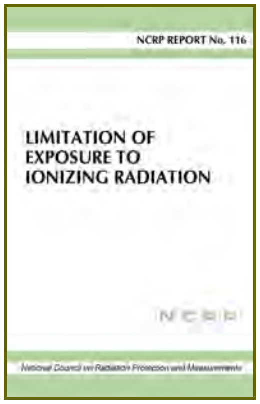
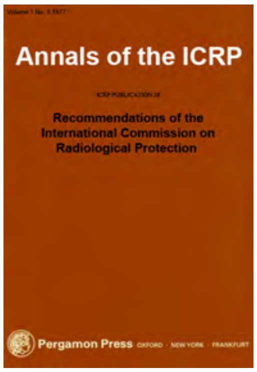
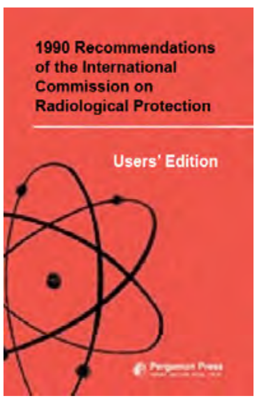
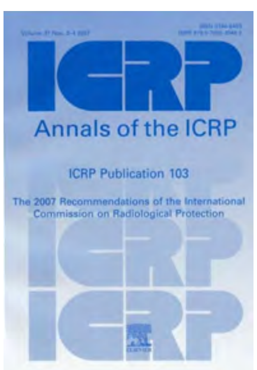








Fifty-First
Annual Meeting Program

Changing Regulations and Radiation Guidance: What Does the Future Hold?

March 16–17, 2015

Hyatt Regency Bethesda
One Bethesda Metro Center
7400 Wisconsin Avenue
Bethesda, MD 20814

NCRP
National Council on Radiation Protection & Measurements

Front cover [top to bottom]:

NCRP Report No. 116, *Limitation of Exposure to Ionizing Radiation* (1993)
ICRP Publication 26, *Recommendations of the International Commission on Radiological Protection* (1977)
ICRP Publication 60, *1990 Recommendations of the International Commission on Radiological Protection (Users' Edition)* (1991)
ICRP Publication 103, *2007 Recommendations of the International Commission on Radiological Protection* (2007)

NCRP Mission:

To support radiation protection by providing independent scientific analysis, information and recommendations that represent the consensus of leading scientists.

amazonsmile

NCRP Resource Development Committee is launching a series of efforts to increase the financial stability of NCRP. The first effort is to request Council members and friends who shop online at Amazon to make a simple (no cost) modification. Simply register at AmazonSmile (https://smile.amazon.com/), and the AmazonSmile Foundation will donate 0.5 % of the purchase price to NCRP at no charge to you! It's easy!

Follow the directions and be sure to select the National Council on Radiation Protection and Measurements (from the pull down list or searchable request) as the 501(c)(3) public charitable organization to receive the Amazon contribution for each purchase. Donations are anonymous. However, we would like to recognize your support and if you notify NCRP (Laura.Atwell@ncrponline.org) we will add your name to the NCRP list of AmazonSmile contributors.

Introduction

Changing Regulations and Radiation Guidance: What Does the Future Hold?

Fifty-First Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP)

As NCRP begins its second half century since our Congressional charter in 1964, our program of activities encompasses the future landscape of radiation protection regulation and guidance in the United States. The wide range of uses for radiation and radioactive materials pose challenges and opportunities that must be addressed in a consistent and coherent way. The United States stands at a junction where decisions are needed in a number of areas, recommendations and scientific information are being updated, and serious examinations are being made of the basis and rationale for our system of protection. Within NCRP, work is underway in a Council Committee to update existing NCRP recommendations, last published as Report No. 116 in 1993.

The radiation regulatory scheme for the United States has served the public well, but societal changes necessitate that we reexamine the nation's radiation regulations. These changes include rapid expansion of new technologies (*e.g.*, computed tomography, hydraulic fracturing, *in situ* recovery of uranium); aging nuclear power plants and new reactors being built; advances in radiation science (biology, epidemiology, dosimetry, risk assessment); and the integration of stakeholder participation into the regulation process.

There are many overarching regulatory issues (and protection guidelines) to grapple with. How should international approaches and principles be reflected in U.S. regulations? Can the International System of Units be incorporated while accommodating U.S. units as necessary? How should sex and age risk information be incorporated? Should regulatory standards continue as dose standards or do risk standards play a role? How should key potential exposure pathways be protected, in particular groundwater, and on what basis? What about a broader look on protecting the environment (flora and fauna)? What approaches can be considered to effectively protect the patient from unnecessary radiation without diminishing medical benefit? What is the cost in implementing changes? How can changes be made with transparency and public involvement? How can changes be effectively communicated? The 2015 Annual Meeting will be stimulating, informative and provocative and will provide a glimpse into the future of radiation protection in the United States.

The 2015 Program includes sessions in five topical areas, and will provide thought provoking presentations by national and international experts and ample opportunities to ask questions.

- Session 1 will examine the basic standards and recommendations, including a presentation on the evolution of the radiation protection system, and the opportunities to reexamine and recraft the "old" federal radiation protection regulations and make them "new" in response to the evolution in scientific understanding and public values.
- Session 2 looks at the security of radiation sources. Topics addressed include the enhancement of radioactive material security from a state perspective, and the decisions for end-of-life for sealed radioactive sources (*i.e.*, how to dispose of a radioactive source once it is no longer useful).
- Session 3 continues the end-of-life theme with examination of other issues in radioactive waste disposal. The first presentation will consider the challenges for long-term management of depleted uranium, which are unique because of the large volumes involved and the very long half-life of uranium. The second presentation will examine alternative radioactive waste strategies, and the implications for management of highly radioactive materials.
- Session 4 moves to the medical sector, which is the arena where more exposure of the U.S. population takes place than any other. The first presentation will examine the revision of state regulations, where

protection from radioactive materials and machine produced radiation is effectively integrated. The second presentation will look at dose to the lens of the eye (a current topic of much debate), and provide a view of the current NCRP committee (SC 1-23) tasked to develop recommendations for the United States.

- Session 5 turns attention to the questions of emergency preparedness and response. The first presentation will cover the work of the International Commission on Radiological Protection to update international recommendations in light of the experience gained in response to the accident at the Fukushima Diiachi nuclear power plant in 2011. This will be followed by a discussion of the updated dosimetry being developed for the U.S. Environmental Protection Agency's Protective Action Guides Manual to help responders plan for radiation emergencies. The last presentation is on the National Alliance for Radiation Readiness, which seeks to leverage partnerships across a variety of resources to enable an effective response.

The Twelfth Annual Warren K. Sinclair address will be given by Dr. Kenneth R. Kase, who will discuss the influence of NCRP on radiation protection in the United States. It is also with sadness that we note the death of Warren Sinclair (our second president) this past year at the age of 90 y. The Thirty-Ninth Lauriston S. Taylor Lecture will be delivered by Dr. Keith F. Eckerman, and new this year, the first Thomas S. Tenforde topical lecture will examine the ethics of radiation protection and be given by Jacques Lochard.

The meeting will conclude with a synthesis and summary by the 2015 Program Committee Chair, Donald A. Cool, who will also provide perspectives on the future framework of recommendations and the movement towards a unified approach to radiation protection across all situations of exposure.

NCRP President, John D. Boice, Jr., will close the 2015 Annual Meeting, briefly summarizing the NCRP perspective, work and opportunities in the coming years.

NCRP and the Radiation Research Society (RRS) are pleased to welcome the third NCRP/RRS Scholars to this year's Annual Meeting. The four young scientists below received competitive travel awards made possible by the generosity of RRS. These awards are aimed at encouraging and retaining young scientists in the field of radiation science. Eligible applicants included junior faculty or students in the radiation sciences or junior health or medical physicists:

- Nicholas Colangelo, Rutgers University
- Benjamin M. Haley, Northwestern University
- Evagelia C. Laiakis, Georgetown University
- Claudia Wiese, Colorado State University

NCRP would like to extend a special "*Thank You*" to the military volunteers for their support during the program sessions.

Questions can be submitted on cards during each session. The session chairs and speakers will address as many questions as time permits. *All* questions and answers will be published in *Health Physics* as part of the proceedings.

Monday, March 16, 2015

Opening Session

8:15 am **Program Welcome**
Donald A. Cool
Program Committee Chair

8:20 am **Welcome**
John D. Boice, Jr.
President, NCRP

Twelfth Annual Warren K. Sinclair Keynote Address

8:30 am **Influence of NCRP on Radiation Protection in the United States: Guidance and Regulation**
Kenneth R. Kase
Honorary Vice President, NCRP

Basic Standards

Michael A. Boyd & Renate Czarwinski,
Session Co-Chairs

9:15 am **Evolution of the Radiation Protection System and Its Implementation**
Edward Lazo
Nuclear Energy Agency, Paris

9:40 am **Federal Directions in Radiation Regulations: Making the "Old" New Again**
Jonathan D. Edwards
U.S. Environmental Protection Agency

10:05 am **Q&A**

10:30 am **Break**

Source Security

Isaf Al-Nabulsi & Ruth E. McBurney,
Session Co-Chairs

11:00 am **Enhanced Radioactive Material Source Security**
Joseph Klinger
Illinois Emergency Management Agency

11:25 am **End of Life Decisions for Sealed Radioactive Sources**
Kathryn H. Pryor
Pacific Northwest National Laboratory

11:50 am **Q&A**

12:15 pm **Lunch**

Waste Disposal

S.Y. Chen & Allen G. Croff, *Session Co-Chairs*

1:30 pm **Factors Important to Effective Long-Term Management Strategies for Depleted Uranium Disposal**
Michael T. Ryan
Health Physics Journal

1:50 pm **Management of Used Fuel and the Nuclear Fuel Cycle**
Peter B. Lyons
John W. Herczeg [presenter]
U.S. Department of Energy

2:15 pm **Q&A**

2:45 pm **Break**

Medical

Donald L. Miller & Michael A. Noska,
Session Co-Chairs

3:15 pm **Revision of Suggested State Regulations**
John P. Winston
State of Pennsylvania

3:40 pm **NCRP Guidance for Lens of the Eye**
Lawrence T. Dauer
Memorial Sloan Kettering Cancer Center

4:05 pm **Q&A**

4:30 pm **Break**

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

5:00 pm **Introduction of the Lecturer**
Richard E. Toohey
M.H. Chew & Associates, Inc.

Dosimetry of Internal Emitters: Contributions of Radiation Protection Bodies and Radiological Events
Keith F. Eckerman
Oak Ridge National Laboratory

6:00 pm **Reception**
Sponsored by Landauer, Inc.

Tuesday, March 17

8:15 am **NCRP Annual Business Meeting**

9:10 am **Break**

First Thomas S. Tenforde Topical Lecture

Donald A. Cool, *Session Chair*

9:30 am **Ethics and Radiation Protection**
Jacques Lochard
Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire, France

10:05 am **Q&A**

Emergency Preparedness

Armin Ansari & John A. MacKinney, *Session Co-Chairs*

10:15 am **Update of ICRP Publications 109 and 111**
Michiaki Kai
Oita University of Nursing and Health Sciences, Japan

10:45 am **Break**

11:05 am **Updated Dosimetry in the New Protective Action Guides Manual**
Sara DeCair
U.S. Environmental Protection Agency

11:35 am **National Alliance for Radiation Readiness: Leveraging Partnerships to Increase Preparedness**
James S. Blumenstock
Association of State and Territorial Health Officials, National Alliance for Radiation Readiness

12:05 **Q&A**

Summary

John D. Boice, Jr., *Session Chair*

12:30 pm **Summary of Meeting**
Donald A. Cool
Program Committee Chair

12:55 pm **Closing Remarks**
John D. Boice, Jr.
President, NCRP

1:00 pm **Adjourn**

Monday, March 16, 2015

Opening Session

8:15 am

Program Welcome
Donald A. Cool
Program Committee Chair

8:20 am

Welcome
John D. Boice, Jr., *President*
National Council on Radiation Protection and Measurements

Twelfth Annual Warren K. Sinclair Keynote Address

8:30 am

Influence of the NCRP on Radiation Protection in the United States: Guidance and Regulation
Kenneth R. Kase
Honorary Vice-President, NCRP

The roots of the National Council on Radiation Protection and Measurements go back to 1928 and are intimately related to the formation of the International Commission on Radiological Protection (ICRP) in July of that year. As the U.S. representative to the international protection group, it became the responsibility of L.S. Taylor in the United States to organize a national committee which could deal most effectively with the protection problems faced at that time. Thus, early in 1929, the Advisory Committee on X-Ray and Radium Protection was established with L.S. Taylor acting as chairman. The National Bureau of Standards (NBS) was identified as the coordinating agency for the Advisory Committee and its reports were published as NBS Handbooks. In 1946 the Advisory Committee membership was increased and it was renamed National Committee on Radiation Protection and remained so until the National Council on Radiation Protection and Measurements was chartered by the U.S. Congress in 1964.

In 1934, the U.S. Advisory Committee on X-Ray and Radium Protection proposed the first formal standard for protecting people from radiation sources, NBS Handbook 15, and issued the first handbook on radium protection, NBS Handbook 18. Revised recommendations for external exposure were issued in July 1936, as NBS Handbook 20. In this Handbook, there appeared for the first time the recommendation of a specific permissible exposure level (then called tolerance dose) of radiation that could be allowed for occupational exposure. Handbook 18 on radium protection was also revised and the new NBS Handbook 23 was issued in 1938. These two handbooks were accepted in this country as the primary guides for protection against x rays and the radiations from radium and remained in force until 1948. Twenty-three additional reports were published, following the change in name to NCRP, between 1948 and 1964 bringing the total number of reports to 30.

The U.S. Atomic Energy Commission (AEC) based its 1957 Standards for Protection Against Radiation on the recommendations of NCRP. Four NCRP reports are cited by the Federal Radiation Council (FRC) in its first report (1960) as forming the basis for the FRC Radiation Protection Guides, Radioactivity Concentration Guides, and subsequent Protective Action Guides. Also, two reports provided the basic guidance for shielding design and protection for construction and operation of high energy accelerator facilities.

In the 50 y since its charter, the recommendations of NCRP together with those of ICRP have led to the radiation protection philosophy that is used by the majority of federal and state agencies today. Radiation protection standards and regulations in the United States currently are based on the ICRP recommendations of 1977 supplemented by the NCRP recommendations of 1987. Since then the recommendations from both ICRP and NCRP have been revised.

The U.S. Nuclear Regulatory Commission has promulgated regulations dealing with administrative requirements, training, various medical applications of radionuclides, enforcement, and numerous other aspects of medical uses of radioactive materials. These regulations rely heavily upon the information and recommendations provided by NCRP, including scientific aspects of occupational protection, ALARA (as low as reasonably achievable), emergency planning, assessment of radiation exposure, and training.

NCRP recommendations are typically used in various operational aspects of the use of radiation and radioactive materials without regulatory requirements or enforcement. Many NCRP reports are also used as educational and training resources. Some examples are:

- designing shielding barriers for radiographic and external beam radiation therapy rooms;
- guidance for the management of patients treated with radioactive materials, as well as guidance for handling medical emergencies;
- American College of Radiology–American Association of Physicists in Medicine Practice Parameter for Diagnostic Reference Levels and Achievable Doses in Medical X-Ray Imaging; and
- the American Board of Health Physics Examination Preparation Guide lists 30 relevant NCRP reports as resources.

In summary, throughout its 86 y history the NCRP and its predecessors have functioned as effective advisors to the nation on radiation protection issues and have provided the fundamental guidance and recommendations necessary for the regulatory basis of the control of radiation exposure, radiation-producing devices and radioactive materials in the United States.

