero tolerance policy. (Can you blame them?)
 - Industry should be able to purchase what they do/do not want. No incentive to melt radioactive materials. There is an abundance of "clean materials". The issue is not one of the DOE, NRC, Nuclear Industry or cleared materials "It is radioactive materials", "economics", and "radiophobia"

Detection Capabilities*

- Scrap Cover Efficiency
- (Inches)
- 10
- 12 to 16
- 18 to 22
- >22

Detection

(Percent)

100%

25%

12%

0%

Detection Capabilities

| Scrap C | over |
|---------------------------|------|
|---------------------------|------|

• (Inches)

7 to 13

• 14 to 16

• 17 to 19

• 20 to 22

Detection Efficiency (Percent)

100%

84%

69%

6%

Lamastra

Cleared Materials

 "It was calculated that if steel scrap with surface contamination levels meeting the release limits of 5400.5 or the NRC's Regulatory Guide 1.86, were present in concentrated masses of as little as 1 ton against the wall of a vehicle, it is likely the scrap would cause alarms in state-of-the-art scrap monitors presently in place at steel mills"*

United Nations Economic Commission for Europe – April 2004

- Sent questionnaire to all UN members
- Generated 55 responses from 48 countries
- Resulted in meeting at UN in Geneva, attended by delegates from 20 countries
- Resulted in publication of document entitled "Group of Experts on Monitoring of Radioactively Contaminated Scrap Metal"
 - United Nations Economic Commission for Europe (UNECE) report, April 2004

UNECE Questionnaire results

- 55 responses from 48 countries
- 38% have not adopted IAEA Code of Conduct
- 73% are currently releasing radioactive materials for recycling from nuclear facilities
- 27% do not monitor imports/exports
 - Of those that do additional problems from non-monitoring of motorized barges (up to 40% of some cargoes)
- 44% already have a regulatory requirement for monitoring imports and exports
- 52% have no reporting protocol for detections

UNECE Questionnaire results

- 17% of countries do NOT support polluter pays principle (disincentive to report)
- 13% had no protocol for transporting back across international boundaries
- 44% reported there is no recourse to return or reject shipments after unloading
- 58% do not notify scrap buyers that shipments contain "cleared" scrap from nuclear facilities
- 23% do not even investigate detection reports

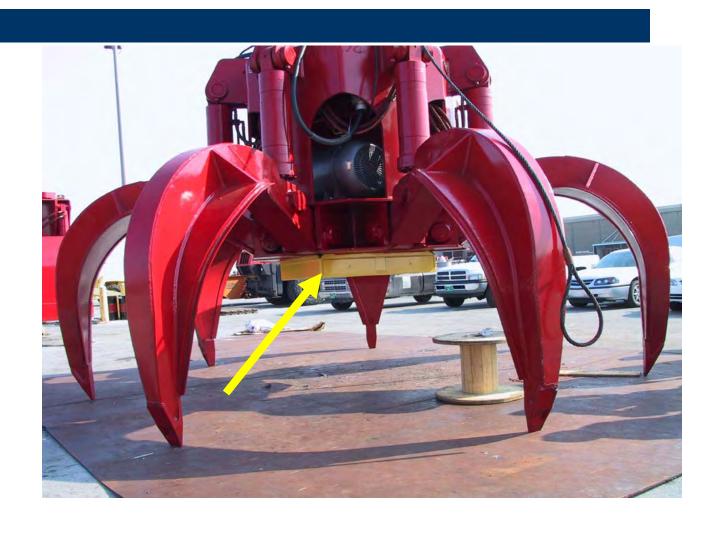
Port Monitoring Pilot Project (USEPA)

- Port of Charleston, SC
- Port of New Orleans
 - Port of North Carolina (was not part of the EPA pilot but purchased the same type systems)

EPA/Customs Port Monitoring Pilot Project

- Grapple monitors
- Very effective for those radioactive materials which would otherwise be shielded by dense scrap.
- Effective for vessels where no detectors were used
- Durable/rugged (more than 3.5 million tons unloaded)
- Easy to isolate found materials safely
- Unmanned

US EPA Port Monitoring Pilot Project



Solutions?

- Better, more capable detection systems
- Fewer false alarms
- Multiple locations
- Better training of employees
- Awareness, i.e. EPA demolition cd/rom

Conclusion:

- The problems continue. Risk is increased
- Need for harmonization of efforts
- Need for regulatory requirement for detectors at import and export facilities
- Need for better locating/reporting/tracking mechanisms
- Need better disposal options

Ray Turner
Radiation Safety Officer
The David J Joseph Company
River Metals Recycling



2005 Annual Meeting of the National Council on Radiation Protection Measurements
"Managing the Disposition of Low-Activity Radioactive Materials"

A Radioactive Metal Processing Industry Perspective

By: Al Johnson



Radioactive Metals Market Drivers

- Generators are motivated to save money and reduce liability.
- Regulators establish / enforce regulations to protect the public.
- Disposal Site Operators provide a competitive alternative to recycling.
- Metal Recycling Industry adamantly opposes introduction of radioactive materials into the scrap metal recycling feed streams and pressure regulators to restrict recycling options.
- General Public perceives anything associated as radioactive to be dangerous. Good intentions (public health) supplant good science (risk-based regulation).

Current Market Conditions

The U.S. Department of Energy and Commercial Nuclear Generators are producing more radioactive waste including metal and building rubble/debris.

- Decommissioning and remediation activities are leading the way
- Annual LLRW disposal volumes increased 200
 percent between 1999 and 2003, primarily due to
 LLRW shipped to commercial disposal by DOE (July
 2004 GAO-04-604 Report)

Current Market Outlook

 Why aren't we processing and recycling more metal from radioactive licensed facilities? Is it the lack of:

- Quantity? NO
- Technology? NO
- Capability? NO
- Tax Credits? No
- Regulatory Hurdles? YES
- Perceived Risks? YES
- Low Disposal Cost? YES!!!!!!!

Current U.S. Market Drivers

- Disposition is being driven by relatively low radioactive disposal costs and readily available disposal space.
 - Disposal at DOE facilities frequently provides the lowest cost option.
 - Envirocare has a very competitive price structure for lower-activity, contact-handled bulk LLW.
 - DOE's disposal prices at Envirocare are reported to be considerably favorable to those available to commercial waste generators.

Current U.S. Market Drivers

- Disposition of radioactive materials, including very low activity metals, is currently driven by relatively low radioactive disposal costs and <u>by readily available</u> <u>disposal space.</u>
 - At current LLRW disposal volumes, disposal availability appears adequate until at least mid-2008 for Class B and C wastes.
 - There are no expected shortfalls in disposal availability for Class A waste. (July 2004 GAO-04-604 Report)

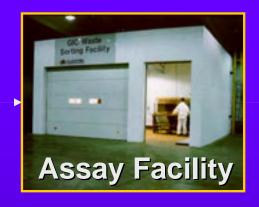
Licensed Radioactive Material Facilities



- ♦ Located in Oak Ridge, TN and regulated by the State of Tennessee
- Owned and operated by Duratek since 1997
- **♦ Largest U.S. commercial radwaste processor**
- Utilizes technologies for volume reduction and risk mitigation

Radioactive Metals Processing Options















Radioactive Metals Processing Options





 Surface contaminated metals can be decontaminated and/or surveyed for release (including recycling) if contamination is removed and verified by surveys.

Metal Processing Options



The Duratek "GARDIAN"
Truck Assay
System

Monitoring demolition debris at the Big Rock D&D Project.

 Volumetric assays of decommissioning rubble and metals can be performed on a large and cost-effective scale at the customer's work site.

Metal Processing Options (Continued)



 Contaminated metals can be recycled into useful radioactive products for use in radioactive material licensed activities and controlled programs.

Where Do the Shield Blocks Go?

 Among other facilities, shield blocks are sent to the Spallation Neutron Source (SNS) facility currently under construction in Oak Ridge, TN.



- Shield blocks become activated from exposure to neutron particles.
- Using radioactive recycled metals in shielding avoids generation of additional radioactive metals.

Contribution to DOE and Other Basics Physics Programs

Beneficial Reuse has provided nearly 60,000 tons of steel shielding to the DOE:

- SNS, FERMI, BNL, Thomas Jefferson National Accelerator Program, Los Alamos National Laboratory, TRIMUF and MIT
- Recycling provides cost savings to the DOE
- Estimated savings are as much as \$0.45 per pound or \$900 per ton
- Total savings for fabricated steel in support of DOE Physics Projects is approximately \$50 million

Advantages of a Licensed Radioactive Scrap Metal Manufacturing and Distribution Process

- Transfer and control of radioactive materials from licensee-to-licensee.
- Programs for the radiation protection of workers, environment, and the general public.
- Assurance that the recycled radioactive material is reliably directed to its authorized first use.
- Ability to manage secondary waste issues that are generated from the processing and concentration of radioactivity.

Economics of a Licensed Radioactive Scrap Metal Manufacturing and Distribution Process

- The feasibility of a melting facility dedicated to either full-time or as a portion of its process capability is debatable.
- The viability of such a radioactive melter is dependent upon product disposition. Options include:
 - 1. Production of ingots for subsequent remelting/casting/fabrication of unregulated (unrestricted use) items at unlicensed facilities, or
 - 2. Direct fabrication into products released for unregulated use
 - 3. Fabrication of items for controlled reuse (conditional use)
- ANSI N13.12-1999 provides specific activity guidance for the first two options, with materials at higher concentrations directed to option 3, the controlled reuse.

Economics of a Licensed Radioactive Scrap Metal Manufacturing and Distribution Process (Continued)

- A sufficient need for these products must be established first.
 - Public and scrap metal recycler will be in opposition to conditional reuse in the public sector.
 - Control and tracking of materials once in general public use (outside licensed programs) will be impractical.
 - Assuming a dose-based restriction on conditional reuse items, the time frame for custodial requirements will be dependent on the use of the materials (dose pathway) and the half-life of the contaminants.
- Military or other government entities may pose opportunities for such conditional reuse.

Economics of a Licensed Radioactive Scrap Metal Manufacturing and Distribution Process (Continued)

- Existing technical data supports partitioning of radionuclides in the melting process (NUREG 1400)
 - Final melt products have significantly reduced radioactive materials concentrations for many radionuclides (e.g., Cs, Ra, U, Pu, Am).
 - Change from surface contamination to volumetric distribution of remaining activity reduces dispersion potential.
 - Many contaminants are concentrated in slag and air pollution control equipment in forms that are easily stabilized for disposal.
- Melting can be an effective decontamination process.

Managing the Disposition of "Clean" Metals Generated by a Radioactive Facility or Process

- The <u>Proposed</u> disposition process involves the receipt of "potentially clean" materials at a licensed facility equipped as a centralized clearing house for:
 - receipt,
 - assay, and
 - disposition of materials that meet a set of pre-approved clearance limits (ex. ANSI N13.12)
- The Advantages to this type of approach would include:
 - A standardized method
 - An economy of scale
 - A more auditable and controlled process

Conclusions

- The use of a licensed steel mill for clearing scrap metal for recycling provides a specific example of a disposition process that has been successfully implemented over the past 10 years in the U.S.
- ◆ The feasibility of expanding the program to include a full fledge clearing house for metal recycling, including the destruction of certain classified metal shapes, should be evaluated along with the long term cost/benefit of the process.
- Recycling radioactive materials for beneficial and controlled reuse is driven by burial cost avoidance, natural resource management, and risk management.



OFFICE OF ENVIRONMENTAL MANAGEMENT



OFFICE OF LOGISTICS & WASTE DISPOSITION ENHANCEMENTS (EM-10)

Low Activity Radioactive Materials Management at the Department of Energy

Frank Marcinowski
Deputy Assistant Secretary for
Logistics and Waste Disposition Enhancements

March 30, 2005

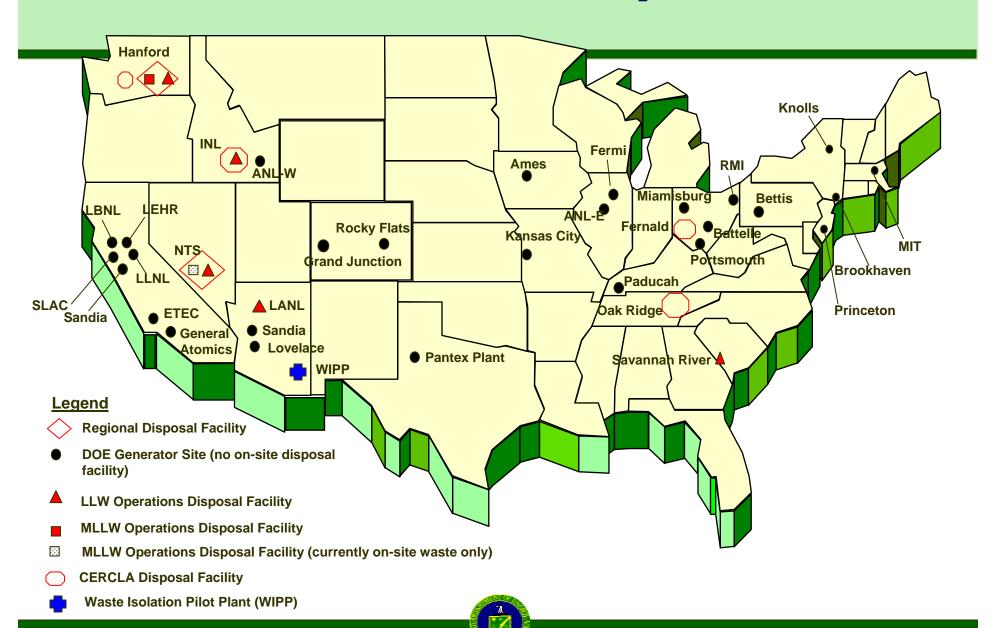


Outline

- > Overview of DOE-EM's Waste Management Efforts
- > DOE programs related to "low activity waste"



DOE's Waste Generator & Disposal Sites



Current DOE/EM Waste Management "Policy"

*** LLW and MLLW wastes:**

- > If practical, disposal on the site at which it is generated
- > If on-site disposal not available, at another DOE disposal facility
- > At commercial disposal facilities if compliant, cost effective, and in best interest of the Department
- ❖ Transuranic (TRU) waste:
 - > If defense, disposed at Waste Isolation Pilot Plant, New Mexico
 - > If non-defense, safe storage awaiting future disposition
- HLW and SNF
 - > Stabilization, if necessary, and safe storage until geologic disposal is available



Scope of EM Cleanup

- * Scope includes remediation and processing of approximately:
 - ❖ 25 tons of plutonium
 - ❖ 108 tons of plutonium residues
 - ❖ 88 million gallons of radioactive liquid waste
 - ❖ 2,500 tons of spent nuclear fuel
 - ❖ 137,000 cubic meters of transuranic waste
 - * 1.3 million cubic meters of low-level waste
 - * 324 nuclear facilities, 3,300 industrial facilities, hundreds of radiological facilities



Scope of the Problem

- DOE Environmental Management Program has shifted focus over the past 4 years to accelerating cleanup, reducing risk and closing sites
- Much of the waste generated by DOE is high volume but low activity
 - Contaminated Soil
 - Demolition debris
 - Scrap metal and Equipment
- High volume waste disposal can be costly if innovative solutions are not developed
 - Ties up resources that could otherwise be applied to risk reduction and cleanup



EM Program Progress

- **EM** transported and disposed of record volumes of waste and material supporting accelerated cleanup and risk reduction in FY 2004
 - > Over **212,000** cubic meters of LL/MLLW
 - > Over **7,000** cubic meters of TRU/TRUM
- * Rocky Flats closure is significantly ahead of schedule
- * Majority of sites' legacy LLW has been disposed



DOE efforts related to "low activity waste"

- Notice of Intent to Prepare a Programmatic Environmental Impact Statement on the disposition of scrap metals
- Draft DOE Guide: Control and Release of Property with Residual Radioactive Material



Programmatic Scrap Metal EIS

- January 2000: Secretary of Energy placed moratorium on unrestricted release of volumetrically contaminated material pending NRC decision on whether to establish national standards for clearance.
- January 2001: Secretary made decision to prepare an EIS
- Efforts initiated for internal reuse and recycling
- Moratorium still in effect
- DOE is monitoring progress of NRC rulemaking



Draft Guide: DOE G 441.1-XX

- "Control and Release of Property with Residual Radioactive Material"
- A Guide not a requirements document
- Can be used for waste and excess materials
- Comments closed and undergoing review



Draft Guide: DOE G 441.1-XX Approach

- Material may be released for disposal under derived authorized limits and measurement protocols for release by DOE field office managers without additional approval if:
- Applicable criteria for onsite or offsite landfills as appropriate are addressed;
- Based on a realistic, but reasonably conservative assessment of potential doses, releases from the material are demonstrated to not exceed 1 mrem per year or a collective dose of more than 10 person rem;
- A procedure is in place to maintain records of releases consistent with DOE Order 5400.5, and
- A copy of documentation is archived, and provided to the Office of Environment (EH-4) at least 40 days prior to the authorized limits becoming effective.



Draft Guide: DOE G 441.1-XX

- Draft Guide has been used by several sites
 - Brookhaven National Lab Peconic River Sediment
 - Battelle Columbus Lab D&D rubble



Summary

- Basis for optimizing waste disposal decisions
 - Health & Environmental Risk
 - Complete site cleanup and reduce active management of waste & excess materials
 - Cost
- Basis for releasing material from radiation control
- Address stakeholder and public concerns



Nuclear Energy Industry Experience with Safe Disposition of Radioactive Materials

Ralph Andersen, CHP Nuclear Energy Institute rla@nei.org



Disposition Options Under NRC Regulation (10 CFR 20)

- Transfer to authorized recipient
- Release in effluents
- Disposal at Part 61 land disposal facility
- Treatment or disposal by incineration
- Disposal of certain materials as though not radioactive
- Release into sanitary sewerage
- Decay in storage
- Retention as residual radioactivity in conjunction with license termination



Approval of Alternate Disposal Methods (10 CFR 20.2002)

"A licensee or applicant for a license may apply to the Commission for approval of proposed procedures, not otherwise authorized in the regulations, to dispose of licensed material..."



20.2002 Submittal Description of Waste

- Volume or mass
- Physical and chemical form
- Principal radionuclides
- Estimated concentrations and total activity
- Basis for estimating concentrations and activities



20.2002 Submittal Disposal Method

- Proposed method of disposal
- Location and description of disposal site
- Local land use characteristics
- Description of physical or administrative controls on use of the site at present and in the future



20.2002 Submittal Estimates of Dose

- Potential exposure pathways
 - Residing on site of disposal
 - Inhalation of re-suspended material
 - Exposure to inadvertent intruder
 - Ingestion of ground water
 - Ingestion of food grown on site
- Maximum dose to member of the public
- Maximum dose to non-occupationally exposed worker



20.2002 Submittal NRC Review Guidelines

- Proposed method should make it unlikely material will be recycled.
- No approval for "concentrated sources" that might pose a future hazard (e.g., when site released from regulatory control).
- Ensure doses are maintained ALARA and within Part 20 dose limits.
- Current practice: maximum estimated doses limited to a "few millirem."



20.2002 Submittal Approval Process

- NRR reviews and approves submittals from reactor licensees in non-Agreement States.
- NRR has the option of using the Federal Register and/or public meetings to gain additional input.
- The respective State agency reviews and approves submittals from reactor licensees in Agreement States.