Basic Standards

Michael A. Boyd & Renate Czarwinski, *Session Co-Chairs*

9:15 am

Evolution of the Radiation Protection System and Its Implementation

Edward Lazo
Nuclear Energy Agency, Paris

The International Commission on Radiological Protection (ICRP) system of radiological protection has for the past 50 y provided a robust framework for developing radiological protection policy, regulation and application. It has, however, been evolving as a result of experience with its implementation, and modernization of social awareness of our shrinking world. These currents have gently pushed the ICRP system in recent years to focus more sharply on particular aspects of its system: optimization, prevailing circumstances, the concept of risk and risk attributability, the use of effective dose and aspects of an individual's risk, and consideration of the independent implementation of the ICRP system's elements. This presentation will cover these issues and their relevance to the ICRP system of protection and its evolution. The broader framework of radiological protection (*e.g.*, science, philosophy, policy, regulation, implementation), of which the ICRP is an important element, will provide a global, equally evolving context for this characterization of the changing ICRP system of radiological protection.

9:40 am

Federal Directions in Radiation Regulations: Making the "Old" New Again

Jonathan D. Edwards
U.S. Environmental Protection Agency

In the United States, the radiation regulatory scheme has served society well but must periodically evolve and adapt to ensure that public health, workers and the environment are properly protected in view of accepted societal values and the advance of science, technology and medical practices. Federal regulators in particular have an important national framework to maintain and manage, using best judgment in weighing a multitude of factors and considerations. In the early 21st century, we find that a few dependable but tired and antiquated "workhorses" of regulation have been already reworked - but many more remain that likely need reworking.

There are several "stressors" driving societal changes that may necessitate re-examination and recrafting of the nation's radiation regulations. Examples of these stressors are:

- rapid growth of new technologies and their expanding use (*e.g.*, computed tomography, fracking, *in situ* recovery of uranium);
- climate change adaptation as well as greenhouse gas reduction strategies;
- energy sector growth and independence strategies;
- no permanent repository for used nuclear fuel and high level wastes;
- aging nuclear power plants that will be relicensed, or decommissioned, and new reactors being constructed;

- more recent environmental policies (such as increased emphasis on protection of groundwater); and
- advances in radiation science, biology, dosimetry and risk assessment as we move from Standard Man to Reference Man to Reference Person to individualized risk.

Just as “stressors” emerge and change, so current thinking evolves on what makes a good regulation. Regulations must be protective yet flexible and reasonable. Requirements should be clear and implementable by the regulated entity or entities, which may be at the state or local level. Enforceability is a must. Regulatory levels and approaches must be based on sound science with appropriate peer review, yet care must be taken not to exceed the science-base and what is useful in supporting sound decisions simply because of advanced technology. To the extent that it is possible and practical, federal regulators try to be forward-looking and anticipate future challenges and “game changers” as they update old regulations, to keep them durable and robust for years to come. Consistency between radiation regulatory approaches and those used for other pollutants/contaminants may need to be examined, as well as re-establishing consistency amongst agencies. And importantly, openness and transparency are vital to rule development; public review and input is sought and often very valuable.

Currently, federal radiation regulators are grappling with some important issues. How best to incorporate gender and age risk information (accommodating the International Commission on Radiological Protection Publications 60 and 103 risk information)? Are regulatory standards best as dose standards or risk standards? How best to achieve desired “as low as reasonably achievable” planning? In the move toward higher emphasis on individual exposure, is collective exposure still a useful consideration? How best to protect key potential exposure pathways, in particular groundwater, and on what basis? How should international approaches and principles be reflected in U.S. regulations? How best to reflect the International System of Unites (SI) measurement units and accommodate U.S. units as necessary?

The U.S. Environmental Protection Agency, Nuclear Regulatory Commission, Department of Energy, Department of Defense, Food and Drug Administration, Department of Homeland Security, National Aeronautics and Space Administration, Occupational Safety and Health Administration, and other federal agencies with radiation protection responsibilities must be genuinely attentive of all the various factors and considerations due in proper rulemaking and strive to achieve the proper balance of these elements in renewed radiation protection regulations.

10:05 am **Q&A**

10:30 am **Break**

Source Security

Isaf Al-Nabulsi & Ruth E. McBurney, *Session Co-Chairs*

11:00 am

Enhanced Radioactive Material Source Security

Joseph G. Klinger
Illinois Emergency Management Agency

Requirements for additional security measures for sealed radioactive sources have evolved since they were first implemented after the terrorist events of September 11, 2001. This presentation will describe the sequence of those measures, commencing with the early orders issued by the U.S. Nuclear Regulatory Commission to the recent adoption of 10 CFR Part 37 requirements. The Part 37 requirements will be discussed in detail as the 37 NRC Agreement States, which regulate approximately 88 % of the radioactive material licensees, will be required to enact the requirements by March 19, 2016. In addition, to the Part 37 requirements, the presentation will also highlight some of the other ongoing efforts of the U.S. Department of Energy's National Nuclear Safety Administration's Global Threat Reduction Initiative and the Low Level Radioactive Waste Forum's recently released report from the Disused Sources Working Group.

11:25 am

End of Life Decisions for Sealed Radioactive Sources

Kathryn H. Pryor
Pacific Northwest National Laboratory

Sealed radioactive sources are encountered in a wide variety of settings — from household smoke detectors to instrument check sources, fixed industrial gauges to industrial radiography to well logging sources to irradiators and medical teletherapy devices. Sealed sources are subject to differing levels of regulatory control by the U.S. Nuclear Regulatory Commission (NRC) and Agreement States, related to but not completely dependent on the quantity of radioactive material that the sealed sources contain. The three levels of control are commonly referred to as "exempt," "generally licensed," or "specifically licensed" and relate to the degree of regulation exercised over the person who possesses and uses the sealed radioactive source. Sealed sources are also categorized under an international classification scheme developed by the International Atomic Energy Agency (IAEA). The IAEA classification is based on both the quantity (activity) and inherent danger of the radionuclide contained in the sealed source, and range from Category 1 (most dangerous) to Category 5 (least dangerous).

In general, the higher the level of activity in the source, the more positive regulatory control that is applied to the use, control, and ultimate disposition of the source. The more regulatory control that is applied, the greater the likelihood that the source will be properly disposed in a licensed radioactive waste disposal facility. Lower levels of attention and oversight can and do lead to sources ending up in the wrong place — as orphan sources in uncontrolled storage, disposed in a sanitary landfill, melted down in recycling operations and incorporated into consumer products, or handled by an unsuspecting member of the public.

The report of the Disused Source Working Group (March 2014) does an excellent job of framing the issues associated with sealed radioactive source control. Generally licensed sources and devices are particularly at risk of being disposed incorrectly. Higher activity generally licensed sources, although required to be registered with the NRC or Agreement State, receive limited regulatory oversight and are not required to be entered into the National Source Tracking System. Users do not always consider the full life-cycle costs when procuring sources/devices and discover that they cannot afford to properly package, transport and dispose of their sources. The NRC requirements for decommissioning funding plans and financial assurance are not adequate to fully cover sealed source disposal costs. While there are regulatory limits for storage of disused sources, enforcement is limited and there is no financial incentive for owners to dispose of the sources. In some cases, the lack of availability of approved Type B shipping casks presents a barrier to sealed source disposal.

Efforts to address this problem are focused on multiple levels. Both the Organization of Agreement States and NRC staff have recommended that a specific license be required for all sources greater than Category 3, and have expressed concern over the potential for aggregation of higher activity generally licensed sources. This recommendation has not been adopted to date. Recommendations have also been made to require licensees to provide higher levels of financial assurance that more accurately reflect true disposal costs.

There are more disposal options open to sealed source owners than in the past, but packaging, transport and disposal costs still stand as a barrier. The Offsite Source Recovery Program (OSRP), sponsored by the National Nuclear Security Administration (NNSA) Office of Global Threat Reduction, provides a mechanism for owners to register their disused sources for pick-up and disposal, and has been particularly successful in collecting and disposing of high activity sources. The Source Collection and Threat Reduction (SCATR) program, funded by the NNSA and administered by the Council of Radiation Control Program Directors, has been in existence since 2007 and provides a pathway for disposal of disused sources, plus financial assistance to do so. As of November 2014, OSRP has collected and disposed of nearly 30,000 U.S. sources (including those under the SCATR program). The SCATR program has paid for ~50 % of the packaging and disposal costs, and over 12,500 sources are anticipated to be disposed under this program through the end of 2014 collection period. This program is continuing into 2015.

11:50 am **Q&A**

12:15 pm Lunch

Waste Disposal

S.Y. Chen & Allen G. Croff, *Session Co-Chairs*

1:30 pm

Factors Important to Effective Long-Term Management Strategies for Depleted Uranium Disposal

Michael T. Ryan
Health Physics Journal

Various aspects of the past and present processing and disposal of low-level and high-level radioactive waste in the United States will be presented and discussed. This is not meant to be a comprehensive treatment of the subject but rather a summary of the current status of current and future radioactive waste management in the United States. A good starting point is the document:

Radioactive Waste: An Introduction from NUREG/BR 0216 Rev 2 May 2002

It states:

"Radioactive wastes are the leftovers from the use of nuclear materials for the production of electricity, diagnosis and treatment of disease, and other purposes.

The materials are either naturally occurring or man-made. Certain kinds of radioactive materials, and the wastes produced from using these materials, are subject to regulatory control by the federal government or the states.

The Department of Energy (DOE) is responsible for radioactive waste related to nuclear weapons production and certain research activities. The Nuclear Regulatory Commission (NRC) and some states regulate commercial radioactive waste that results from the production of electricity and other non-military uses of nuclear material.

Various other federal agencies, such as the Environmental Protection Agency, the Department of Transportation, and the Department of Health and Human Services, also have a role in the regulation of radioactive material.

The NRC regulates the management, storage and disposal of radioactive waste produced as a result of NRC-licensed activities. The agency has entered into agreements with 32 states, called Agreement States, to allow these states to regulate the management, storage and disposal of certain nuclear waste."

1:50 pm

Management of Used Fuel and the Nuclear Fuel Cycle

Peter B. Lyons
John W. Herczeg [presenter]
U.S. Department of Energy

Nuclear power has reliably and economically contributed ~20 % of electrical generation in the United States over the past two decades. It remains the single largest contributor (~60 %) of non-greenhouse gas emitting electric power generation in the United States. Domestic demand for electrical energy is expected to grow at an average rate of 1 % per year.

This presentation will describe the U.S. Department of Energy's (DOE) used fuel management issues and associated research as well as an overview of fuel cycle research.

In January 2013, the Administration released its "Strategy for the Management and Disposal of Used Nuclear Fuel and

High-Level Radioactive Waste." The Strategy is a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing and disposing of used nuclear fuel (UNF) and high-level radioactive waste from civilian nuclear power generation, defense, national security, and other activities. The Strategy embraced the core findings of the Blue Ribbon Commission on America's Nuclear Future. It represents an initial basis for discussions among the Administration, Congress, and other stakeholders on a sustainable path forward for disposal of nuclear waste. Full implementation of the Strategy's components require new legislation however, DOE will continue to implement elements of the strategy within existing authorities.

The Office of Nuclear Energy's Fuel Cycle Research and Development program conducts research, development, and other activities related to UNF and nuclear waste management and disposal issues. The program employs a long-term science-based approach to foster innovative technologies and solutions to achieve this mission.

The development of improved and advanced nuclear fuels is a major objective for both existing LWRs and the entire spectrum of advanced nuclear energy systems. The development of advanced fuels is an essential part of future sustainable fuel cycle options. Advanced fuels is pursuing two paths:

- the development of next generation LWR fuels with enhanced accident tolerance; and
- development over the long term of transmutation fuels with enhanced proliferation resistance and resource utilization.

DOE has also chartered and recently completed a study on the evaluation and screening of nuclear fuel cycle options as an analytical tool to provide information regarding the benefits and challenges of nuclear fuel cycle options.

DOE actively cooperates in the international arena on advanced fuel cycles, including areas such as fast reactors and plutonium disposition.

The Used Fuel Nuclear Disposition Program continues to conduct research and technology to enable storage, transportation and disposal of UNF and wastes generated by existing and future fuel cycles. To support the evolution of the domestic UNF inventory, special emphasis is placed on understanding the behavior of high burn-up fuels. DOE is working with industry to confirm understanding of the material degradation processes in storage environments. DOE is also performing research regarding the feasibility of characterizing and engineering deep boreholes as an alternative to safe disposal of radioactive waste.

2:15 pm **Q&A**

2:45 pm **Break**

Medical

Donald L. Miller & Michael A. Noska, *Session Co-Chairs*

3:15 pm

Revision of Suggested State Regulations

John P. Winston
State of Pennsylvania

It is the mission of the Conference of Radiation Control Program Directors (CRCPD) to promote radiological health in all aspects and phases of implementation and to create a seamless and coherent regulatory structure across the United States. The CRCPD currently has 25 committees charged with the development of Suggested State Regulations (SSR) for everything from transportation and waste disposal, to tanning, and medical therapy. The SR-F Committee is responsible for the suggested regulations of the equipment and processes used in medical diagnostic and interventional x-ray procedures. Several states are required by law to adopt the SSR verbatim, making it vital that they are kept current.

Innovations in technology and changes in regulatory focus require nearly constant revisions by the CRCPD of the SSR. The SR-F chapter of the SSR was last updated in 2009, and several developments and occurrences since its publication prompted the CRCPD Board of Directors to initiate an update. With the transition to filmless technology, state radiation control programs were looking for applicable standards for quality control of computed and digital radiography systems. The overexposure of patients receiving computed tomography (CT) brain perfusion studies lead to a call for better control of CT protocols. NCRP Report No. 168, *Radiation Dose Management for Fluoroscopically-Guided Interventional Medical Procedures*, provided guidance for credentialing and privileging physicians performing these procedures and better management of protocols and outcomes. In line with CRCPD and the Food and Drug Administration's (FDA) long-standing Nationwide Evaluation of X-Ray Trends (NEXT) Program, several organizations, including the NCRP and American Association of Physicists in Medicine (AAPM), published diagnostic reference levels (DRL), leading a desire to now require facilities to incorporate the use of DRL in their quality assurance program. The trending toward improved awareness of dose is supported by advances in dose tracking and calculation.

The current revision of SR-F brought together representatives from the state radiation control programs, FDA, AAPM, American College of Radiology, and industry. Through the course of two meetings and multiple conference calls, the committee finalized an updated draft. The CRCPD process for the development of SSR is well-established and includes internal and external peer review, review by the state Director Members, approval by the Board of Directors, and concurrence from relevant federal agencies. Once final, an SSR allows a state radiation control program to proceed through their own regulatory process with a vetted set of regulations, making this difficult process more efficient and effective.

3:40 pm

NCRP Guidance for Lens of the Eye

Lawrence T. Dauer
Memorial Sloan Kettering Cancer Center

The major radiation damage response of the clear crystalline lens of the eye is the loss of lens clarity resulting in clouding or opaqueness known as a cataract that in an extreme case (usually after high doses >5 Gy in a single exposure) can cause blindness. However, exposure to "relatively" low doses of radiation can lead to only minor opacifications many years later, depending on the type of radiation, how the exposure was delivered, and on genetic susceptibilities of the individual exposed, and where the cataract forms relative to the visual axis. The International Commission on Radiological Protection (ICRP) recently recommended a significant reduction in dose limits to the lens, based on an evaluation of the epidemiological evidence of cataracts in radiation-exposed human populations. Consideration of these recommendations for lower dose limits and the cost-benefit consequences associated with adopting them are under study worldwide by countries including the United States. NCRP's Scientific Committee (SC) 1-23 has evaluated clinical and experimental evidence for the risk of radiation-induced cataract, considered cataract types and dose and dose-rate dependence of cataract formation, and provided guidance on whether existing dose limits to the eye should be changed in the United States, and identified what research gaps exist in our understanding of radiation effects on the lens of the eye. SC 1-23 recently drafted a commentary on the topic and is continuing work toward a more comprehensive future report on radiation effects on the eye.