Example #1

| Waste Type | Demolition debris |
|------------------------|--------------------------------------------------------------------------|
| | (predominantly concrete) |
| Disposal Method | Offsite landfill |
| Radionuclides | H ³ , Fe ⁵⁵ , Co ⁶⁰ , Cs ¹³⁷ |
| Concentrations (Bq/g) | 0.6 |
| Total Activity (Bq) | 10^{10} |
| Estimated Dose (mSv/y) | < 0.01 |

Example #2

| Waste Type | Scrap wood items |
|------------------------|----------------------------------------------------------------------------|
| Disposal Method | Offsite sanitary landfill |
| Radionuclides | Mn ⁵⁴ , Co ⁵⁸ , Co ⁶⁰ , Cs ¹³⁷ |
| Concentration (Bq/g) | 1.4 |
| Total Activity (Bq/y) | 3×10^4 |
| Estimated Dose (mSv/y) | 0.01 |



Example #3

| Waste Type | Sewage sludge |
|------------------------|---------------------------------------------------------|
| Disposal Method | Offsite sanitary landfill |
| Radionuclides | Mn ⁵⁴ , Co ⁶⁰ , Cs ¹³⁷ |
| Concentration (Bq/g) | 4 x 10 ⁻³ |
| Total Activity (Bq/y) | 4×10^5 |
| Estimated Dose (mSv/y) | < 0.01 |



Power Reactor Submittals (38) Summary

| Waste Types | Concrete, resins, roofing, sand, soil, sediment, sewage sludge, waste oil, wood |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Disposal Methods | Offsite landfills, sewage treatment plant, onsite fill, onsite incineration |
| Radionuclides | H ³ , Cr ⁵¹ , Mn ⁵⁴ , Co ⁵⁸ , Co ⁶⁰ , Zn ⁶⁵ , Cs ¹³⁴ , Cs ¹³⁷ |
| Concentrations (Bq/g) | $10^{-4} - 10^{0}$ |
| Total Activities (Bq) | $10^3 - 10^9$ |
| Estimated Doses (mSv/y) | 0.001 - 0.05 |

In Conclusion

- The 10 CFR 20.2002 experience base can be used to:
 - Facilitate a standardized approach to approval of alternate disposal options.
 - Inform NRC and EPA rulemaking on disposition options.
 - "Pilot test" new disposition options for possible future generic approval.



Low-Level Waste Management – An Analysis of Public-Interest NGO Positions

H. Keith Florig
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Presented at the annual meeting of the National Council on Radiation Protection and Measurements, 30-31 March 2005, Crystal City Marriott, Crystal City, VA.

Some public-interest non-govt. organizations (PINGOs) with positions on low-level waste

Environment – consumer – civic – peace - nuclear safety

- Inst. for Energy & Environ. Research
- Public Citizen
- Nuclear Information & Resource Service
- Sierra Club
- Greenpeace
- Natural Resources Defense Council
- Nuclear Energy Information Service
- League of Women Voters
- Union of Concerned Scientists

Importance of PINGOs in LLW policy

- PINGOs represent the interests and opinions of a significant fraction of the public, and are trusted by them
- PINGOs have a demonstrated ability to persuade political leaders
- PINGOs are staffed with smart and thoughtful people
- Failure to treat PINGOs as seriously and as equally as other stakeholders breeds anger, spite, and lose-lose outcomes

Representative PINGO positions on recycling & LLW facility siting

Recycling of slightly radioactive materials:

- "Just what part of 'NO!' does the NRC not understand? People just won't put up with more radioactivity in their homes and possessions"
 - Diane D'Arrigo, Nuclear Information & Resource Service

Siting of LLW facilities:

- "By working backward from the <u>impossibility of assuring safe</u> <u>permanent isolation</u> for the full period of nuclear waste toxicity to the cause of the problem (i.e., continued production of the waste), we'd have the opportunity to make the best reasonable. commonsensical case for <u>a national policy of curtailing</u>, with the intent of <u>ending</u>, the generation of most radioactive wastes."
- Judith Johnsrud, Sierra Club

PINGO Worldview 101:

Technical vs. Democratic Values

(Fiorino 1989; Plough & Krimsky 1987)

Caricatured values of radiation users & regulators

- Focus on natural science dimensions of issue
- Objectivity (if it can't be measured and modeled, it's not relevant)
- Meritocracy (in disputes, defer to technical status)
- Utilitarian ethics (what's good for the mean is good for all)

Caricatured values of PINGOs (and much of the public)

- "Acceptable risk" is part of larger issue of "acceptable morality"
- Natural science aspects are part of larger social, economic, ethical, and political picture.
- Fair process trumps technical rigor
- Pluralism (faith in collective wisdom, not experts)
- Experiential (trust history, not theory)
- Rawlsian ethics [can't sacrifice the welfare of a few (especially worst off) for the good of all]

General areas of PINGO differences with radiation-using community

- Ethical: Fairness of process and outcome
- Which alternatives are on and off the table
- Objectivity of regulatory authorities
- Technical: concerns in risk assessment

PINGOs: Ethical bases of prevailing radiation protection system is incomplete

- 1. Justification principle (benefit-cost)
- 2. Optimization/ALARA (cost-effectiveness)
- 3. Dose-limitation (acceptable individual risk)

Major deficiencies of three principles & their application

(Shrader-Frechette & Persson 2002)

- Who is empowered to establish principles?
- Who defines and measures benefits, acceptable risk, etc.?
- No criterion for the distribution of costs and benefits.
- No criterion for cumulative dose (differences in avoidance for first and last bit of marginal individual dose)
- Use of natural background as benchmark for acceptable risk

PINGO concerns regarding fair process

PINGOs want equal opportunity to

- Frame the question
- Post alternatives for consideration
- Obtain information about process itself (transparency)
- Prepare and introduce evidence
- Deliberate with public officials & other stakeholders

PINGO concerns regarding fair outcome

- Radiation users argue that population and individual dose of recycle and LLW disposal are justified by the societal benefits of the activities.
- PINGOs argue that those at risk are not those who benefit.
- For recycling, PINGOs reject shift of liability burden from radiation using industries to metals processing industries

PINGO attitude toward a particular risk is shaped by the <u>legitimacy</u> of the activity that produced it

Nuclear power/weapons operations should be regulated more tightly than other uses of radiation because

- the decisions that produced the current reactor fleet/weapons stocks were not participatory
- NRC/DoE have never produced analyses concluding that nuclear power/weapons are justified in the sense of providing more societal benefits than costs, relative to alternatives.

PINGOs believe risk assessment is a house of cards

- Screening systems for recycle are leaky (e.g., hot fleas), even when operated according to regulations
- Recyclers have an economic incentive to skirt screening regulations, unless regulatory enforcement makes it unprofitable to do so.
- Vigilance fades, "conditional reuse" is unenforceable.
- Integrity of disposal sites cannot be assumed beyond institutional lifetimes of risk management authorities (~100 years)
- Burden of proof on dose-response at low doses should be on industry, not on the public.

"Acceptable" risk from recycling

Doses from <u>background radiation</u> and past doses from man-made radiation are <u>irrelevant</u> to deciding threshold of acceptability for doses from recycling of radioactive solid materials.

Analogy: Lightning exposes everyone to 100-120 dB thunder many times per year. Therefore, it is acceptable for air-horn manufacturers to occasionally test their products in the open in residential neighborhoods, even at night.

PINGOs believe NRC is captured by nuclear industry & untrustworthy

"(NRC's) job is to prevent exposures to the public and the environment, not to convince us that it's a trivial amount."

Wenonah Hauter, Public Citizen

"... the issue here is the intelligent public's increasingly well-informed understanding that governmental and contractor institutions that now purport to protect them from radiation risk have hitherto unjustifiably withheld information, lied, and demonstrated a startling incapacity to technically abide by public protection standards."

- Dan Guttman, Johns Hopkins Univ.

Both quotes from 2001 statements to the National Research Council Committee on Alternatives for Controlling the Release of Solid Materials from NRC-Licensed Facilities

PINGOs believe radiation users are out of touch with public preferences and frames

"It's hard to imagine a nuclear enterprise more tone deaf to public concerns or a more cockamamie scheme than taking radioactive waste and disposing of it in consumer products,"

- Dan Hirsch, Committee to Bridge the Gap.

"(Scientists) fail to see that a definitive element of public judgment (concerns) the claims made by scientific experts about the intellectual power of scientific risk knowledge and its sovereignty over the larger issue of consequences..."

(Wynne 2001)

PINGOs want serious discussion of broader range of alternatives

- Work toward stopping production of most radioactive waste.
- Community monitoring of air, water, soil
- Conduct research on better isolation of all radioactive materials
- Short half-life (<100 yrs) stored on-site
- No recycle or reuse

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Policy Development from the Industry Perspective

- Discussion of major issues facing industry for implementation of low activity waste disposition options
- Case studies of how specific waste streams are impacted by these issues



Public and political concern, reaction, and opposition

- Strong public reaction due to radiophobia
 - Opposition to any regulatory solution
 - Concern over use of any products from recycle
 - Opposition to specific disposal options
- Public opposition may lead to political obstacles
- Must be countered by factual and independent information on the potential health and safety risks and economic benefits
 - Comprehensive study by creditable entity that evaluates all health and safety risks (including non-radiological) and economic benefits from a life cycle standpoint



Regulatory and jurisdictional issues

- Current infrastructure of multiple and conflicting government agency jurisdiction, regulation, and policy
 - USDOT exempt levels
 - Pre 78 11(e)(2) regulated different than other mill tailings
 - No national consistent NORM standards
 - LLRW Compact jurisdiction
 - NRC and EPA agreement state jurisdictional issues
- Maintaining current system while transitioning to new national standards



Material control and release issues

- For the generating facility there are issues relating to the control, release, shipping, and transfer of materials
- For the receiving facility there are worker exposure, monitoring, design, long term care, and liability issues



Waste stream specific issues

Contaminated metals

- Public concern regarding recycle of materials
- Currently released under RG 1.86 limits
- Bulk verses surface contamination limits
- Release by generator verses centralized or disposition facility
- Concerns of recycle industry verses generators
- Disposal facility issues
 - Pubic concern
 - Long term care and liability
 - Worker exposure at unlicensed facilities



Low activity legacy and D&D waste

- Currently NRC case by case exemption and uranium mill feed stock
- Generator waste characterization and release
- Need to address additional waste stream like SMN
- May need to be shipped as USDOT non-exempt
- National release limits verses case by case based on risk level of receiving facility
- Disposal facility issues
 - Pubic concern
 - Regulatory authority (USEPA verses authorized state)
 - Long term care and liability
 - Worker exposure at unlicensed facilities





- Currently site specific limits not based on risk
- Inconsistent state verses national standards
- Oil and gas NORM compared to other NORM
- Higher toxicity of NORM radionuclides compared to others
- Generator waste characterization and release
- May need to be shipped as USDOT non-exempt
- Disposal facility issues
 - Pubic concern
 - Long term care and liability
 - Worker exposure at unlicensed facilities
 - USDOE take title issues inhibit use of mill tailing disposal sites



Summary

- Many difficult issue facing industry
- Conflicts between interests of various industry groups make a consensus difficult
- Only viable option agreeable to most industry stakeholders may be land disposal in acceptable facilities, which may be limited to RCRA subtitle C or mill tailings disposal facilities that have a license to deal with the transfer, acceptance, worker exposure, and release issues.