The visual examination of human cataracts and categorizing them by type and scoring of their severity have undergone a major evolution in the last few decades. Ophthalmologic instrumentation has improved from hand-held microscopes and subjective scoring, to capturing digital images, and using more objective methods to score cataracts. However, most of the epidemiological evidence for radiation-induced cataracts has not been obtained with these new quantitative tools. Since cataracts are also associated with normal aging of the eye, and cataracts can arise due to numerous diseases, or exposure to toxins other than radiation, it is important to maintain frequent eye examinations and medical records to document and to assess the baseline level of lens clarity. However, many epidemiological studies of radiation-associated cataracts are lacking high-quality, baseline data on lens clarity in individuals who later develop cataracts, and technical deficiencies in cataract-scoring methods have contributed uncertainties to some of the most significant data acquired.

The biology of the lens has identified new molecular and cellular characteristics of the two lens cell types revealing underlying mechanisms responsible for the differentiation of the lens epithelial cells into lens fiber cells, and how radiation damage can hinder this process in a dose-dependent manner, perhaps linked to the latency of cataract appearance. Radiation cataracts have been considered the epitome of a deterministic effect that appears only after a dose threshold has been exceeded. However, the threshold dose for cataract has been progressively declining in humans and in experimental models. The choice of a biological model for investigating experimental radiation-induced cataract has been heavily influenced by rodent studies driven by cost issues; however, the lifespan of rodents is significantly shorter than that of humans, and this influences a number of species-dependent lens outcomes since it is not clear how to extrapolate rodent cataract risk data to humans. Recent evidence supporting the role of stem cells in the lens may offer future biological modifications to moderate radiation responses. The important comparison of the risk of cataract and loss of visual acuity that can be partially overcome by successful lens replacement surgery, with the risk of radiation-induced cancer with its more serious consequences and more invasive treatments has impacted the evaluation of radiation-induced detriment to the lens, and decisions to consider dose limit reductions.

The main points of the commentary will be addressed in this brief presentation, including a review of the current epidemiological and radiobiological evidence as well as current and future recommendations.

4:05 pm **Q&A**

4:30 pm **Break**

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

5:00 pm **Introduction of the Lecturer**

Richard E. Toohey

Dosimetry of Internal Emitters: Contributions of Radiation Protection Bodies and Radiological Events

Keith F. Eckerman
Oak Ridge National Laboratory

Since the early days of the Manhattan Engineer District, Oak Ridge National Laboratory (ORNL) has served to advance the dosimetry models used to set protection standards for radionuclides taken into the body. Throughout the years this effort benefited significantly from ORNL staff's active participation in national and international scientific bodies. The first such interaction was in 1946 with the National Committee on Radiation Protection (NCRP), chaired by L.S. Taylor, which led to the 1949 to 1953 series of tripartite conferences of experts from Canada, the United Kingdom, and the United States. These conferences addressed the need for standardization of dosimetry models and led to the establishment of an anatomic and physiologic model called "Standard Man," a precursor of the reference worker defined in ICRP Publication 23. Standard

Changing Regulations and Radiation Guidance: What Does the Future Hold?

Man was used in setting the maximum permissible concentrations in air and water published in NBS Handbook 52 and subsequent reports by NCRP and the International Commission on Radiological Protection (ICRP). K.Z. Morgan, then director of the Health Physics Division at ORNL, participated in the tripartite conferences and subsequently established ORNL as a modeling and computational resource for development of radiation protection standards. ORNL's role expanded with participation in the work of the Medical Internal Radiation Dose (MIRD) Committee of the Society of Nuclear Medicine. Results of interactions with the MIRD Committee are evident in the radiation protection guidance for internal emitters in ICRP Publication 30. The annual limit on intake and derived air concentration values tabulated Publication 30 were computed by an ORNL-based task group of ICRP Committee 2. A few years after the appearance of Publication 30, the Chernobyl nuclear reactor accident made clear the need to develop standard dosimetry models for pre-adult ages as members of the public. In the late 1980s ICRP began an effort to extend its reference worker concept to a reference family and develop dosimetric models for application to intake of radionuclide by members of the public. However, the modeling approach underlying the ICRP Publication 30 computational framework was not amenable to age and gender considerations. With support of U.S. federal agencies, ORNL had begun efforts in the early 1980s to develop age- and gender-specific dosimetric models including physiologically informed biokinetic models and age-specific dosimetric phantoms. ORNL's models and methods became the starting point for the ICRP's series of reports on dose coefficients for radionuclide intake by the public. Currently ICRP Committee 2 is overseeing development of a second generation of post-Chernobyl models and methods, with updates of Publications 30 and 68 soon to appear and new models for members of the public in preparation. The focus of this Lauriston S. Taylor Lecture is to chronicle advancements in the dosimetry of internal emitters with some discussion of models and methods but with due deference to decisions within scientific bodies and stimulated by radiological events.

6:00 pm

Reception in Honor of the Lecturer
Sponsored by Landauer, Inc.

LANDAUER®

Tuesday, March 17

8:15 am **NCRP Annual Business Meeting**

9:10 am **Break**

First Thomas S. Tenforde Topical Lecture

Donald A. Cool, *Session Chair*

9:30 am

Ethics and Radiation Protection

Jacques Lochard
Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire, France

The system of radiological protection is based on three pillars: science, ethical and social values, and experience. As far as ethics is concerned the fundamental principles structuring the system (justification, optimization and limitation) combines values that are at the heart of the three major theories of moral philosophy: respect for the rights of the individual (which falls within deontological ethics), the pursuit of collective interest (which falls within utilitarian ethics), and the promotion of vigilance and fairness (which falls within the ethics of virtue).

Two key values underlie the radiation protection system: prudence and justice. Prudence (in modern terms "precautionary principle") is the cornerstone of the system that allows taking into account uncertainties concerning both deterministic and stochastic effects of radiation on health. Prudence has a very long and universal ethical tradition in Western countries, but also in the Buddhist and Confucianism traditions as well as the ancient people of Oceania and America.

Justice is the way to ensure social equity and fairness in decisions related to protection within the present generation, but also with respect to future generations (intergenerational equity). This promotion of social justice and equity is mainly undertaken in practice by introducing restrictions on individual exposures in the system of radiological protection.

Over the past decade the system has also integrated procedural values such as, stakeholder involvement, right to know, informed consent, and self-help protection, reflecting the importance to properly inform and also preserve the autonomy and dignity of persons potentially or actually exposed to radiation.

10:05 am **Q&A**

Emergency Preparedness

Armin Ansari & John A. MacKinney, *Session Co-Chairs*

10:15 am

Update of ICRP Publications 109 and 111

Michiaki Kai
Oita University of Nursing and Health Sciences, Japan

The International Commission on Radiological Protection (ICRP) approved in September 2013 the creation of a Task Group (TG) of Committee 4 to update ICRP Publications 109 and 111 in the light of the lessons from Fukushima and recent international developments concerning the protection of people in emergency exposure situations, and people living in long-term contaminated areas after a nuclear accident or a radiation emergency.

So far the TG focused its reflection on several issues revealed by the Fukushima accident in relation with the justification and optimization of emergency decisions, the characterization of the radiological situation, the protection of emergency and recovery responders, the decontamination and waste management strategies, the management of contaminated foodstuffs and commodities, the shift from the emergency to the existing exposure situation, and the co-expertise process to develop radiation protection culture among the affected population.

An important aspect of the TG's approach focuses on clarifying the consequences of the introduction of the situation-based approach to implementation of radiological protection introduced in ICRP Publication 103 in place of the previous approach based on the distinction between practices and interventions. While this change was taken into account by Publications 109 and 111, the reactions of the authorities, as well as those of the affected people in Japan, have shown the difficulty for the people concerned to think the situation otherwise than as a planned exposure situation.

The TG will re-emphasize in the updated report the fundamental role of the optimization principle for implementing protective strategies both during the emergency and the recovery using time-dependent reference levels according the evolution of the prevailing circumstances.

In developing its work, the TG is taking into account the conclusions and recommendations of the dialogues initiated by ICRP in the affected areas of Fukushima on the rehabilitation of living conditions after the Fukushima as well as the results of a series of consultations with authorities, experts, operators, and affected people.

10:45 am **Break**

11:05 am

Updated Dosimetry in the New Protective Action Guides Manual

Sara DeCair
U.S. Environmental Protection Agency

In 2013, the U.S. Environmental Protection Agency (EPA) proposed an update to the 1992 *Protective Action Guides (PAG) Manual*. The PAG Manual provides guidance to state and local officials planning for radiological emergencies. EPA requested public comment on the proposed revisions, while making them available for interim use by officials faced with an emergency situation. Developed with interagency partners, EPA's proposal incorporates newer dosimetric methods, identifies tools and guidelines developed since the current document was issued, and extends the scope of the PAGs to all significant radiological incidents, including radiological dispersal devices or improvised nuclear devices.

In order to best serve the emergency management community, scientific policy direction had to be set on how to use International Commission on Radiological Protection (ICRP) 60, 66, and 72 y of age groups in dose assessment when implementing emergency guidelines. Certain guidelines that lend themselves to different PAGs for different subpopulations are the PAGs for potassium iodide, food and water. These guidelines provide age-specific recommendations because of the radiosensitivity of the thyroid and young children with respect to ingestion and inhalation doses in particular. Taking protective actions like using potassium iodide, avoiding certain foods or using alternative sources of drinking water can be relatively simple to implement by the parents of young children. Clear public messages can convey which age groups should take which action, unlike how an evacuation or relocation order should apply to entire households or neighborhoods.

New in the PAG Manual is planning guidance for the late phase of an incident, after the situation is stabilized and efforts turn toward recovery. Because the late phase can take years to complete, decision makers are faced with managing public exposures in areas not fully remediated. The proposal includes quick reference operational guidelines to inform re-entry to the contaminated zone. Broad guidance on approaches to wide-area cleanup and cleanup goals is also provided. EPA adapted the cleanup process from the 2008 U.S. Department of Homeland Security (DHS) *Planning Guidance for Protection and Recovery Following Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents* and the final PAG Manual will supersede that DHS guidance. Waste management guidance is also provided. Recognizing that an incident could result in radioactive waste volumes that severely strain or exceed available resources and capacity, officials may consider alternatives for disposal of waste that is relatively lightly contaminated. Waste management, including treatment, staging, interim and long-term storage, must be an integral part of recovery.

Learn more about the proposed PAG Manual and plans for finalization and implementation.

11:35 am

National Alliance for Radiation Readiness: Leveraging Partnerships to Increase Preparedness

James S. Blumenstock
Association of State and Territorial Health Officials, National Alliance for Radiation Readiness

The National Alliance for Radiation Readiness (NARR) is a collective of 17 national member organizations that have banded together to serve as the collective "voice of health" in radiological preparedness through the:

- participation in national dialogues on radiological emergency issues;
- provision of thoughtful feedback on documents, policies, and guidelines; and
- convening of partners to raise awareness of and resolve radiological emergency issues.

NARR benefits from the intersection of public health, radiation control, and emergency management professionals; all with an interest in bolstering the nation's preparedness for a radiological or nuclear incident. NARR is able to provide a unique perspective on radiological and nuclear preparedness by creating multi-disciplinary workgroups to develop guidance, recommendations, and provide subject matter feedback.

NARR aims to build response and recovery capacity and capabilities by supporting the sharing resources and tools, including technical methods and information through the development of an online clearinghouse. NARR also aims to identify and disseminate of best practices, along with define and educate on the roles and responsibilities of local, state and federal government and the numerous agencies involved with the response to a radiological emergency.

Following the Fukushima incident, NARR led a review of the U.S. public health and medical response to domestic concerns. NARR leveraged this information to develop a table-top exercise testing the current passenger screening guidelines that were developed following Fukushima. Due to the lessons learned from the exercise, NARR has drafted expanded traveler screening guidance for ports of entry. In addition to passenger screening, NARR has developed a list of considerations for prioritization of laboratory samples following a radiological event. This list was created to help jurisdictions plan for the surge of samples that would present at labs following a radiological event.

This presentation will not only introduce you to NARR and its member organizations, it will provide you with an overview of how NARR utilizes its member organizations to enhance preparedness by developing products and opportunities for inclusion.

12:05 pm **Q&A**

Summary

John D. Boice, Jr., *Session Chair*

12:30 pm

Summary of Meeting
Donald A. Cool
Program Committee Chair

12:55 pm

Closing Remarks
John D. Boice, Jr.
President, NCRP

1:00 pm

Adjourn

Program Committee

Donald A. Cool, *Chair*
U.S. Nuclear Regulatory Commission

Ruth E. McBurney, *Co-Chair*
Conference of Radiation Control Program Directors

Kathryn H. Pryor, *Co-Chair*
Pacific Northwest National Laboratory

Isaf Al-Nabulsi
U.S. Department of Energy

Armin Ansari
Centers for Disease Control and Prevention

Renate Czarwinski
International Radiation Protection Association

Jonathan D. Edwards
U.S. Environmental Protection Agency

John A. MacKinney
U.S. Department of Homeland Security

Donald L. Miller
U.S. Food and Drug Administration

Michael A. Noska
U.S. Food and Drug Administration

Michael T. Ryan, *Consultant*
Health Physics Journal

Registration

Monday, March 16, 2015	7:00 am – 5:00 pm
Tuesday, March 17, 2015	7:00 am – 11:00 am

Register online: http://registration.ncrponline.org

2016 Annual Meeting

Meeting the Needs of the Nation for Radiation Protection

Kathryn H. Pryor & Richard E. Toohey, *Co-Chairs*

March 7–8, 2016
Bethesda, Maryland

Publications (http://NCRPpublications.org)

NCRP	Title	Price / PDF
Report No. 175	Decision Making for Late-Phase Recovery from Major Nuclear or Radiological Incidents (2014)	$ 160 / 128
Commentary No. 23	Radiation Protection for Space Activities: Supplement to Previous Recommendations (2014)	30 / 24
Report No. 174	Preconception and Prenatal Radiation Exposure: Health Effects and Protective Guidance (2013)	175 / 140
Report No. 172	Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States (2012)	65 / 52
Report No. 165	Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers (2010)	75 / 60
Report No. 146	Approaches to Risk Management in Remediation of Radioactively Contaminated Sites (2004)	50 / 40
Statement No. 10	Recent Applications of the NCRP Public Dose Limit Recommendation for Ionizing Radiation (2004)	—
Statement No. 9	Extension of the Skin Dose Limit for Hot Particles to Other External Sources of Skin Irradiation (2001)	—
Report No. 129	Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies (1999)	50 / 40
Statement No. 8	The Application of ALARA for Occupational Exposures (1999)	—
Report No. 116	Limitation of Exposure to Ionizing Radiation (1993)	35 / 28

Please visit the NCRP website, http://NCRPpublications.org, for a complete list of publications. Reports and commentaries are available in both soft- and hardcopy formats unless otherwise noted. Book reviews of NCRP publications are also available at this website. Contact NCRP's Executive Director, Dr. David A. Smith (smith@ncrponline.org), for more information.