J.B. Little James Stevens Professor of Radiobiology Director, John B. Little Center for Radiation Sciences & Environmental Health

Doctoral Students: 26

Advisor: 19

Post Doctoral Fellows: 56

Students/ Fellows

Currently Members of

Radiation Research

Society; 30

Students/Fellows Currently

Members of NCRP Council

Sally Amundson

Andy Grosovsky

Howard Liber

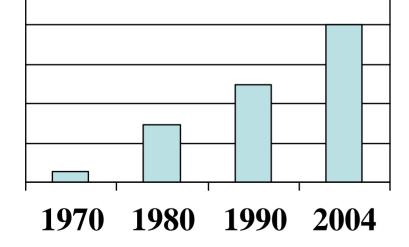
Ann Kennedy

Amy Kronenberg

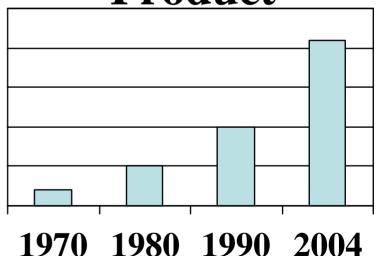
J. B. Little

United States

Cumulative Number Of Publications



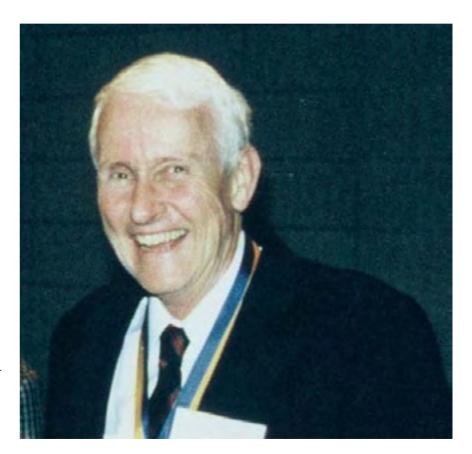
Gross National Product



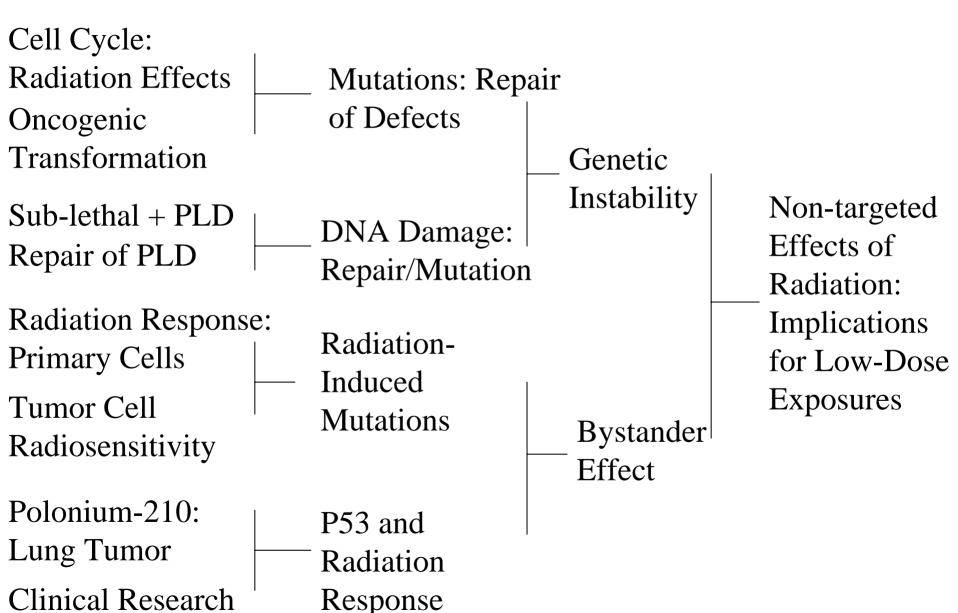
J. B. Little Awards

- Outstanding Investigator: NCI
- Failla Award
- Kaplan Distinguished Scientist Award
- National Associate Member: National Academy of Sciences

The Annual Symposia of the John B. Little Center for Radiation Sciences and Environmental Health



Radiobiology Championship



Nontargeted Effects of Radiation: Implications for Low-Dose Exposures

John B. Little
Center for Radiation Sciences
and Environmental Health
Harvard School of Public Health

TRADITIONAL THINKING

Biological effects of radiation occur in irradiated cells as a consequence of the DNA damage they incur.

IMPLICATIONS

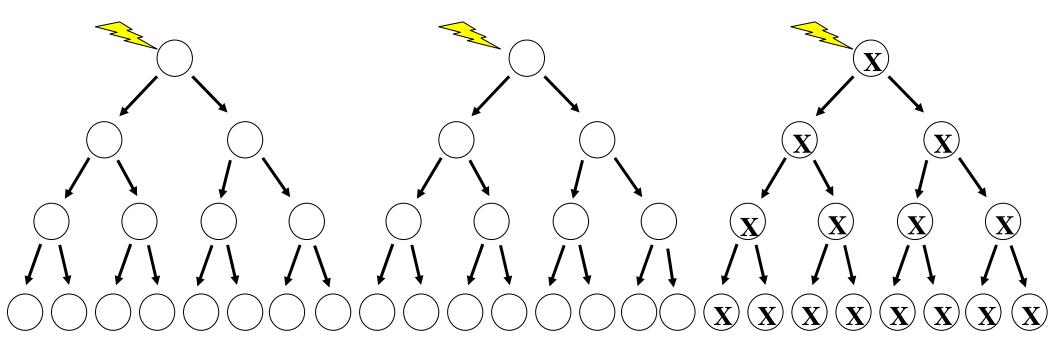
- Biological effects occur in irradiated cells.
- Radiation traversal through the nucleus of the cell is a prerequisite to produce a biological response.
- DNA is the target molecule in the cell.

EVIDENCE FOR NON-DNA TARGETED EFFECTS OF RADIATION

- Radiation-induced genomic instability.
- Bystander effects.
- Genetic effects produced by cytoplasmic irradiation.

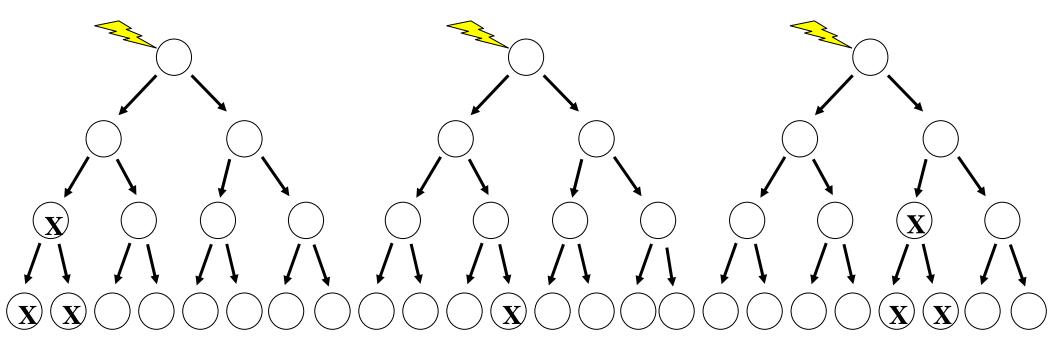
RADIATION-INDUCED GENOMIC INSTABILITY

 Biological effects, including elevated frequencies of mutations and chromosomal aberrations, arise in the descendants of irradiated cells.



DIRECT RADIATION INDUCED MUTATIONS

low frequency event



RADIATION INDUCED GENOMIC INSTABILITY mutations arise in the descendents of irradiated cells

- high frequency event
- saturates at low doses

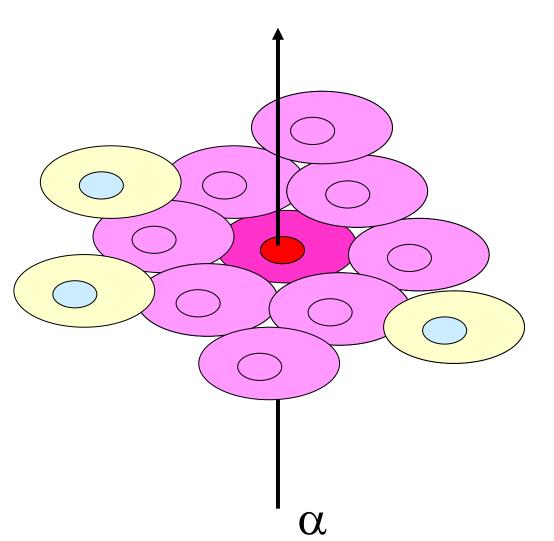
RADIATION-INDUCED GENOMIC INSTABILITY

- Biological effects, mutations and chromosomal aberrations, may arise in the distant progeny of irradiated cells.
- Induction of such instability is a high frequency event. Saturates at low doses.
- The induced mutations are different from those arising in directly irradiated cells.