Annual Warren K. Sinclair Keynote Address

Honorary Vice President Dr. Kenneth R. Kase has been selected to give the 12th Warren K. Sinclair Keynote Address at the 2015 Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP). The Address, entitled *Influence of the NCRP on Radiation Protection in the United States: Guidance and Regulation*, which will be a featured presentation at the 51st NCRP Annual Meeting to be held March 16 and 17, 2015. The Address will be given at 8:30 a.m. on March 16, 2015 in the Crystal Ballroom, Hyatt Regency Bethesda, One Bethesda Metro Center, 7400 Wisconsin Avenue. The keynote speaker series honors Dr. Warren K. Sinclair, NCRP's second President (1977 to 1991) who died this past year at the age of 90 y [Boice and Schauer (2014) "Warren Keith Sinclair (1924 to 2014)," Health Phys. **107**(5), 461-463].

Dr. Kase was a member of the Council for 24 y, served as Senior Vice President for 9 y, and for 12 y as Scientific Vice President and Chair of Scientific Committee 46 for Operational Radiation Safety. He also was a member of Committee 4 of the International Commission on Radiation Protection from 1997 to 2001. Dr. Kase completed his term as President of the International Radiation Protection Association (IRPA) in May 2012. He served as Vice-President from 2004 to 2008, and chaired the International Congress Program Committee for the 2000 International Congress on Radiation Protection (IRPA 10) in Hiroshima, Japan.

Kenneth Kase began his career in Health Physics at Lawrence Livermore National Laboratory, California, in 1963 and moved to Stanford Linear Accelerator Center (SLAC) in 1969. In 1975 he received a PhD from Stanford University and was appointed to the faculty of Radiation Oncology at the Harvard Medical School. He was appointed Professor of Radiation Oncology at the University of Massachusetts Medical School in 1985. In 1992 he returned to Stanford and was appointed Associate Director of SLAC and Director of the Environment, Safety and Health Division in 1995. He retired from that post in 2001 and from SLAC in 2005.

Throughout his career Dr. Kase has been active in research activities related to radiation physics and radiation protection, particularly in radiation measurements and the operation of particle accelerators. He has published over 75 papers in peer reviewed journals, co-authored one book, and edited three others on radiation dosimetry.

Dr. Kase served on the Board of Directors of the Health Physics Society (HPS) from 1989 to1992 and 2002 to 2005 and as President of the HPS in 2003 to 2004. He served on the Board of Directors of the American Association of Physicists in Medicine (AAPM) from 1984 to 1991, and as AAPM Treasurer from 1986 to 1991. Dr. Kase also has been an associate editor of *Health Physics*, *Medical Physics*, and *Radiation Research*. Currently, Dr. Kase is co-Chair of Council Committee 1 on Radiation Protection Guidance for the United States.

Lauriston S. Taylor Lecture

Dr. Keith F Eckerman has been selected to give the 39th Lauriston S. Taylor Lecture at the 2015 Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP). The lecture, entitled Dosimetry of Internal Emitters: Contribution of Radiation Protection Bodies and Radiological Events, will be the featured presentation at the 51st Annual Meeting to be held March 16-17, 2015. The Lecture will be given in the Crystal Ballroom of the Hyatt Regency Bethesda, One Bethesda Metro Center, 7400 Wisconsin Avenue, Bethesda, Maryland at 5:00 p.m. on March 16, 2015. The lecture series honors the late Dr. Lauriston S. Taylor, the NCRP founding President (1929 to 1977) and President Emeritus (1977 to 2004). A reception sponsored by Landauer, Inc. follows the presentation and all are invited to attend.

Dr. Eckerman is a retired staff member of the Environmental Sciences Division of the Oak Ridge National Laboratory.

In 1962, Dr. Eckerman graduated with a B.S. in Mathematics and Chemistry, and minor in Physics, from the University of Wisconsin-Platteville. From 1962 to 1966 he taught high school and attended a National Science Foundation Program at Marquette University. To complete the research for an M.S. in Physics, Dr. Eckerman, under sponsorship of the U.S. Atomic Energy Commission, spent an academic year at Oak Ridge Institute for Science and Education (ORISE) and obtained his M.S. degree from Marquette University in 1967. He attended Northwestern University from 1967 to 1972 and received his Ph.D. degree in Radiological Health. Dr. Eckerman worked at Argonne National Laboratory from 1972 to 1974 and with the U.S. Nuclear Regulatory Commission (1974 to 1978) prior to joining Oak Ridge National Laboratory in 1979. He retired from the laboratory in 2013.

Dr. Eckerman served on a number of NCRP scientific committees (SC) in the early 1980s; most recently on SC 4-1 (Management of Persons Contaminated with Radionuclides) and SC 6-9 (U.S. Radiation Workers and Nuclear Weapons Test Participants Radiation Dose Assessment). Dr. Eckerman is a Distinguished Emeritus Member of the Council. In 1999 he received the Distinguished Scientific Achievement Award from the Health Physics Society, in 2001 the Loevinger-Berman Award from the Society of Nuclear Medicine, and the Gold Medal in Radiation Protection awarded by the Royal Swedish Academy of Sciences in 2012.

Dr. Eckerman was a member of Committee 2 of the International Commission on Radiological Protection (ICRP) from 1984 to 2012 and chaired the Task Group on Dose Calculations from 1984 to 2007. Dr. Eckerman is an Emeritus Member of the ICRP.

The 2015 Annual Meeting celebrates 51 years since Congress chartered the NCRP as the voice for radiation protection in the United States. The theme is Changing Regulations and Radiation Guidance: What Does the Future Hold? Dr. Eckerman has served and provided leadership and direction to the radiation protection community for over three decades and most recently during the adoption of changes in regulations related to the intake of radioactive elements into the body. Dr. Eckerman is a perfect fit to be the “main event” at the 2015 Annual Meeting!

Biographies

Isaf Al-Nabulsi, *Program Committee*, has more than 20 y of experience in radiation sciences. In her role as Senior Technical Advisor, she reports directly to the Director, Office of Health and Safety and provides advice on a wide range of topics, including radiobiology and dosimetry, domestic and international health activities, radiation protection policy, computed tomography scanning for early lung cancer detection, and human subject research issues. In addition, she serves as the Japan Program Manager. Dr. Al-Nabulsi joined DOE in 2008 in the Office of Former Worker Screening Programs. Prior to joining DOE, she served as a Program Administrator for the congressionally mandated Veterans Advisory Board on Dose Reconstruction for the U.S. Department of Defense and the U.S. Department of Veterans Affairs at NCRP. She previously held a position as senior program officer/study director with the Board on Radiation Effects Research at the National Research Council/National Academy of Sciences where she directed 12 studies, five of which were congressionally mandated studies, such as Review of the Dose Reconstruction Program of the Defense Threat Reduction Agency, Assessment of the Scientific Information for the Radiation Exposure Screening and Education Program, including a project requested by the President of the United States, entitled Distribution and Administration of Potassium Iodide in the Event of a Nuclear Incident.

Dr. Al-Nabulsi received her MS in radiation sciences from Georgetown University and her PhD in biomedical chemistry from the School of Pharmacy at the University of Maryland at Baltimore. She is a member of the Radiation Research Society, Health Physics Society, and Medical Response Work Group of the Health Physics Society Homeland Security Section.

Armin Ansari, *Program Committee*, is a health physicist at the Centers for Disease Control and Prevention (CDC) serving as subject matter expert in CDC's radiation emergency preparedness and response activities. Dr. Ansari received both his BS and PhD degrees in radiation biophysics from the University of Kansas, starting his career as a radiation biologist, and did his postdoctoral research at Oak Ridge and Los Alamos National Laboratories. He was a senior scientist with the radiological consulting firm of Auxier & Associates before joining CDC in 2002. Dr. Ansari was the lead author of the CDC guide for state and local public health planners on population monitoring, and a contributing author to the federal Planning Guidance for Response to a Nuclear Detonation. He was the 2009 recipient of Excellence in Public Health Practice Award from the National Center for Environmental Health, and a 2011 recipient of Outstanding Achievement Award from Conference of Radiation Control Program Directors, Inc. Dr. Ansari is also an adjunct associate professor of nuclear and radiological engineering at Georgia Institute of Technology, a member of Georgia East Metro Medical Reserve Corps, and a member of Gwinnett County Community Emergency Response Team. He recently published the text book *Radiation Threats and Your Safety: A Guide to Preparation and Response for Professionals and Community*. Dr. Ansari had served on the Board of Directors of the Health Physics Society, and is past president of the Society.

James S. Blumenstock holds the position of Chief Program Officer for Health Security for the Association of State and Territorial Health Officials (ASTHO). His portfolio includes the state public health practice program areas of infectious and emerging diseases, immunization, environmental health, and public health preparedness (including pandemic influenza preparedness). Mr. Blumenstock also serves as a member of the Association's Executive Management Team responsible for enterprise-wide strategic planning, administrative services, member support, and public health advocacy.

Prior to his arrival at ASTHO on November 1, 2005, Mr. Blumenstock was the Deputy Commissioner of Health for the New Jersey Department of Health and Senior Services where he retired after almost 32 y of career public health service. In this capacity, he had executive oversight responsibilities for a department branch of over 650 staff, an operating budget of approximately $125 million, which was comprised of the Division of Public Health and Environmental Laboratories; Division of Epidemiology, Occupational and

Environmental Health; Division of Local Health Practice and Regional Systems Development; Division of Health Emergency Preparedness and Response, and the Office of Animal Welfare. During his tenure, he also represented the Department on a number of boards, councils and commissions including the New Jersey Domestic Security Preparedness Task Force.

Mr. Blumenstock is the proud recipient of the ASTHO 2004 Noble J. Swearingen Award for excellence in public health administration and the Dennis J. Sullivan award, the highest honor bestowed by the New Jersey Public Health Association for dedicated and outstanding service and contribution to the cause of public health. He is also a Year 14 Scholar of the Public Health Leadership Institute and held an elected office serving his community for 12 y.

Jim Blumenstock received his BS in Environmental Science from Rutgers University in 1973 and a MS in Health Sciences Administration from Jersey City State College in 1977. He is a native of New Jersey which is still his primary residence with his wife of 40 y, Lee. They have three children and three grandchildren.

John D. Boice, Jr., *NCRP President* and Professor of Medicine at Vanderbilt University School of Medicine, Nashville, Tennessee. He is an international authority on radiation effects and currently serves on the Main Commission of the International Commission on Radiological Protection and as a U.S. advisor to the United Nations Scientific Committee on the Effects of Atomic Radiation. During 27 y of service in the U.S. Public Health Service, Dr. Boice developed and became the first chief of the Radiation Epidemiology Branch at the National Cancer Institute. Dr. Boice has established programs of research in all major areas of radiation epidemiology, with major projects dealing with populations exposed to medical, occupational, military and environmental radiation. These research efforts have aimed at clarifying cancer and other health risks associated with exposure to ionizing radiation, especially at low-dose levels. Boice's seminal discoveries and over 440 publications have been used to formulate public health measures to reduce population exposure to radiation and prevent radiation-associated diseases. He has delivered the Lauriston S. Taylor Lecture at the NCRP and the Fessinger-Springer Lecture at the University of Texas at El Paso. In 2008, Dr. Boice received the Harvard School of Public Health Alumni Award of Merit. He has also received the E.O. Lawrence Award from the Department of Energy - an honor bestowed on Richard Feynman and Murray Gell-Mann among others - and the Gorgas Medal from the Association of Military Surgeons of the United States. In 1999 he received the outstanding alumnus award from the University of Texas at El Paso (formerly Texas Western College). Dr. Boice recently launched the Million U.S. Radiation Workers and Veterans Study to examine the lifetime risk of cancer following relatively low-dose exposures received gradually over time.

Michael A. Boyd, *Session Co-Chair*, is a senior health physicist in the U.S. Environmental Protection Agency (EPA) Office of Radiation and Indoor Air/Radiation Protection Division (RPD) and has been with EPA since 1988. As a member of RPD's Center for Science and Technology, Mr. Boyd manages the development of new federal guidance documents. He is also the co-chair of the Federal Guidance Subcommittee of the Interagency Steering Committee on Radiation Standards (ISCORS). Mr. Boyd is a recently elected member of the International Commission on Radiological Protection Committee 4. He chairs the Health Physics Society's International Collaboration Committee and is on the Bureau of the Organisation for Economic Co-operation and Development/Nuclear Energy Agency's Committee on Radiation Protection and Public Health. He has a BS in Biology and MS in Public Health from the University of North Carolina at Chapel Hill.

Biographies

S.Y. Chen, *Session Co-Chair*, is currently Director of Professional Master of Health Physic Program at the Illinois Institute of Technology (IIT), Chicago. Prior to joining IIT, he was Senior Environmental Systems Engineer and also served as the Strategic Area Manager in Risk and Waste Management in the Environmental Science Division at Argonne National Laboratory, Argonne, Illinois. He received his BS in nuclear engineering from National Tsing Hua University in Taiwan and obtained his MS and PhD in nuclear engineering from the University of Illinois at Champaign-Urbana. Dr. Chen's professional interests include radiation protection, human and environmental health risk, and nuclear accident analysis; with special expertise in environmental cleanup, radioactive material disposition management, and nuclear waste transportation. Dr. Chen has been a NCRP Council member since 1999, and served on its Board (2004 to 2011). He currently serves as NCRP Scientific Vice President on Environmental Radiation and Waste Issues (since 2004). Dr. Chen has served on the U.S. Environmental Protection Agency's Science Advisory Board/Radiation Advisory Committee since 2009. He is a long-time member of the Health Physics Society and of the American Nuclear Society. He was elected to Fellow by the Health Physics Society in 2013, and is a Certified Health Physicist by the American Board of Health Physics. While at Argonne, Dr. Chen developed an integrated risk assessment program that addresses the broad-based issues to support federal risk-based policies. Dr. Chen had served on numerous capacities at NCRP, including chairing Scientific Committee (SC) 87-4 which led to the publication of Report No. 141, *Managing Potentially Radioactive Scarp Metal*, and also chairing SC 5-1, Decision Making for Late-Phase Recovery from Major Nuclear or Radiological Incidents. He served as Chair of NCRP 2005 Annual Meeting Program Committee, Managing the Disposition of Low-Activity Radioactive Materials, and as Co-Chair of NCRP 2013 Annual Meeting Program Committee, Radiation Dose and the Impacts on Exposed Populations.

Donald A. Cool, *Program Committee Chair*, is currently the Senior Level Advisor for Radiation Safety and International Liaison in the Office of Nuclear Material Safety and Safeguards with the U.S. Nuclear Regulatory Commission. In this position, he is responsible for coordinating the wide range of international activities of NRC related to radiation protection, safety and security of byproduct materials, decommissioning and waste management, radiation protection policy, and international standards. He has more than 30 y of experience in NRC, and has previously served in various senior management positions including Director, Division of Industrial and Medical Nuclear Safety, and other increasingly responsible positions within the NRC staff. Dr. Cool received his Masters and Doctorate degrees in Radiation Biology from the University of Rochester School of Medicine and Dentistry. He is a member of the Main Commission of International Commission on Radiological Protection (ICRP), Chairman of ICRP Committee 4 on Practical Applications, and a member of NCRP. He serves as co-chair of the U.S. Federal Interagency Steering Committee on Radiation Standards (ISCORS) and co-chair of the ISCORS Federal Guidance Subcommittee. He has served on numerous panels and expert groups of the International Atomic Energy Agency and the Nuclear Energy Agency Committee on Radiation Protection and Public Health.

Allen G. Croff is an adjunct professor at Vanderbilt University lecturing and participating in projects concerning the nuclear engineering and the nuclear fuel cycle, and a consultant to the Nuclear Waste Technical Review Board. He worked at Oak Ridge National Laboratory (ORNL) for 30 y in areas concerning waste management, nuclear fuel cycle, and nuclear materials research and development. His career at ORNL included creation of the ORIGEN2 computer code, developing and evaluating radioactive waste classification systems, and evaluating current and advanced nuclear fuel cycles.

After retiring from ORNL in 2003, he was vice-chairman of the Advisory Committee on Nuclear Waste and Materials that provided technical advice to the commissioners of the U.S. Nuclear Regulatory Commission on waste disposal, the fuel cycle, and nuclear materials management from 2004 to 2008. He then became a senior technical advisor to the Blue Ribbon Commission on America's Nuclear Future from 2010 to 2012 in parallel with his activities at Vanderbilt University.

Throughout his career he had extensive external U.S. and international involvements on technical review, oversight and integration committees. He has been a member of 10 committees, and the Nuclear and Radiation Studies Board of the National Academy of Sciences, he led the committee that wrote NCRP Report No. 139 concerning risk-based waste classification, he was a member of the Nuclear Energy Research Advisory Committee, and chaired the Nuclear Development Committee of the Nuclear Energy Agency for 10 y.

Renate Czarwinski, *Program Committee*, began her career in Health Physics in 1971 with the study of Experimental Physics and Radiation Protection Physics at the Technical University of Dresden, finalized in 1975. After an industrial mission she moved to the National Board for Nuclear Safety and Radiation Protection in Berlin in 1977. She graduated from a postgraduate program from 1982 to 1984 and received her license as an inspector for radiation protection in nuclear facilities. From 1990 to 1996, as a research assistant, she was responsible for internal and external dose assessments as well as for assessment of radiation exposures in buildings and the environment. She coordinated national radon campaigns and managed European radon research projects. In 1996 Ms. Czarwinski was appointed as Head of Radiation Protection at Workplaces Section in the German Federal Office for Radiation Protection with responsibilities for the assessment of safety and security of radioactive sources and the establishment of a register on high activity sources based on the European Directive.

From 2007 to 2012 Ms. Czarwinski acted as the Head of Radiation Safety and Monitoring Section of the International Atomic Energy Agency in Vienna. Under her leadership the revision of the Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards was finalized as General Safety Requirements Part 3 (interim). Radiation protection of patients and workers, monitoring services and exposures of the public due to natural sources of radiation and emergency situations were further topics of her responsibility. Ms. Czarwinski is a member in the Interagency Committee on Radiation Safety and chaired this committee for 2 y. Since June 2012 Ms. Czarwinski has been the Head of Section on Safety and Security of Radiation Sources; Radiation Incidents; Type Approvals in the Federal Office for Radiation Protection in Berlin, Germany. She is now involved in the transposition and implementation of the revised European Basic Safety Standards 2013/59/EURATOM into German legislation.

Throughout her career Ms. Czarwinski has been active in research activities related to radiation physics and in practical activities related to radiation protection. She has published numerous scientific papers and participated as an invited lecturer in various training courses, meetings and conferences. In July 2012 Ms. Czarwinski received the Health Physics Society's Landauer Lecturer Award which honors prominent individuals who have made significant contributions to the field of radiation research and protection.

Furthermore she is an active volunteer in national and international nongovernmental organizations. Since 2004 she has been a Member of the Executive Council of the International Radiation Protection Association (IRPA) and was elected as President of IRPA in 2012.

Since 1995 Ms. Czarwinski has been a member of the editorial committee and sub-editor of the journal *Strahlenschutz-PRAXIS*. Since 2007 she has served as an International Editorial Advisor to the *Journal of Radiological Protection*, United Kingdom and for the last 2 y also as an editorial adviser to the e-journal *Radiation Protection Regulator*, United Kingdom.

Biographies

Lawrence T. Dauer is Associate Attending Physicist, and Associate Clinical Member in the Departments of Medical Physics and Radiology at Memorial Sloan-Kettering Cancer Center (MSKCC) in New York City. He earned an MS in Health Physics and a PhD in Adult Education. He is certified in comprehensive health physics by the American Board of Health Physics and is past chair of the Radiation Safety Committee of the American Association of Physicists in Medicine (AAPM), past President of the Greater New York Chapter of the Health Physics Society (HPS), Executive Council Member of the Medical Physics Section of the HPS, a Member of the joint Safety Committee of the Society for Interventional Radiology and the American College of Radiology, past council member of the Radiological and Medical Physics chapter of the AAPM, and a member of editorial and review boards of several scientific journals. He serves as the Chair of the MSKCC Emergency Management Committee, a member of the Radiation Injury Treatment Network. In 2005, he received the Elda E. Anderson Award from the Health Physics Society. He is currently a Council member of the NCRP. He also serves as a member of International Commission on Radiological Protection Committee 3 on protection in medicine, a member of the science council for the International Organization for Medical Physics, and was on the program committee for the International Atomic Energy Agency's International Conference on Radiation Protection in Medicine-Setting the Scene for the Next Decade. He has several publications in the topical areas of radiation protection and risks in the fields of detection, radiology, interventional radiology, x-ray imaging, nuclear medicine, and radiation oncology, as well as surgery and medicine.

Sara DeCair has been a health physicist with the U.S. Environmental Protection Agency's (EPA) Office of Radiation and Indoor Air since 2003. She works on policy, planning, training and outreach for EPA's radiological emergency preparedness and response program. She is the project and technical lead for revising the Protective Action Guides Manual. She previously worked for 7 y with the State of Michigan's Department of Environmental Quality. She spent three of those years in nuclear power plant emergency planning and before that was an inspector of radioactive materials registrants and a radiation incident responder.

Jonathan D. Edwards, *Program Committee*, became Director of the U.S. Environmental Protection Agency's (EPA) Radiation Protection Division in December of 2008. As Division Director, he is responsible for several programs including EPA's radiological emergency response program, environmental oversight of the U.S. Department of Energy's deep geological repository known as the Waste Isolation Pilot Plant near Carlsbad, New Mexico; scientific and technical radiation risk assessments; and other radiation protection activities and programs.

Mr. Edwards graduated from the U.S. Naval Academy in Annapolis, Maryland, in 1985, completed 2 y of post-graduate nuclear engineering instruction and training, and served on the fast attack submarine USS SPADEFISH (SSN-668) as Main Propulsion Assistant and Assistant Engineer.

Upon leaving the Navy in 1993, Mr. Edwards began work with the EPA as a health physicist in the radiation program, going on to work with the Office of Science Policy in the EPA Office of Research and Development. In early 2003, at about the time of the creation of the U.S. Department of Homeland Security, then-EPA Administrator Christy Todd Whitman approved his reassignment to Deputy Director of EPA's Office of Homeland Security (OHS), a new policy office formed to advise the EPA Administrator on homeland security issues. Mr. Edwards served a number of years with EPA's OHS, garnering wide respect for his agency-wide leadership on initial EPA homeland security policies and strategies. He served with OHS until his current assignment as Director, Radiation Protection Division.

Biographies

John W. Herczeg currently serves as the Deputy Assistant Secretary for Fuel Cycle Technologies with the U.S. Department of Energy's (DOE) Office of Nuclear Energy (NE), whose mission promotes nuclear power as a resource capable of meeting the nation's energy, environmental, and national security needs. He manages a research and development budget of approximately $185 million and a federal staff workforce of about 50 employees. Prior to his current position, Dr. Herczeg was the Associate Deputy Assistant Secretary for Fuel Cycle technologies from 2011 to 2013.

Dr. Herczeg has contributed to the development of innovative energy technologies throughout his professional career. He was instrumental in the launching of several key program offices and initiatives within NE. For example, he established NE's first Nuclear Energy Research Advisory Committee which is comprised of outside experts which provide guidance to the Assistant Secretary for Nuclear Energy. Furthermore, he established and led a team that developed the first Nuclear Energy Research Initiative (NERI) solicitation and awards. Proposals were reviewed and selected based upon their creativity, scientific and technical quality, and relevance to DOE's nuclear energy mission. To date, NE has sponsored 186 NERI project awards with an investment of approximately $185 million.

In addition, Dr. Herczeg was called to serve in a senior level advisory capacity to the Deputy Secretary of Energy and participate in the developing the foundation of the Global Nuclear Energy Partnership from 2005 to 2006. This high-level initiative was designed to reduce the risk of proliferation and provide for the safe management of used fuel, while encouraging the expansion of nuclear energy. In this capacity, he directed the establishment of bilateral international nuclear energy cooperative research and development agreements with fuel cycle countries. He successfully negotiated an Action Plan with Russia on Civil Nuclear Energy Cooperation. Action plans with Japan, France and China soon followed.

As a recognized expert in the nuclear energy field both in the United States and worldwide, Dr. Herczeg was the U.S. representative to the International Atomic Energy Agency Standing Advisory Committee group on Nuclear Energy from 2004 to 2010; He is also the Chair of the Nuclear Science Committee of the Nuclear Energy Agency where he has been instrumental in the reorganization of the Committee's reactor physics and fuel cycle activities.

Before joining DOE he worked at Brookhaven National Laboratory and in private industry he worked in the Nuclear Electric Utility Industry Office in Control Data Corporation and was on the scientific staff at Brookhaven National Laboratory.

Dr. Herczeg holds a PhD and an MS in Nuclear Engineering from Purdue University, as well as a BS in Physics from Bowling Green State University in Ohio.

Michiaki Kai is a Professor of Environmental Health at Oita University of Nursing and Health Sciences. He has been conducting the research on radiation carcinogenesis and its risk. Dr. Kai's recent work looks at risk analysis of computed tomography exposure. Since 2005, he is a member of ICRP Committee 4 and Chair for Task Group 93 dealing with emergency and post-existing exposure situations after a nuclear accident. He is also the ex-president of the Society for Risk Analysis Japan.

Joseph G. Klinger has been the Assistant Director of the Illinois Emergency Management Agency (IEMA) since January 2007. From May 2010 to February 2011, he served as the IEMA Interim Director and as the Governor's Homeland Security Advisor. Mr. Klinger currently serves as the Illinois Governor's Deputy Homeland Security Advisor. As Assistant Director, he oversees the day-to-day operations of the agency, which has 228 employees and an annual budget of $477 million.

A major component within IEMA is a robust nuclear safety program with many innovative programs. Illinois has 11 operating nuclear power reactors, more than any other state, and IEMA has been an Agreement State since 1987 with approximately 740 radioactive material licensees. IEMA also regulates 11,000 x-ray facilities, accredits over 13,000 radiologic technologists, and is one of four certifying states under the Mammography Quality Standards Act Program.

In June 2008, Mr. Klinger was appointed as a Commissioner on the Central Midwest Interstate Low-Level Radioactive Waste Compact Commission and currently serves as Chairman. The Commission oversees all low-level radioactive waste issues in the compact consisting of Illinois and Kentucky. He is currently the past-Chairperson for the Conference of Radiation Control Program Directors, Inc. (CRCPD) and serves as one of two representatives from the National Emergency Management Association for the National Alliance for Radiation Readiness.

Mr. Klinger has worked for IEMA for over 26 y. Prior to his role as Assistant Director, he served as the agency's Manager of the Radioactive Materials Program since 1996. He began employment as the Head of Radioactive Material Licensing in August 1988. From 1980 to 1988, Mr. Klinger was the Licensing Branch Administrator for the Texas Bureau of Radiation Control.

Mr. Klinger has been a consultant to the International Atomic Energy Agency (IAEA) in Vienna, Austria and assisted IAEA in the development of the Radioactive Source Categorization document currently used globally for security efforts. He performed technical assist visits to Latvia and Panama in the global effort to control all significant sources of radioactive material. He has been a featured speaker at many state, national and international meetings, including a conference on the "Peaceful Use of Radioactive Materials" in Hanoi, Vietnam in March 1999. Most recently, in October 2013, he presented a poster session regarding CRCPD Orphan Source and Source Collection and Threat Reduction Program at the IAEA "Safety and Security of Radioactive Sources: Maintaining Continuous Global Control of Sources throughout Their Life Cycle" in Abu Dhabi, UAE.

Joseph Klinger earned his BS in Microbiology/Chemistry and completed some graduate studies at the University of Texas at Austin, and his MS in Health Care Management/Public Administration at Southwest Texas State University (now Texas State University). He is currently enrolled in the Executive Leaders Program (ELP) through the Naval Postgraduate School - Center for Homeland Defense and Security. Over his 34+ years in Health Physics, he has completed extensive health physics training in courses at Oak Ridge Associated Universities, University of Texas, College of Engineering, and other institutions.

In 1985, he was commissioned an Officer in the U.S. Navy Reserve as a Radiation Health Officer, Environmental Health Officer and Health Care Manager in the Medical Service Corps. He was deployed in 2004 to 2005 to the Middle East in support of Operation Enduring Freedom (Afghanistan) and Operation Iraqi Freedom. Mr. Klinger began his military career in 1967 as a U.S. Marine Corps Combat Infantryman in Vietnam and retired in 2008 as a Navy Captain.

Biographies

Edward Lazo holds BS and MS degrees in Nuclear Engineering, and a PhD in Radiation Protection, and has been focused in all his professional positions on the practical application of knowledge and experience. His experience has included applied decommissioning at Three Mile Island, environmental restoration at contaminated U.S. Department of Energy sites, operating laboratory and accelerator radiation protection at Brookhaven National Laboratory, and operational radiation protection at French nuclear power stations with Framatome (now Areva) and Electricite de France. Since 1993 he has been with the Nuclear Energy Agency's (NEA) Division of Radiation Protection and Radioactive Waste Management, where he is the Scientific Secretariat of the NEA's Committee on Radiation Protection and Public Health, and is responsible for all subgroups (totaling ~250 experts from 31 countries). His work at NEA has focused on the evolution of the system of radiological protection, radiological risk assessment and management, stakeholder involvement and risk governance, radiation protection policy and regulation, nuclear emergency management, occupational exposure at nuclear power plants, and decommissioning. Dr. Lazo was also the Chair of the International Congress Programme Committee for IRPA13, and has participated in the work of the International Commission on Radiological Protection (ICRP) Committee 4 as an observer since 1995 (as a member of the task groups that developed ICRP Publications 101, 109, 111, 124, and 125).

Jacques Lochard was educated in Economics and has more than 35 y experience in radiological protection. His main contribution in radiation protection has been in the development of methodologies and implementation tools in the field of optimization of protection. He has written several tens of articles in scientific journals and proceedings of international conferences, covering both the theoretical and practical aspects of optimization. From 1990 to 2010, he was involved in international projects on the consequences of the Chernobyl catastrophe and the rehabilitation of living conditions in the contaminated territories in Belarus. He is currently involved in several activities in Japan in relation to the Fukushima accident. Jacques Lochard has been President of the French Society of Radiation Protection (1997 to 1999), Chairman of the Committee on Radiation Protection and Public Health of the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (2005 to 2009) and Executive Officer of the International Radiation Protection Association (2000 to 2012). He is currently Vice-Chair of the International Commission on Radiological Protection.

Peter B. Lyons was confirmed as the Assistant Secretary for Nuclear Energy, U.S. Department of Energy (DOE), on April 14, 2011 after serving as the Acting Assistant Secretary since November 2010. Dr. Lyons was appointed to his previous role as Principal Deputy Assistant Secretary of the Office of Nuclear Energy (NE) in September 2009.

Under Dr. Lyons' leadership, the Office has made great strides in incorporating modeling and simulation into all programs through the Nuclear Energy Advanced Modeling and Simulation program and the Energy Innovation Hub. He focused on management of used fuel by contributing to the development of the Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste. In addition, NE established the Small Modular Reactor Licensing Technical Support program for a new generation of safe, reliable, low-carbon nuclear energy technology. And he championed the Nuclear Energy University Program, which has successfully supported U.S. universities in preparing the next generation of nuclear engineering leaders.