BYSTANDER EFFECT

 In a mixed population of irradiated and nonirradiated cells, biological effects may arise in those cells that receive no radiation exposure ("bystander cells")

Radiation-Induced Bystander Effect in Cell Cultures Irradiated by Very Low Fluences of α -Particles

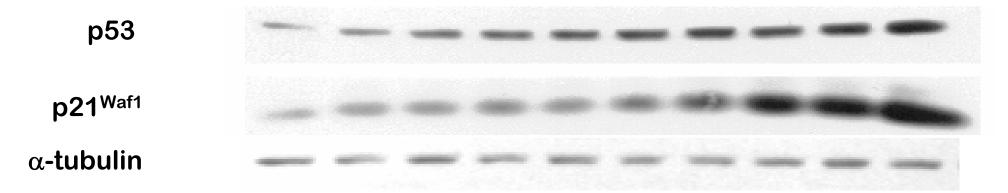


Sister Chromatid exchanges
Gene Expression
Mutations
Chromosomal Aberrations
Cell killing

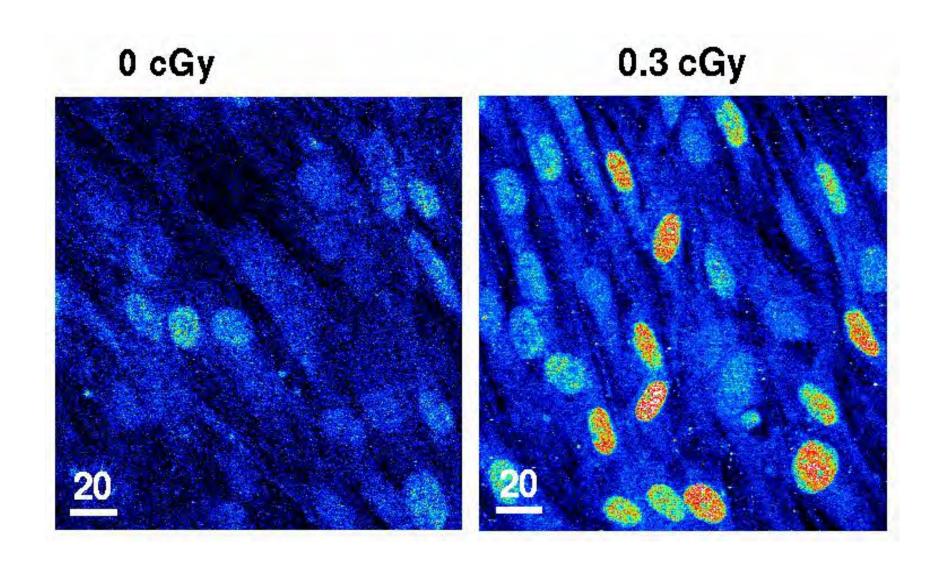
p53 and p21 Waf1 expression levels in α -Irradiated normal human fibroblast cultures (AG1522)







In situ Immunofluorescence detection of p21^{WAF1} expression in alpha-irradiated human 1522 Cells



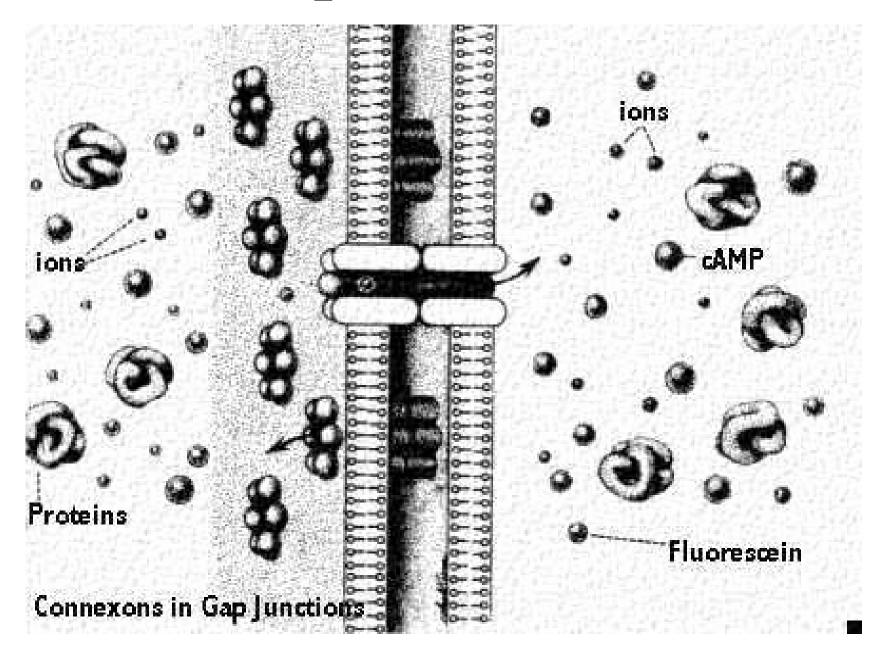
BYSTANDER EFFECT

 How are damage signals transmitted from irradiated to nonirradiated cells?

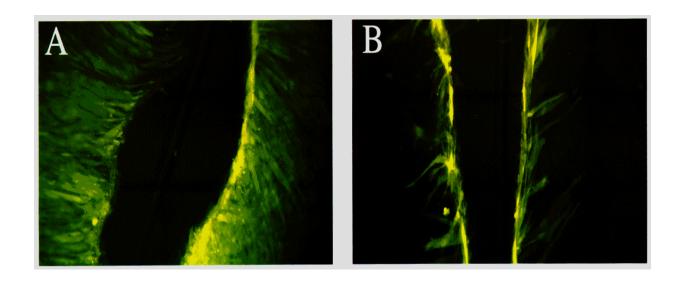
DIRECT CELL TO CELL COMMUNICATION

- The role of Connexin43 mediated
 Gap-Junction intercellular communication
- For intercellular communication, the "gap junction" is one of the most widespread mechanisms, being found in most animal tissues and perhaps all animal species.

Gap Junction



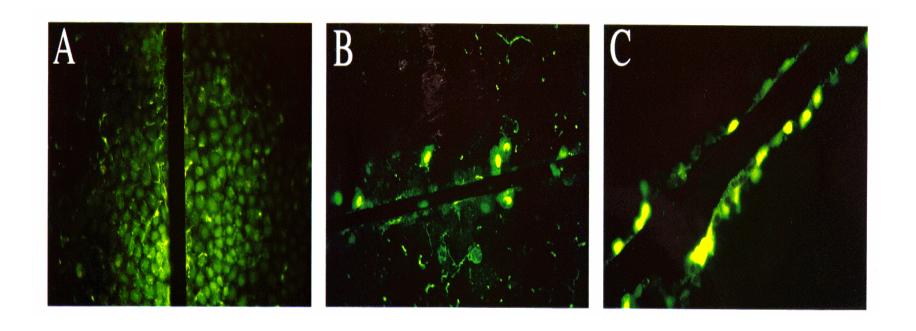
Effect of an inhibitor of gap junction communication (Lindane) on transfer of the fluorescent dye Lucifer yellow through gap-junctions



Control human fibroblasts

Lindane-treated

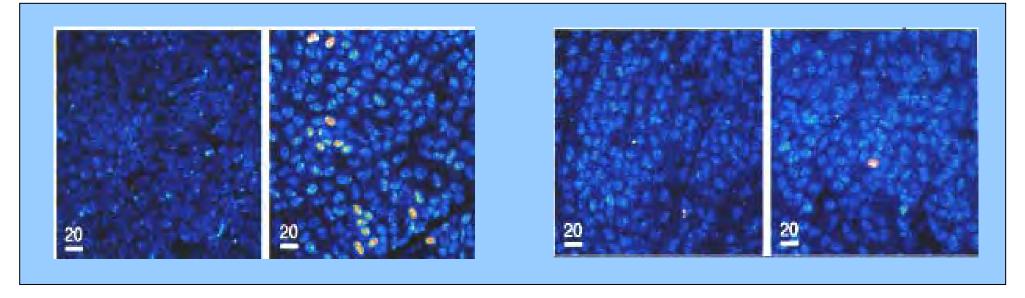
Dye Transfer in isogenic gap junction communication competent and deficient cells



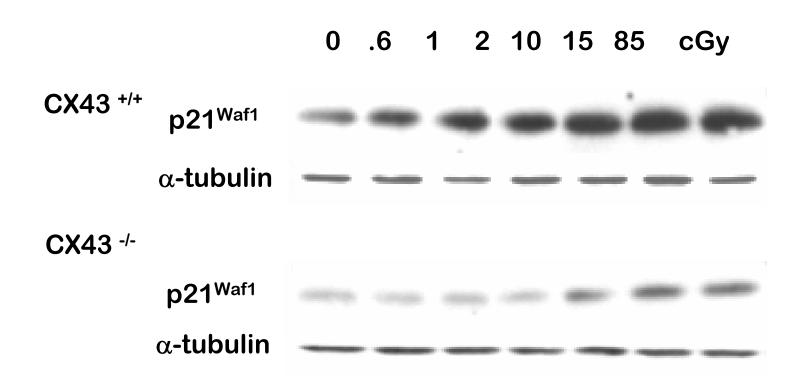
- (A) Transfer of Lucifer yellow dye through gap-junctions in control cells
- (B) Inhibition of its transfer by Lindane.
- (C) Inability to transfer Lucifer yellow to adjacent cells in gap-junction deficient cells.

p21^{WAF1} expression in gap junction communication competent or deficient cells

competent cells 0 cGy 0.3 cGy deficient cells 0 cGy 0.3cGy



P21^{Waf1} expression in normal and CX43⁻/- mouse knock-out cells exposed to α -particles



Gene Expression by cDNA Microarray Analyses In α -particle Irradiated AG1522 Human Fibroblasts

1 cGy

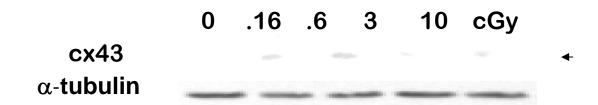
Connexin-43

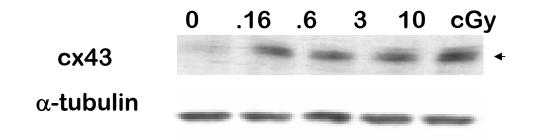
Regulation of Gene Expression in Bystander Cells

| • | <u>GenBank</u> | Gene | Fold |
|---|----------------|--------------------------|-------------|
| • | <u>Symbol</u> | | |
| • | HSCGJP | Connexin43 | 5 |
| • | D79205 | Ribosomal protein L394.5 | |
| • | HUMPRP | Prion protein | 3.1 |
| • | HSU09953 | Ribosomal protein L9 | 3.1 |
| • | D49817 | Phosphofructokinase | 2.9 |
| • | HSVPAM92 | Proton ATPase subunit | 2.8 |
| • | HSRPL31 | Ribosomal protein L312.6 | |
| • | HSL21PROT | Ribosomal protein L212.6 | |
| • | HUMTHYB4 | Thymosin beta-4 | 2.6 |
| • | S45630 | Alpha B-crystallin | 2.5 |
| • | HSU14968 | Ribosomal protein L27a | 2.4 |
| • | HSRPRNA | Ribosomal protein | 2.4 |
| • | HSU54778 | 14-3-3-epsilon | 2.4 |