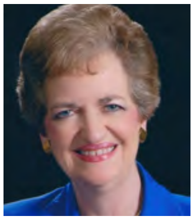
Prior to joining DOE, Dr. Lyons was sworn in as a Commissioner of the U.S. Nuclear Regulatory Commission (NRC) on January 25, 2005 and served until his term ended on June 30, 2009. At NRC, Dr. Lyons focused on the safety of operating reactors, even as new reactor licensing and possible construction emerged. He was a consistent voice for improving partnerships with international regulatory agencies. He emphasized active and forward-looking research programs to support sound regulatory decisions, address current issues and anticipate future ones. He was also a strong proponent of science and technology education.

Before becoming a Commissioner, Dr. Lyons served as Science Advisor on the staff of U.S. Senator Pete Domenici and the Senate Committee on Energy and Natural Resources where he focused on military and civilian uses of nuclear technology from 1997 to 2005. From 1969 to 1996, Dr. Lyons worked at the Los Alamos National Laboratory where he served as Director for Industrial Partnerships, Deputy Associate Director for Energy and Environment, and Deputy Associate Director-Defense Research and Applications. While at Los Alamos, he spent over a decade supporting nuclear test diagnostics.

Dr. Lyons has published more than 100 technical papers, holds three patents related to fiber optics and plasma diagnostics, and served as chairman of the North Atlantic Treaty Organization Nuclear Effects Task Group for 5 y. He received his doctorate in nuclear astrophysics from the California Institute of Technology in 1969 and earned his undergraduate degree in physics and mathematics from the University of Arizona in 1964. Dr. Lyons is a Fellow of the American Nuclear Society, a Fellow of the American Physical Society, and was elected to 16 y on the Los Alamos School Board.

John A. MacKinney, *Program Committee*, is the Director of Nuclear and Radiological Policy at the U.S. Department of Homeland Security (DHS). Mr. MacKinney has 24 y of experience in radiation science and risk, emergency protective action guides, technology and policy for long-term cleanup, research and development, nuclear weapons effects in urban areas, terrorism prevention, and science and policy to counter the nuclear terrorism threat. Mr. MacKinney advises and supports the Secretary of Homeland Security and the Assistant Secretary for Policy in all matters related to nuclear and radiological policy, especially terrorism prevention, response and recovery, and coordinates departmental and interagency policy development and programs to counter nuclear and radiological terrorism. Specific policy initiatives of Mr. MacKinney include requirements for response to a terrorist nuclear attack, long-term cleanup policy after acts of nuclear or radiological terrorism, counterterrorism response policy, and deterrence of weapons of mass destruction terrorism. In his Policy Director position, Mr. MacKinney represents DHS to the White House for all nuclear and radiological matters, coordinating policy development with the White House and other federal departments. He has served on a number of senior-level White House National Security Council (NSC), Homeland Security Council (HSC), and Office of Science and Technology Policy (OSTP) committees and working groups, including the HSC Scenarios Writing Group, the NSC/HSC Counterproliferation Technology Coordination Committee, the OSTP Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Subcommittee and Working Group, the OSTP Nuclear Defense Research and Development Subcommittee, all NSC Countering Nuclear Threats Policy Subcommittees, and special groups dedicated to the development of Presidential policy directives. Mr. MacKinney has served as an expert consultant to the World Bank on nuclear and radiological issues. He previously worked at the U.S. Environmental Protection Agency's Radiation Protection Division, and the National Homeland Security Research Center where he led a team of researchers investigating solutions for RDD and IND attack response and recovery. Mr. MacKinney holds a BS in Geology from Wheaton College (Wheaton, Illinois), an MS in Geophysics from the University of Wisconsin, and a MPH from the Johns Hopkins University, School of Public Health. He is certified in risk assessment and policy through the Risk Sciences and Public Policy Institute.

Biographies



Ruth E. McBurney, *Program Committee Co-Chair*, is the Executive Director of the Conference of Radiation Control Program Directors. In that position, she manages and directs the administrative office for the organization. Prior to taking that position in January 2007, she was the Manager of the Radiation Safety Licensing Branch at the Texas Department of State Health Services, culminating 25 y of service in the Texas Radiation Control Program, most of which involved licensing and standards development. Ms. McBurney has served on the U.S. Nuclear Regulatory Commission's Advisory Committee on the Medical Use of Isotopes and the U.S. Food and Drug Administration's National Mammography Quality Assurance Advisory Committee. She is currently serving as a Member of NCRP, and is also on the Board of Directors. She served as a consultant to the International Atomic Energy Agency in the categorization of radiation sources and recently served on a committee of the National Academy of Science regarding replacement technologies for high-risk radiation sources. She has also been a U.S. delegate to the International Radiation Protection Association's 10th, 11th, 12th, and 13th Congresses.

Ms. McBurney holds a BS in Biology from Henderson State University in Arkansas and an MS in Radiation Sciences from the University of Arkansas for Medical Sciences. She is also certified in comprehensive health physics by the American Board of Health Physics.

Donald L. Miller, *Program Committee*, is the Chief Medical Officer for Radiological Health in the Office of In Vitro Diagnostics and Radiological Health of the Center for Devices and Radiological Health at the U.S. Food and Drug Administration (FDA). He received a BA in molecular biophysics and biochemistry from Yale University and an MD from the New York University School of Medicine. He completed his residency and fellowship at the New York University Medical Center. Dr. Miller, an interventional radiologist, is a Fellow of the Society of Interventional Radiology and of the American College of Radiology and an Honorary Member of the American Association of Physicists in Medicine. He is Vice-Chair of Committee 3 of the International Commission on Radiological Protection and serves as a consultant to the International Atomic Energy Agency and the World Health Organization. He served as Vice-Chair for NCRP Report No. 168 and Consultant for NCRP Report No. 172. He currently serves as Co-Chair of NCRP Program Area Committee 4 and a member of the Nominating Committee. Prior to joining FDA, Dr. Miller was a Professor of Radiology and Radiological Sciences at the Uniformed Services University of the Health Sciences and an adjunct investigator at the National Cancer Institute. His research interests have centered on radiation protection in medicine.

Michael A. Noska, *Program Committee*, is the Senior Advisor for Health Physics, the Agency Radiation Safety Officer, and the Team Lead for Radiological Emergency Response at the U.S. Food and Drug Administration (FDA). He has been a health physicist with the U.S. Public Health Service (PHS) for 21 y and has had multiple assignments at the National Institutes of Health and the FDA with a focus on internal radiation dosimetry and radiological emergency preparedness and response. Prior to joining the PHS, Captain Noska worked as a research assistant in radiopharmaceutical laboratories at Harvard Medical School and Duke University Medical Center developing radiolabeled monoclonal antibodies for the treatment of cancer. He received his MS from the University of North Carolina School of Public Health as a Department of Energy Applied Health Physics Fellow. Captain Noska is the current Chair of the Federal Advisory Team for the Environment, Food and Health and a member of the Federal Radiological Preparedness Coordinating Committee. He is also the Past Chair of the Environmental Health Officer Professional Advisory Committee to the U.S. Surgeon General and Past President of the Baltimore-Washington Chapter of the Health Physics Society. Captain Noska serves on several interagency committees and work groups related to radiological emergency response. In 2011, he deployed to Japan as part of a team from the U.S. Department of Health and Human Services in support of the U.S. Ambassador following the Great Tohoku Earthquake and the nuclear crisis at the Fukushima Dai-ichi Nuclear Power Station.

Kathryn H. Pryor, *Program Committee Co-Chair*, has been a member of Program Area Committee (PAC) 2 since 2007 and a member of NCRP since 2010. She has served on Scientific Committees 2-4, 2-5, 2-7, 1-19, and 6-9. Ms. Pryor is currently on the NCRP Board of Directors and is Scientific Vice President of PAC 2. She received her BS in Biology in 1979 and MS in Radiological Sciences in 1981, both from the University of Washington.

Ms. Pryor currently holds the position of Chief Health Physicist at the Pacific Northwest National Laboratory (PNNL) in Richland, Washington, and has provided management and technical support to the PNNL Radiation Protection Division since 1992. She also served as the Chief Radiological Engineer for the design of the Pit Disassembly and Conversion Project. Ms. Pryor has previously held radiation protection technical support positions at the San Onofre Nuclear Generating Station and the Trojan Nuclear Plant, and was the Radiation Safety Officer at the University of Southern California Health Sciences Campus.

Ms. Pryor is a Fellow member of the Health Physics Society (HPS) and served as President-Elect, President, and Past President from 2010 to 2013. She is certified in comprehensive practice by the American Board of Health Physics (ABHP), and served on the ABHP both as a member and Chair from 1998 to 2002. Ms. Pryor was awarded the William McAdams Outstanding Service Award by ABHP in 2007 and the John P. Corley Meritorious Service Award by the Columbia Chapter of HPS in 2003.

Biographies

Michael T. Ryan, *Program Committee Consultant*, is an independent consultant in radiological sciences and health physics. He is an Adjunct Faculty member at Vanderbilt University in the Department of Environmental Engineering and the Texas A&M University in the Department of Nuclear Engineering. He was previously an Associate Professor in the Department of Health Administration and Policy at the Medical University of South Carolina (MUSC). He earned his BS in radiological health physics from Lowell Technological Institute in 1974. In 1976, he earned an MS in radiological sciences and protection from the University of Lowell under a U.S. Energy Research and Development Administration Scholarship. Dr. Ryan received the PhD in 1982 from the Georgia Institute of Technology, where he was recently inducted into the Academy of Distinguished Alumni. He is a recipient of the Francis Cabot Lowell Distinguished Alumni for Arts and Sciences Award for the University of Massachusetts Lowell.

Dr. Ryan is Editor In Chief of *Health Physics*. In 1989, he received the Health Physics Society (HPS) Elda E. Anderson Award, which is awarded each year to the one young member who has demonstrated excellence in research, discovery, and/or significant contribution to the field of health physics. Dr. Ryan has held numerous offices in HPS, including President of the Environmental Section and the Savannah River Chapter. Dr. Ryan served on the Technical Advisory Radiation Control Council for the State of South Carolina for 19 y. He is a member of NCRP. He has served as Scientific Vice President for Radioactive and Mixed Waste Management and Chair of Scientific Committee 87 and a member of the Board of Directors. Dr. Ryan is certified in the comprehensive practice of health physics by the American Board of Health Physics. In additional to his adjunct appointment at Texas A&M University, Dr. Ryan has taught radiation protection courses on the undergraduate and graduate level at the University of South Carolina and the College of Charleston. In addition, Dr. Ryan has authored and coauthored many refereed articles and publications in the areas of environmental radiation assessment, radiation dosimetry, and regulatory compliance for radioactive materials.

Dr. Ryan is active in his consultancy with a number of national corporations and government agencies. This work generally involves radioactive waste management, radiological health and regulatory compliance for workplace and environmental issues. He most recently served for several years on the independent review panel for decommissioning wok at Brookhaven National Laboratories. He completed a 9 y term as Chairman of the External Advisory Board for Radiation Protection at Sandia National Laboratories in 2007. He is a member of a similar external review board for Lawrence Livermore National Laboratory. He completed 8 y of service on the Scientific Review Group appointed by the Assistant Secretary of Energy to review the ongoing research in health effects at the former weapons complex sites in the Southern Urals. He has also served on several committees of the National Academy of Sciences producing reports regarding radioactive waste management topics. He also served as Chairman for the U.S. Nuclear Regulatory Commission Advisory Committee on Nuclear Waste and Materials. Dr. Ryan has served on Committee since 2002 until it was merged with the Advisory Committee on Reactor Safeguards (ACRS) in 2008. In June, 2008, Dr. Ryan became a member of the ACRS.

Prior to his appointment at MUSC, Dr. Ryan was served as Vice President of Barnwell Operations for Chem-Nuclear Systems, Inc., and had overall responsibility for operation of the low-level radioactive waste disposal and service facilities in Barnwell, South Carolina. Dr. Ryan's area of responsibility included management of a scientific, technical, and support staff; and implementation of the scientific programs to assure the safe and compliant operation of the company's low-level radioactive waste processing and disposal facilities. These programs included facility operations and implementation of policy and procedures for operation, environmental monitoring and regulatory compliance. Prior to this assignment Dr. Ryan served since 1988 as the Vice President of Regulatory Affairs, having responsibility for developing and implementing the company's regulatory compliance policies and programs to comply with state and federal regulators. Before joining Chem-Nuclear Systems, Inc., as Director of the Environmental and Dosimetry Laboratory in 1983, Dr. Ryan spent 7 y in environmental health physics at Oak Ridge National Laboratory.

Biographies

John P. Winston earned his BS in environmental sciences from the Pennsylvania State University and has worked as a Radiation Health Physicist for the Pennsylvania Bureau of Radiation Protection for 29 y. He has coauthored Pennsylvania studies on fluoroscopy, computed tomography, and dental panoramic x rays, and drafted regulations on x-ray producing machines used in the Commonwealth. Mr. Winston has chaired several Conference of Radiation Control Program Directors (CRCPD) committees: H-7 (Quality Assurance in Diagnostic X Ray), H-22 (Reducing Risk from Fluoroscopy Procedures), and, currently, SR-F (Suggested Regulations for Diagnostic and Interventional X Ray). He is also a member of CRCPD's H-39 (CT Brain Perfusion) and H-38 (Medical Events) committees. He served on CRCPD's Board of Directors for 7 y including: Chairperson (2009) and Treasurer (2004 to 2007). Mr. Winston is a member of the Interagency Steering Committee on Radiation Standards Working Group on Medical Radiation charged with writing the Federal Guidance Report No. 14: *Radiation Protection Guidance for Diagnostic and Interventional X-Ray Procedures*, and NCRP Scientific Committee 4-6.

ICRP 2015

3rd International Symposium on the System of Radiological Protection

October 20-22, 2015 | Mayfield Hotel and Resort, Seoul, KOREA

Registration Open: February 2015
ICRP 2015 Website Open: February 2015

"More than 90% of ICRP 2013 attendees were very or extremely satisfied"
"95% of ICRP 2013 attendees said they would recommend their colleagues come to Seoul to attend ICRP 2015"

Venue

Mayfield Hotel and Resort, KOREA
- Address: 94 Banghwadae-ro, Gangseo-gu, Seoul, Korea
- Tel: +82-2-2660-9000
- Website: http://www.mayfield.co.kr/

Symposium Program

Session 1. ICRP: Ongoing Work
Co-Chairs: **Claire Cousins** (Chair, ICRP & Addenbrooke's Hospital, UK), **Christopher Clement** (Scientific Secretary, ICRP)

Session 2. Exploring Existing Exposure Situations
Co-Chairs: **Jean-Francois Lecomte** (Secretary, ICRP Committee 4 & Institute for Radiological Protection and Nuclear Safety (IRSN), France), **Agneta Rising** (Director General, World Nuclear Association)

Session 3. Radiological Protection in Medicine Today
Co-Chairs: **Donald Miller** (Vice-Chair, ICRP Committee 3 & Center for Devices and Radiological Health, Food and Drug Administration, USA), **Il Han Kim** (President, Korean Association for Radiation Protection & Seoul National University, Korea)

Session 4. The Science behind Doses in Radiological Protection
Co-Chairs: **Jaiki Lee** (Member, ICRP Main Commission & Hanyang University, Korea), **Hans-Georg Menzel** (Chair, International Commission on Radiological Units and Measurements & Member, ICRP Main Commission)

Session 5. New Developments in Understanding Radiation Effects
Co-Chairs: **Werner Ruhm** (Secretary, ICRP Committee 1 & Helmholtz Zentrum Munchen, Germany), **Malcolm Crick** (Scientific Secretary, United Nations Scientific Committee on the Effects of Atomic Radiation)

Session 6. Ethics in Radiological Protection
Co-Chairs: **Jacques Lochard** (Vice-Chair, ICRP & Nuclear Protection and Evaluation Centre (CEPN), France), **KunWoo Cho** (Member, ICRP Committee 4 & Korea Institute of Nuclear Safety)

ICRP INTERNATIONAL COMMISSION OF RADIOLOGICAL PROTECTION
KARP The Korean Association for Radiation Protection

ICRP 2015 Secretariat | TEL: +82-2-765-7996 | FAX: +82-303-3441-7996 | E-mail: icrp2015@icrp.org

Contracts/Grants/Contributors/Sponsors

These organizations have supported the work of the National Council on Radiation Protection and Measurements during the period of January 1 to December 31, 2014.

Contracts

U.S. Food and Drug Administration

Grants

Centers for Disease Control and Prevention
National Aeronautics and Space Administration
National Institutes of Health / National Cancer Institute
U.S. Department of Energy (contributions from the National Aeronautics and Space Administration, U.S. Environmental Protection Agency, and U.S. Nuclear Regulatory Commission)
U.S. Nuclear Regulatory Commission

Contributors

American Academy of Health Physics
American Academy of Oral and Maxillofacial Radiology
American Association of Physicists in Medicine
American College of Radiology Foundation
American Osteopathic College of Radiology
American Registry of Radiologic Technologists
American Roentgen Ray Society
American Society for Radiation Oncology
American Society of Radiologic Technologists
Council on Radionuclides and Radiopharmaceuticals
Health Physics Society
Landauer, Inc.
Lillian and Robert Brent Fund
National Electrical Manufacturers Association
Radiological Society of North America
Society for Cardiovascular Angiography and Interventions Foundation
Society of Interventional Radiology
Society of Nuclear Medicine and Molecular Imaging*
Society of Pediatric Radiology

Corporate Sponsors

3M
Landauer, Inc.
Nuclear Energy Institute

Evolution of the RP System and its Implications

Dr Ted Lazo
OECD Nuclear Energy Agency

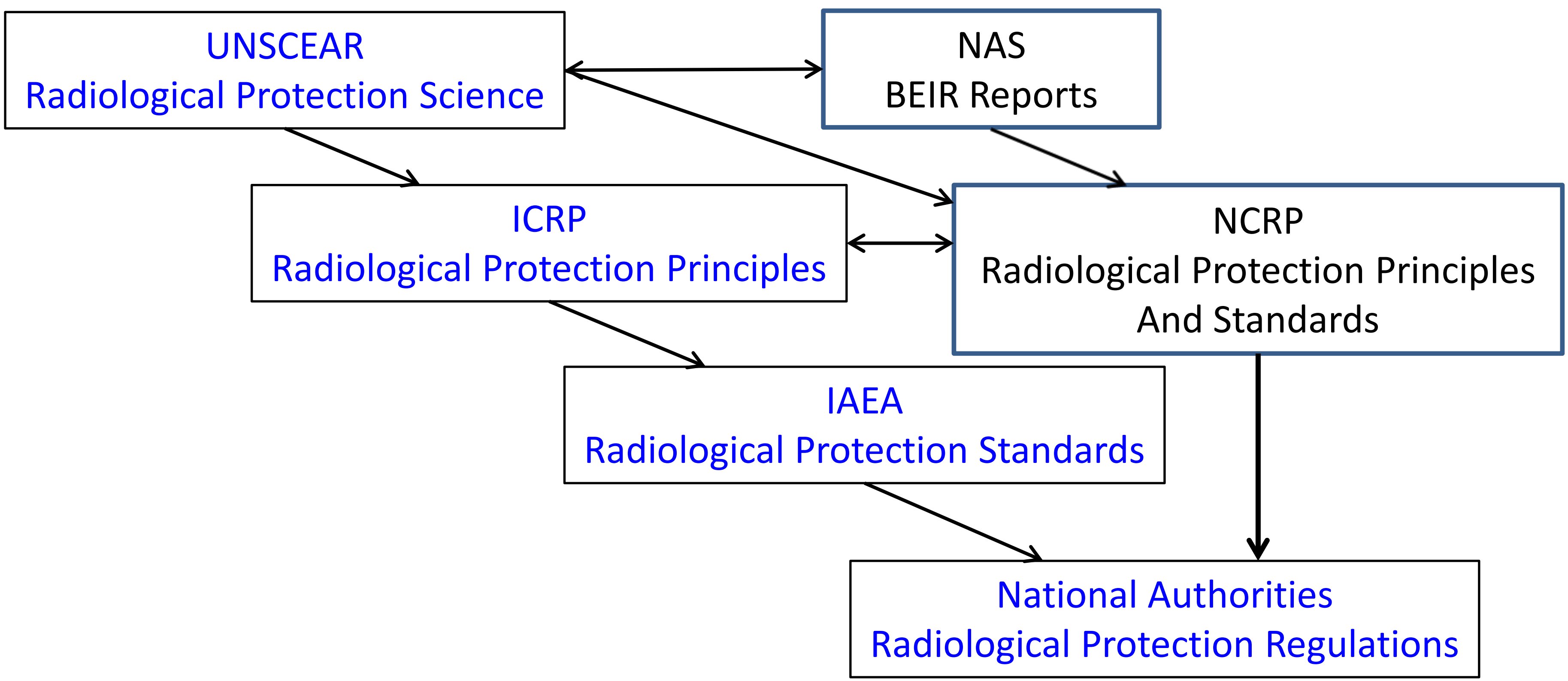
© 2014 Organisation for Economic Co-operation and Development

Overview

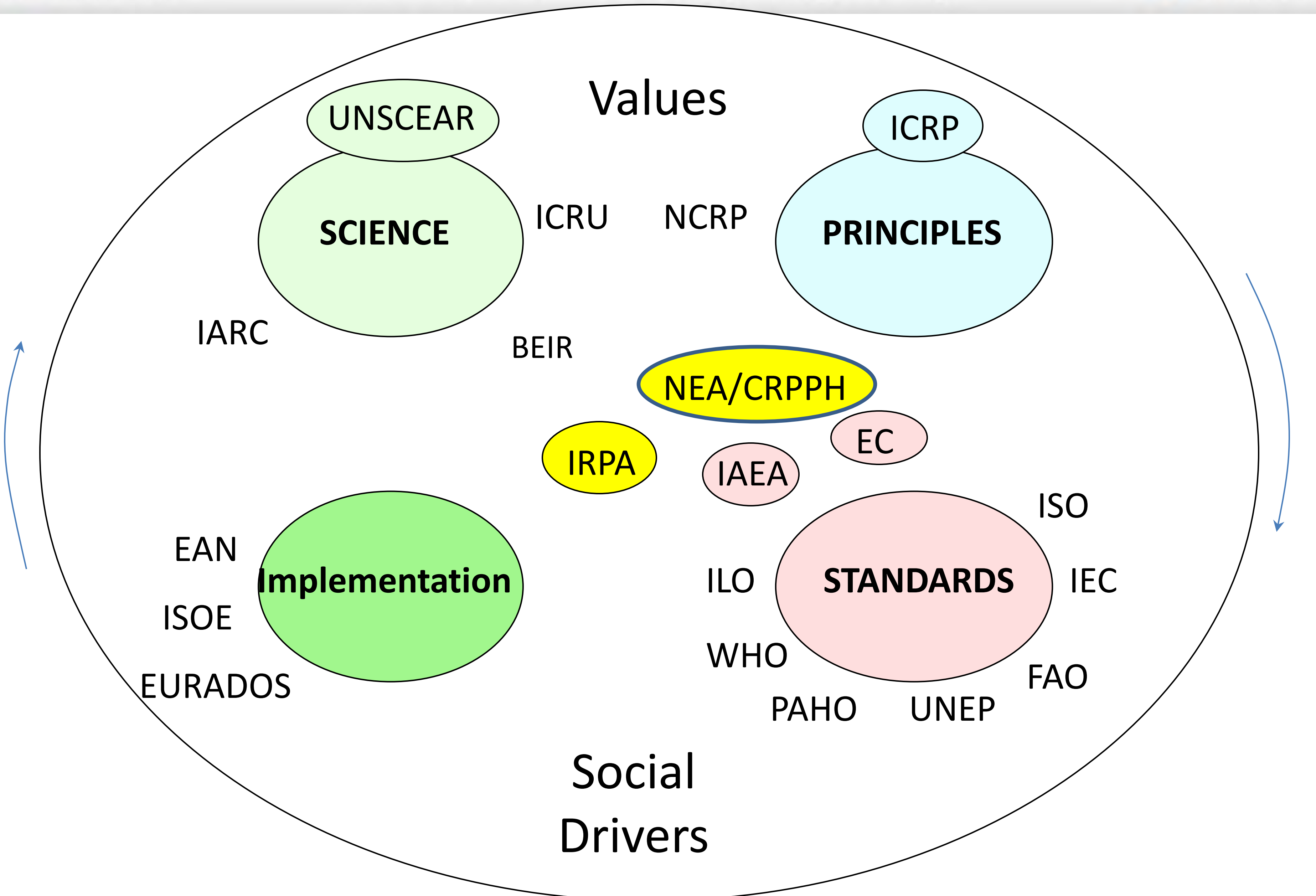
- Evolution of the ICRP System of Radiological Protection
  - Publication 60 to Publication 103
  - Publication 103 to Post Fukushima
- Implications of Evolution
  - Individual Concerns
  - Optimisation
  - Prevailing Circumstances
  - Use of Elements of the System
- Conclusions

© 2014 Organisation for Economic Co-operation and Development

Linear Development of the System



© 2014 Organisation for Economic Co-operation and Development



© 2014 Organisation for Economic Co-operation and Development

Change Happens

© 2014 Organisation for Economic Co-operation and Development

Publication 60 to Publication 103

Publication 60

- Process-based
- More focus on cost-benefit optimisation
- Decision-making an RP process

Publication 103

- Situation-based
- More focus on broad view of optimisation
- Decision-making includes Stakeholder input

© 2014 Organisation for Economic Co-operation and Development

Post-Fukushima Interpretation of Publication 103

- Broad view of who is a stakeholder
- Further emphasis on stakeholder input to protection decisions
- Importance of trust

© 2014 Organisation for Economic Co-operation and Development

Implications of Individual Concerns

- Almost ANYTHING is easily available on the internet
- Children are more at risk than adults for leukaemia, and for cancers of the thyroid, skin, breast, and brain
- The importance of parental concern for their children's protection was graphically demonstrated during the Fukushima accident – "what is the risk to MY child?"
- Effective dose is "technically" not an appropriate quantity for describing risk retrospectively
- A specific individual's risk can not be accurately assessed, but is of great interest (also for medical treatment)
- Individual concerns are driven by an individual's prevailing circumstances – this applies to occupational, medical and public exposures

© 2014 Organisation for Economic Co-operation and Development

Implications of Optimisation Evolution

- Optimisation has become much more central to decision-making processes
- The ICRP has since Publication 60 focused on optimisation as a "source specific" process
- The Fukushima accident, and the increased importance of stakeholder input, has broadened the view of "source specific" to encompass all aspects of the prevailing circumstances, including social, economic, radiological, etc.
- Some radiological protection criteria have become more of a starting point than an end-point

© 2014 Organisation for Economic Co-operation and Development

Implications of Prevailing Circumstances

- The focus on source-specific optimisation and individual risk has significantly increased the importance of the prevailing circumstances in radiological protection decision making
- Decisions in similar circumstances will be taken within a common RP framework, but will not necessarily be the same – for example clean-up criteria; evacuation criteria; environmental release criteria; etc.
- The elements of the RP system used to achieve accepted and sustainable protection decisions will be driven largely by the prevailing circumstances

© 2014 Organisation for Economic Co-operation and Development

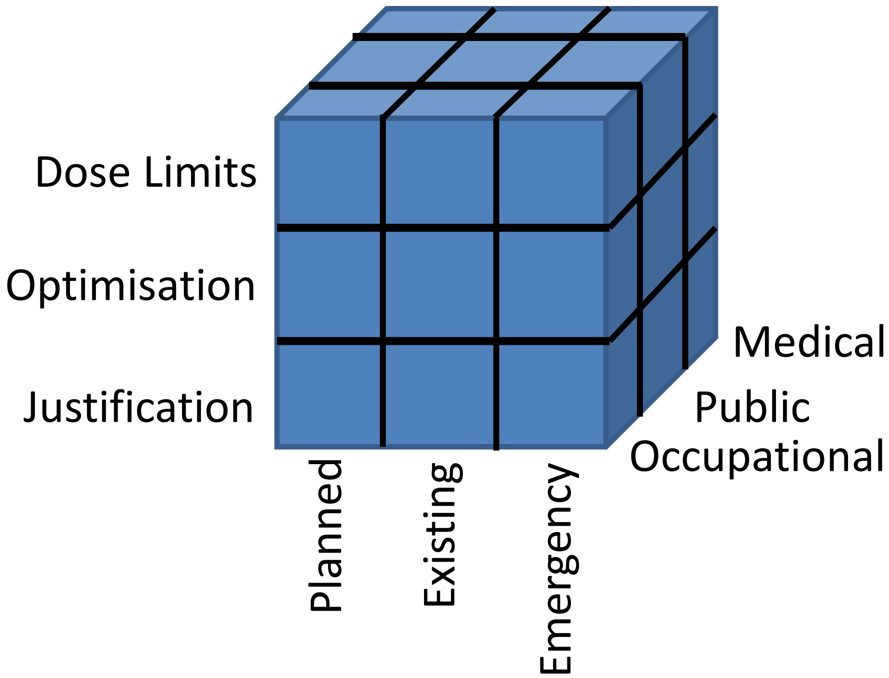
Implications of Use of System Elements

- A key distinction between Exposure Situations is the application, or not, of Dose Limits
- Prevailing circumstances are increasingly seen as driving the identification of protection aspects and framework elements that can best be applied to achieve optimised protection.
- This suggests that the assessment of prevailing circumstances is a key element of the RP system
- For example, some aspects of Emergency and Existing Situations involve well planned work and well characterised sources, where the use of occupational dose limits, rather than reference levels, would make sense

© 2014 Organisation for Economic Co-operation and Development

Key Elements of the ICRP System of RP

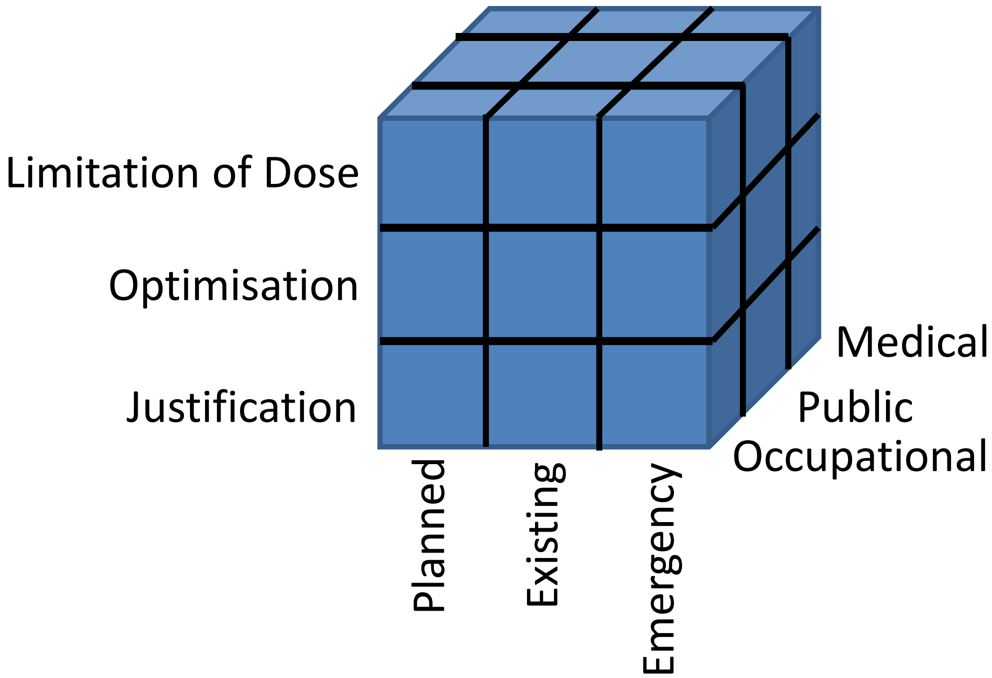
- ICRP Principles
  - Justification
  - Optimisation
  - Application of Dose Limits
- Exposure Situations
  - Planned
  - Existing
  - Emergency
- Types of Exposure
  - Occupational
  - Medical
  - Public