CONNEXIN43 is up-regulated in α -Particle-irradiated Cells

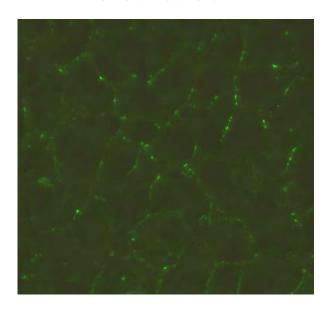




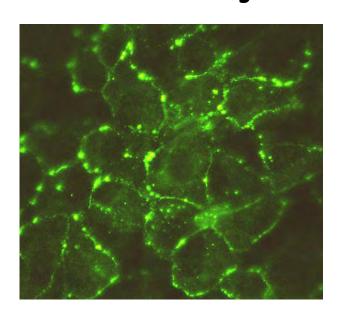


Ionizing radiation upregulates expression of Connexin43

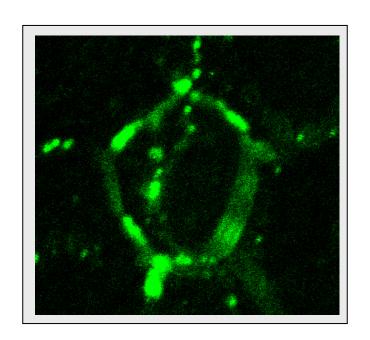
Control



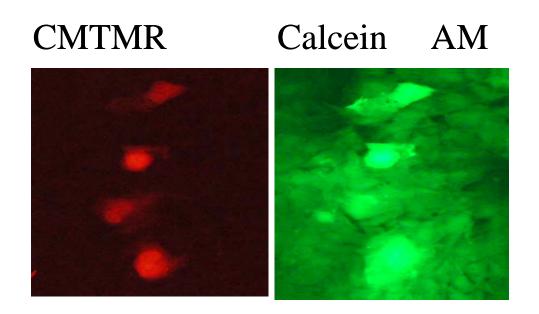
Gamma-rays



Induced Connexin43 localizes in specific membrane regions



Functional Gap-Junction Communication Between Irradiated and non-Irradiated Human Fibroblasts



CONCLUSIONS

- In cultures in which cells are in contact, radiation damage signals are transmitted to nearby cells through gap junctions.
- Irradiation itself enhances intercellular communication
- Implies that individual irradiated cells cannot be considered as isolated functional units in most tissues.

OXIDATIVE STRESS IS ENHANCED IN BYSTANDER CELLS

At what cellular level does the oxidative metabolic environment signal the induction of bystander effects?

- Irradiated cell?
- Bystander cell?

– Is the molecule signaling the bystander effect a byproduct of oxidative metabolism?

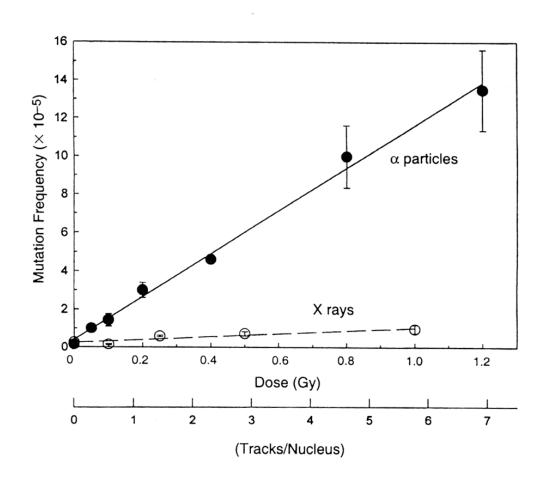
GENETIC EFFECTS IN BYSTANDER CELLS

Sister chromatid exchanges.

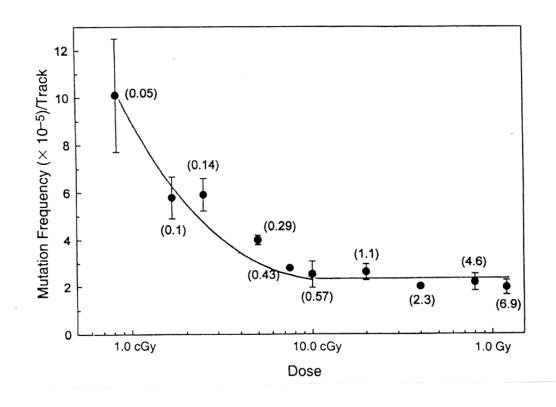
Gene mutations.

Chromosomal aberrations.

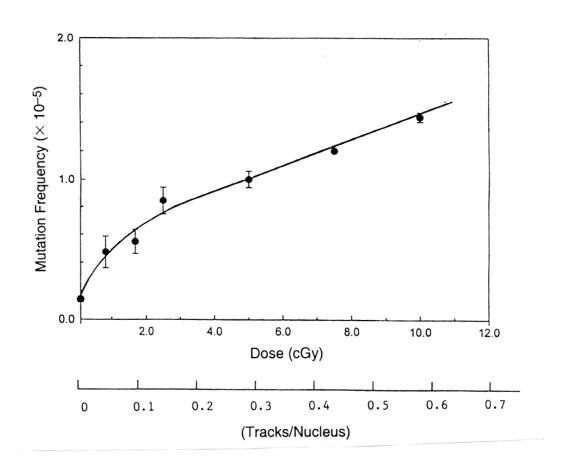
α-particle induced *HPRT* mutations (high doses)



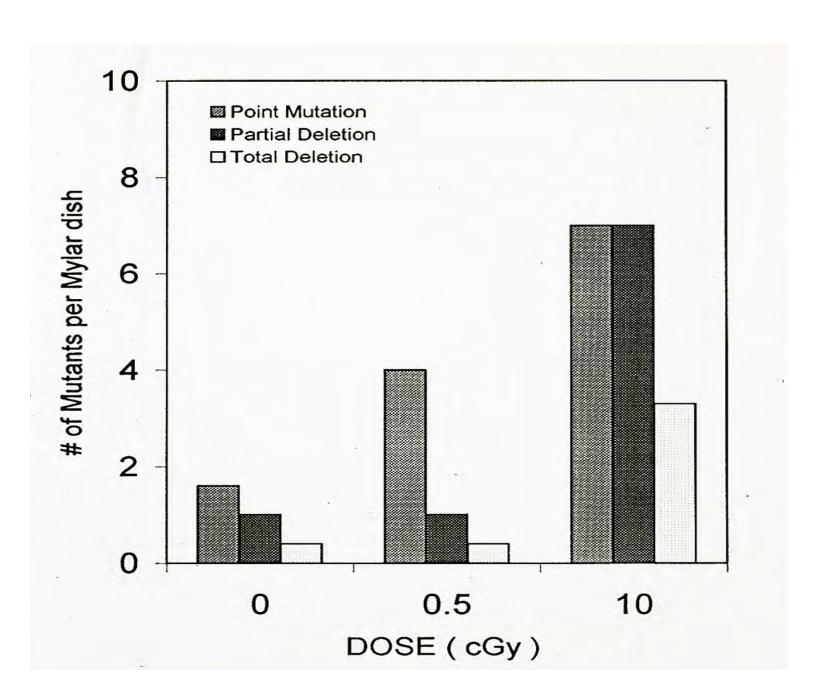
Induced mutation frequency per nuclear α -particle tract



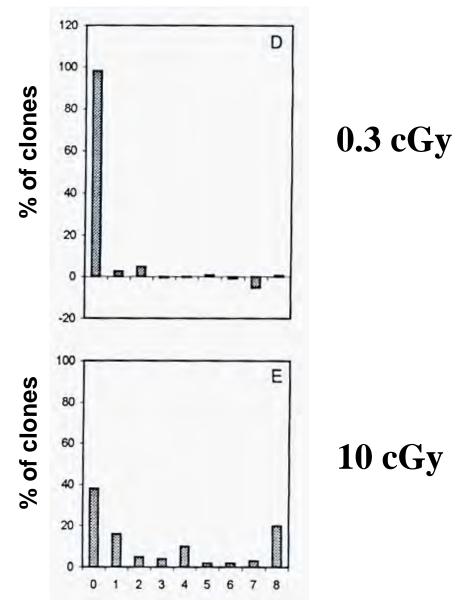
Mutations induced by low-dose alpha-irradiation



Molecular structure of mutations in α -irradiated cultures



Molecular structure of induced mutations in bystander cells



of exons deleted per clone

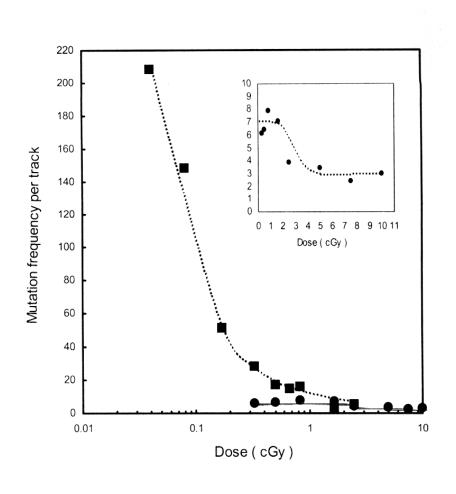
CONCLUSIONS

- Mutations induced in bystander cells are almost entirely point mutations.
- These are consistent with oxidative base damage rather than DNA double strand breaks.
- The dose-response curve is nonlinear at very low alpha particle fluences.

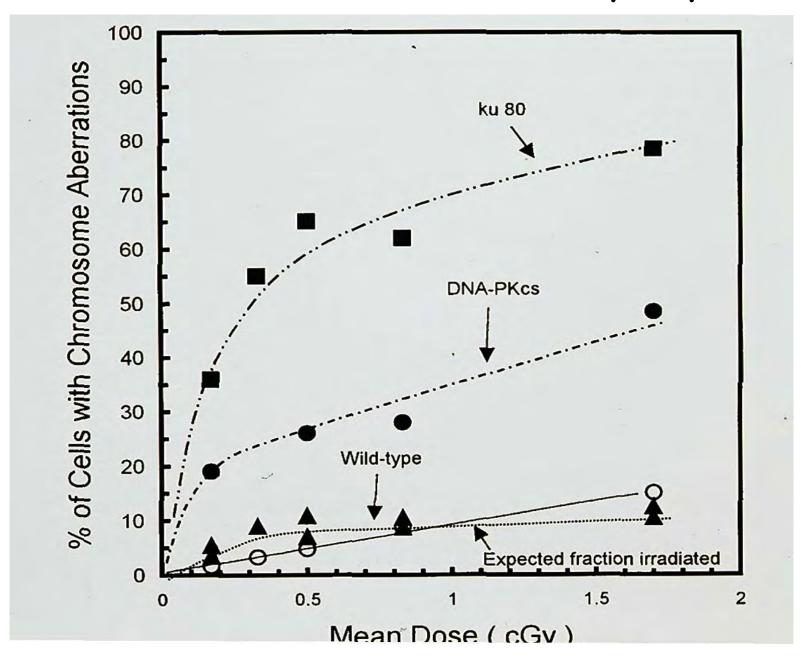
ROLE OF DNA REPAIR PROCESSES

Non-homologous end joining (NHEJ)

Induced mutation frequency per α -particle tract in repair-deficient cells



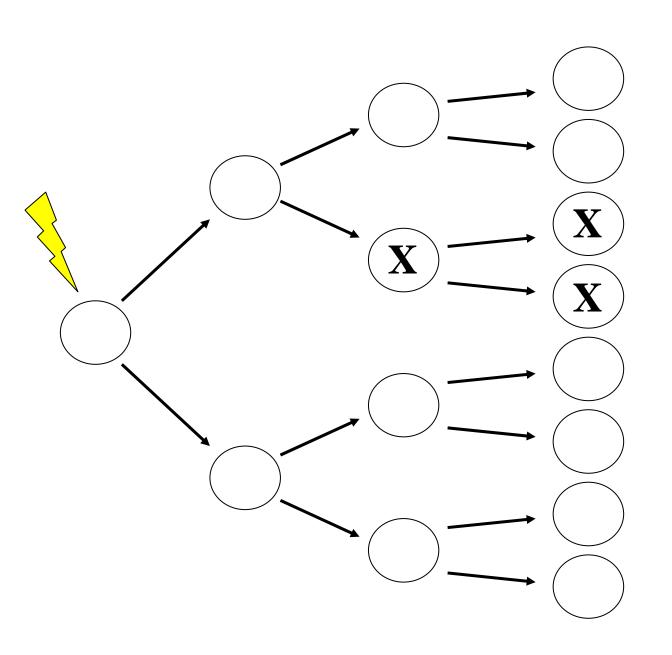
Induction of Chromosomal Aberrations in α -irradiated mouse knock-out cells for the NHEJ repair pathway



CONCLUSIONS/HYPOTHESES

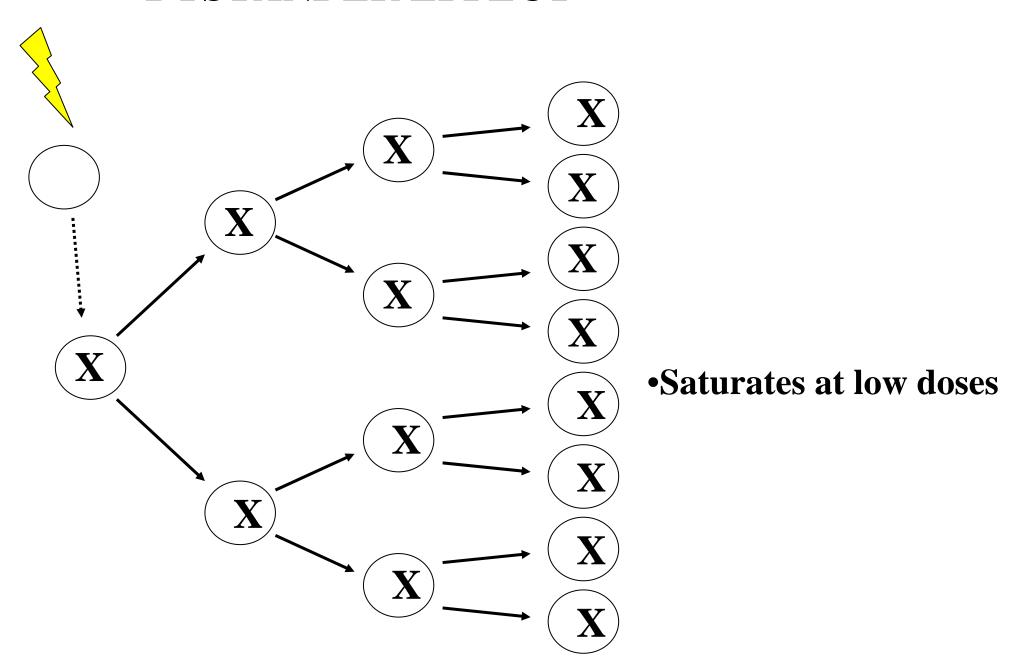
- Biological effects in bystander cells are a result of the upregulation of oxidative metabolism.
- Mutations in wild-type bystander cells result primarily from oxidative base damage. Some DNA DSB will be produced, but they will be repaired.
- In repair deficient bystander cells, mutations result from unrepaired/misrepaired DNA double strand breaks which are highly mutagenic lesions.
- This hypothesis in consistent with the marked sensitivity of repair deficient bystander cells to gross chromosomal aberrations.

RADIATION INDUCED GENOMIC INSTABILITY

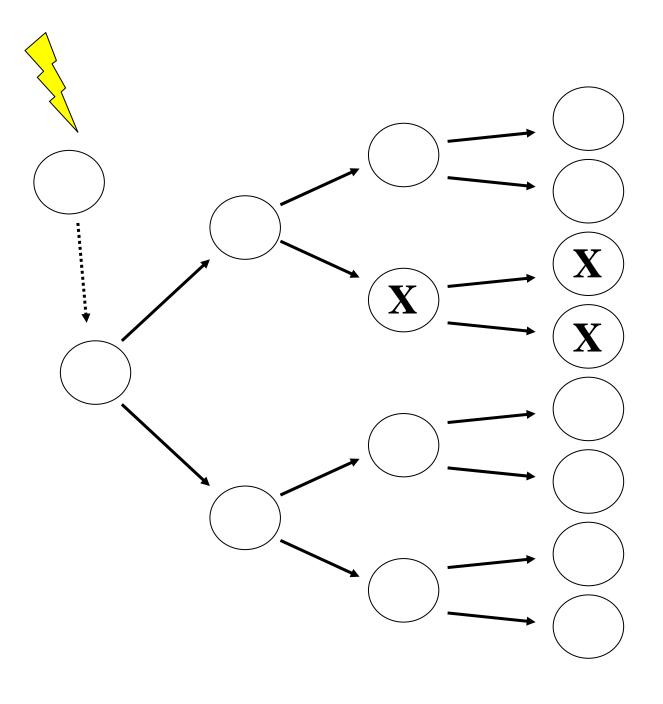


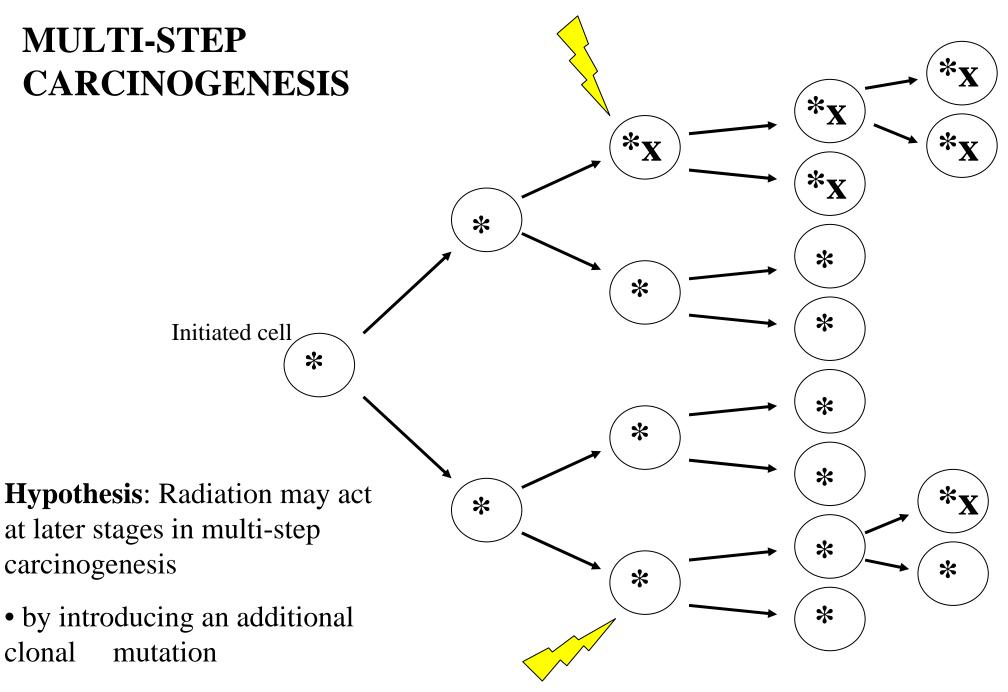
- •Mutations
- •Chromosomal aberrations
- •Cell killing
- •High frequency event
- Saturates at low doses
- •Transgenerational effects?

BYSTANDER EFFECT



BYSTANDER EFFECT ----> GENOMIC INSTABILITY





• by enhancing instability thus facilitating the accumulation of new mutations

Acknowledgements

Edouard Azzam
Hatsumi Nagasawa
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Improving Radioactive Waste Management:

An Overview of EPA's Low-Activity Waste Effort

U.S. Environmental Protection Agency Office of Radiation and Indoor Air Radiation Protection Division

Presentation to the Annual Meeting of the National Council on Radiation Protection and Measurements March 31, 2005





EPA's Overall Approach

- Issued Advance Notice of Proposed Rulemaking outlining approach to low-activity waste that would (68 FR 65120, November 18, 2003):
 - Identify additional protective options appropriate to potential risks of disposal
 - Apply consistent methods to evaluate the risks of radioactive material, regardless of origin
 - Target lower-activity wastes as suited to such considerations
 - Maintain appropriate regulatory controls



Greater Protection and Improved Waste Management

- EPA's approach is intended to:
 - Address environmental concerns (e.g., limited disposal options, continued storage, long transportation)
 - Improve regulatory context (fragmented and inconsistent regulation based on statutory definition or waste origin)
- Additional, protective disposal options should result in:
 - Greater public health protection
 - More efficient use of resources in risk reduction



Elements of EPA's ANPR

- Introduces concept of "low activity"
 - No current statutory or regulatory definition
- Focuses on radiation content rather than origin
 - Evaluate safety for the material in question
- Articulates potential universe of "low activity"
 - Mixed waste, TENORM, Low-level waste,
 Uranium or thorium ore processing waste,
 NRC exempt or "unimportant quantities"
 - Could include DOE waste as well as commercial



Elements of the ANPR (cont.)

- Discusses methods and modeling to be used to define "low activity" waste
- Identifies hazardous waste landfills as potential destinations for "low activity" waste
- Discusses regulatory and non-regulatory mechanisms
- Asks many questions in all areas



Next Steps

- Continue to evaluate public comments
 - More than 1,500 submittals
 - Mostly individuals opposing "deregulation"
- Continue technical exploration of options and methods
- Continue dialogue/outreach with Agencies, States and other stakeholders
- Develop recommendation on future course(s) of action



Dr. Carl J. Paperiello, Director
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

NCRP 2005 Symposium March 30-31, 2005

CURRENT NRC WASTE DISPOSAL REQUIREMENTS

10 CFR Part 20, Subpart K

10 CFR Part 20.1302 Liquids and Gases

10 CFR Part 20.2002 Alternative Disposition

CURRENT NRC INFORMATION SOURCES

NRC Website: <u>WWW.NRC.GOV</u>

- Click Nuclear Materials
- Click Materials Decommissioning
- Click All Materials Rulemaking
- Click Controlling the Disposition of Solid Materials

HISTORY - INITIATION

- Federal Register June 30, 1999
- "Issues Paper"
- Public Meetings 1999-2000
- SECY -00-0070
- Commission Briefing May 2000

HISTORY – SRM August 18, 2000

- Defer Final Decision
- NAS Study
- Develop Technical Basis
- Monitor International Activities
- Liaison with other Federal Agencies

HISTORY – NAS REPORT

- Broaden the Range of Approaches
- Incorporate Broad-Based Stakeholder Participatory Decision Making
- Develop Overarching Policy Statement
- Use Dose-Based Standard
- Use of 10 microSv/yr Good Starting Point
- Use of Conceptual Framework of NUREG-1640
- Follow International Efforts

HISTORY – FOLLOWUP TO NAS REPORT

- SECY-02-0133 Options Paper
- SRM Commission Selected Option 3b
- Enhanced Participatory Rulemaking
- Broad Range of Alternatives
- Consider Conditional or Restricted Release
- Consider ANSI N13.12 Standard

TECHNICAL BASES

- NUREG-1640, Vol. 1-4, "Radiological Assessment for Clearance of Materials from Nuclear Facilities"
- NUREG-1725, "Human Interaction with Reused Soil: An Information Search"
- NUREG-1761, "Radiological Surveys for Controlling Release of Solid Materials"

INTERNATIONAL ACTIVITIES

IAEA Safety Guide RS-G-1.7

"Application of the Concepts of Exclusion, Exemption, and Clearance"

NRC ONGOING ACTIVITIES

- Proposed Rule Package due to Commission March 31, 2005
- GEIS to Support Proposed Rulemaking being reviewed
- Strong Consideration of "Limited Path" Alternative
- Strong Consideration of 1 mrem/yr dose criteria
- Restrict uses of material
- Restrict to EPA/State regulated landfill disposal
- Case-by-case requests
- No final decision yet

U.S. Department of EnergyPolicies, Directives &Guidance for RadiologicalControl & Release of Property

By

A. Wallo, S. Domotor and G. Vázquez NCRP Annual Meeting, March 30-31, 2005

DOE Directives, Radiation Protection of the Public and the Environment

□ Policy-DOE P 441.1, Department of Energy Radiological Health & Safety Policy

□ Directive-Order DOE 5400.5, Radiation
 Protection of the Public and the Environment

DOE Radiation Protection of the Public & the Environment-Objectives

- Protect the public and the environment
- Implement legally applicable standards
- Maintain doses as far below dose limits and constraints as is reasonably achievable (ALARA)
- Establish standards & requirements consistent with other national standards, & national and international radiation protection recommendations
- Provide accessible, useable guidance & tools

Order DOE 5400.5, Radiation Protection of the Public & the Environment

- Sets out requirements for DOE operations to protect public and environment from undue radiation
 - all sources, all pathways dose limit
 - ALARA process
- Includes specific requirements for:
 - controlling wastes & liquid effluents
 - controlling air emissions & drinking water systems
 - environmental protection & monitoring
 - controlling and releasing property

Principal Requirements for Control and Release of Property

- survey or characterize radiological condition
- perform dose assessments
- establish authorized limits with ALARA
- develop documentation
- verify and QA release process
- keep public informed
- maintain records and report releases

General Requirements for the Control and Release of DOE Property

- ALARA dose constraint for releases
 - -real property is 25 mrem/yr, w/goal of a few mrem/yr (actual or likely use)
 - -contingency analysis for worst plausible use
 - -personal property is <1mrem/yr, w/possible few mrem/yr for a restricted release
- Use of surface activity guidelines for structures and personal property allowed

Recent DOE Property Release Limitation: scrap metal

- Secretarial moratorium-release of volumetrically contaminated metal (January 2000)
 - -metal + volumetrically contaminated
 - -then, no release into commerce
- Secretarial suspension-recycle of scrap metal from RCAs (July 2000)
 - -scrap metal + in radiological area (per 10 CFR 835)
 - -then, no release for recycle into commerce

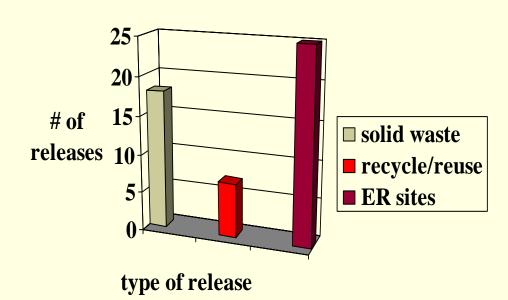
Primary Guidance and Tools

- Guide for "Control and Release of Property with Residual Radioactive Material", April 2002
- EH Guidance Memorandum, November 1995
- ALARA Guidance, Volumes 1 and 2
- Modeling Tools:
 - -RESRAD
 - -RESRAD-BUILD
 - -RESRAD-RECYCLE
 - -TSD Dose

Summary-Property Release Actions

- EH reviews for volumetric and dose-based-ALARA personal property
- Most releases use Surface Guidelines
- Real property approved by program and field

property releases



Principal Considerations in Setting Regulatory Priorities

- Maintain and update existing guidance and tools
- Improvements are desirable but not urgent; current property control & release system works
- DOE moving toward management systems approach for ES&H program. Radiation protection program will have to be integrated into this new approach

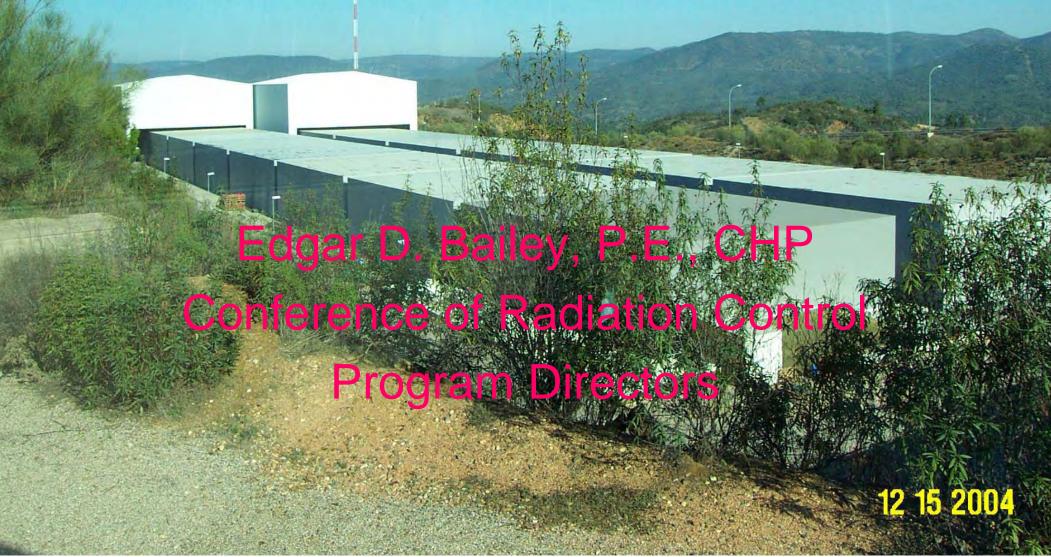
DOE Regulatory Activities

- Update Order DOE 5400.5
 - -proposed 10 CFR Part 834
 - -revised Order
- Issue guide on the control and release of property in final
- Issue ALARA guidance in final
- Update and revise guide DOE/EH-0173T, "Effluent Monitoring & Environmental Surveillance"

Other Related Activities

- Coordinated through ISCORS or other interagency means:
 - -federal guidance
 - -dose factors update
 - -sewage sludge study
 - -BEIR VII
 - -ICRP next recommendations
 - -DOE scrap metal PEIS
 - -NRC solid materials GEIS
 - -EPA Low Activity Radioactive Waste
 - -DOE low dose studies





LLRW Waste Sites

- Beatty, Nevada
- West Valley, New York
- Maxey Flats, Kentucky
- Barnwell, South Carolina
 - Sheffield, Illinois
 - Richland, Washington

Operating Sites

Beatty, Nevada

Richland, Washington

Barnwell, South Carolina

Presently Operating Sites

Richland, Washington

Barnwell, South Carolina

Clive, Utah

U. S. Nuclear Regulatory Commission

De Minimus Rule

Below Regulatory Concern

U. S. Nuclear Regulatory Commission

 Decommissioning and Decontamination Rule

U. S. Nuclear Regulatory Commission

Clearance Rule

 U. S. Environmental Protection Agency

ANPR

TEXAS

300-Day Regulation

"Exempt Waste"

NORM

Oil and Gas Production and Processing

PENNSYLVANIA

Landfill Portal and Leakage Monitoring

CALIFORNIA

Executive Order on "Decommissioned Waste"

QUESTIONS

- Will some states simply not adopt similar regulations?
- Will some states adopt lower permitted concentrations?
- Will some states adopt a more limited set of acceptable sites for such disposal?
- "Dumping grounds of the nation?"





Closing Remarks

Thomas S. Tenforde



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2006 NCRP Annual Meeting – Chernobyl at Twenty

- April 3-4, 2006 (full two-day meeting)
- Crystal Forum of the Crystal City Marriott, Arlington, Virginia