© 2014 Organisation for Economic Co-operation and Development

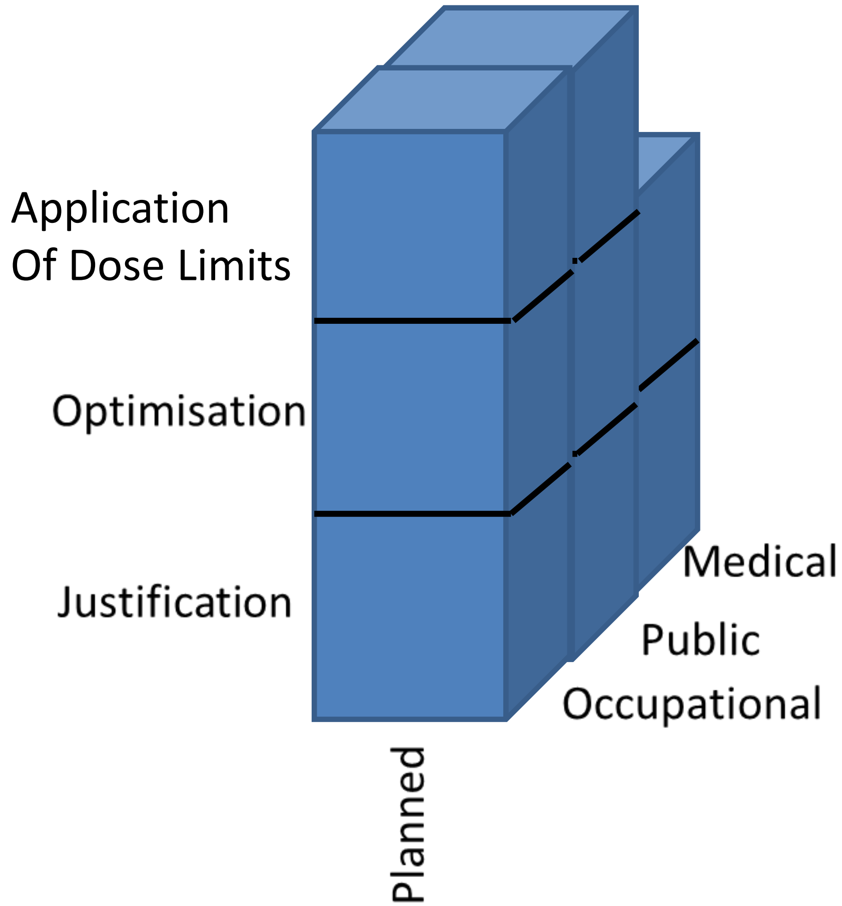
Key Elements of the ICRP System of RP

- ICRP Principles
  - Justification
  - Optimisation
  - Limitation of Dose
- Exposure Situations
  - Planned
  - Existing
  - Emergency
- Types of Exposure
  - Occupational
  - Medical
  - Public



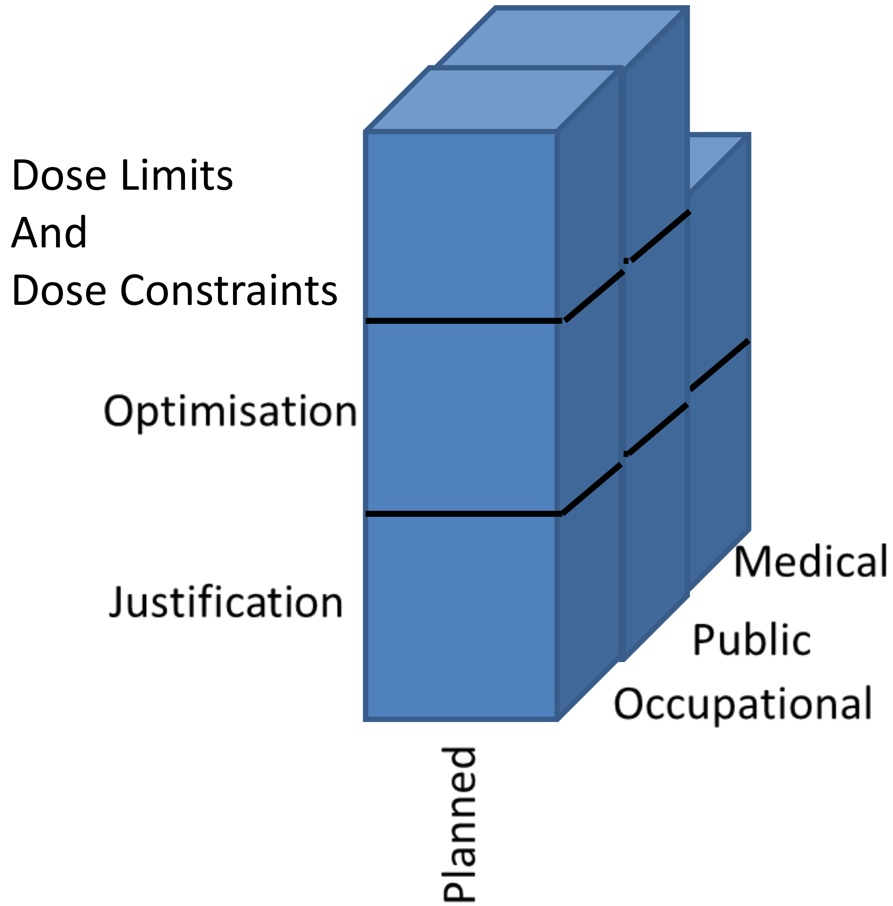
© 2014 Organisation for Economic Co-operation and Development

For Planned Situations



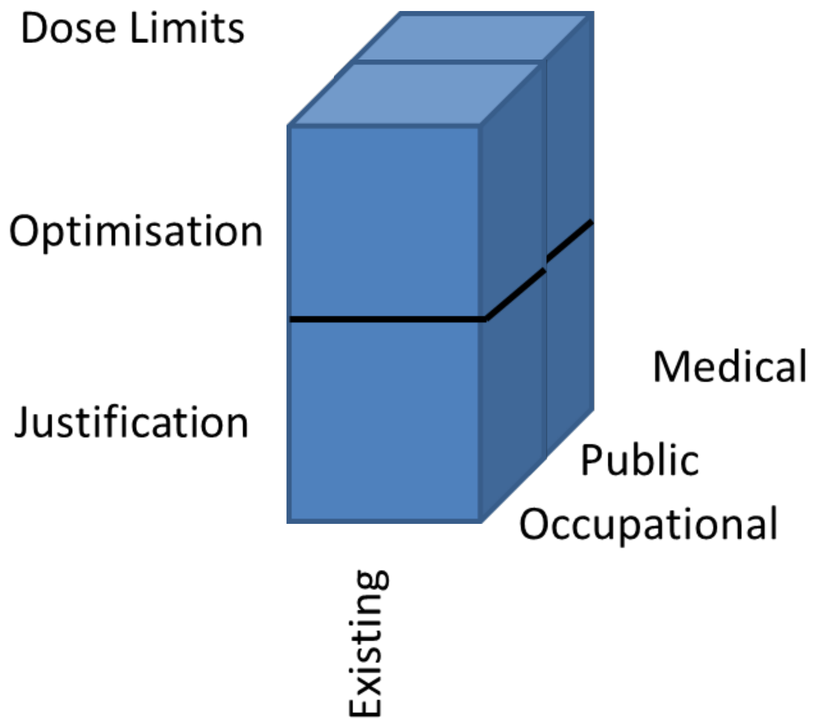
© 2014 Organisation for Economic Co-operation and Development

For Planned Situations



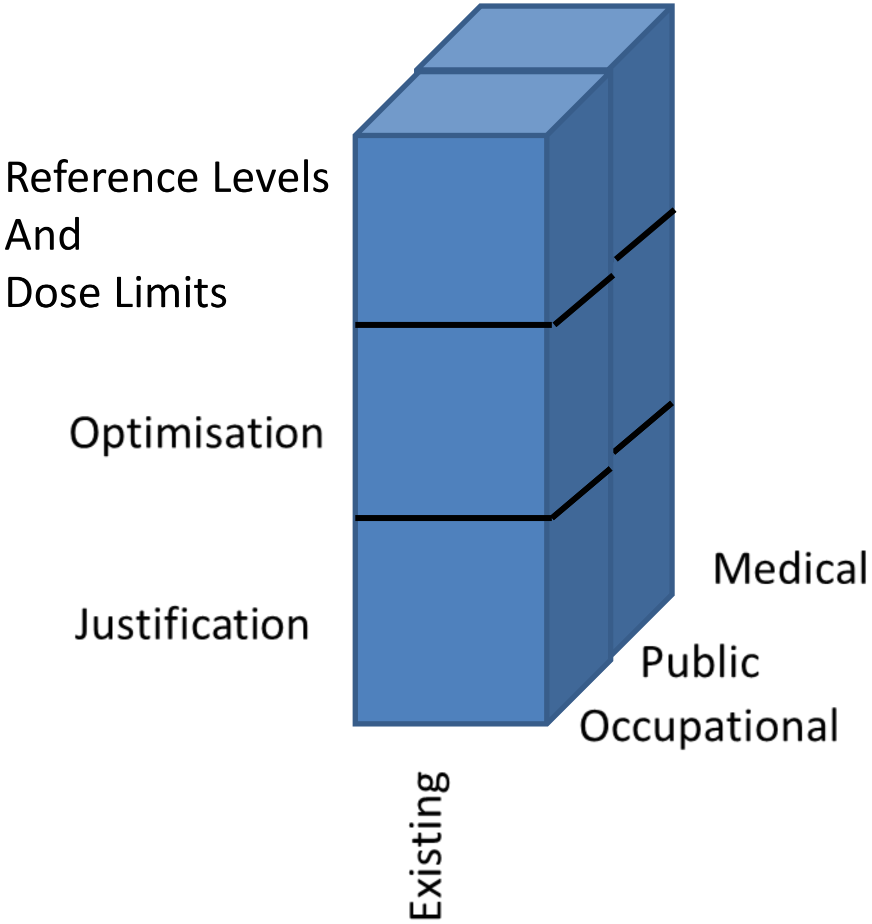
© 2014 Organisation for Economic Co-operation and Development

For Existing Situations



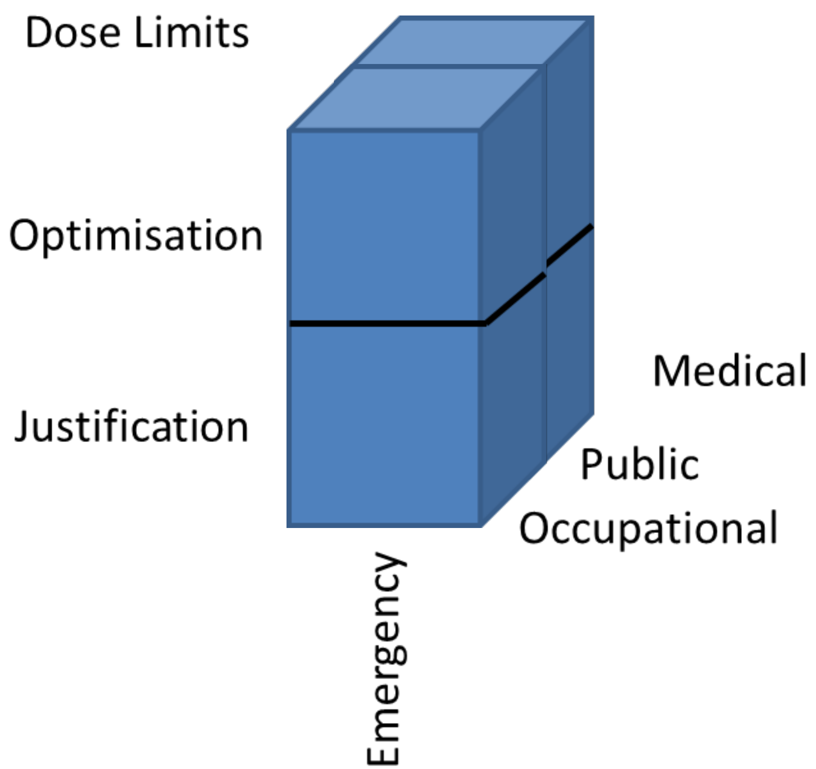
© 2014 Organisation for Economic Co-operation and Development

For Existing Situations



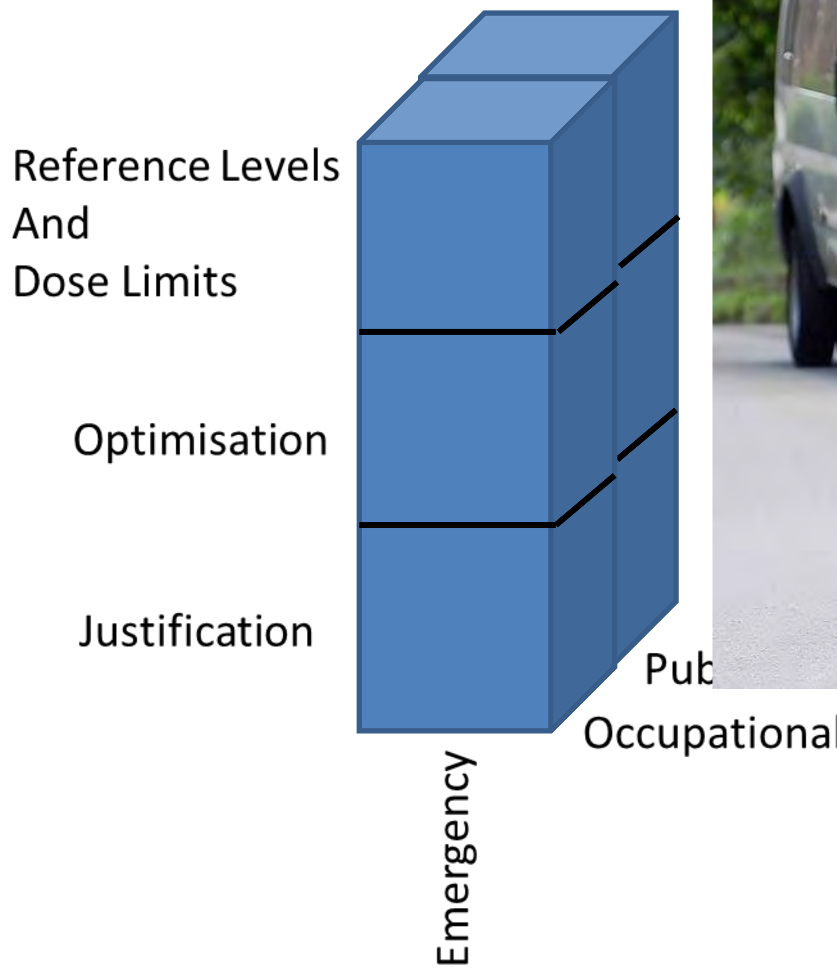
© 2014 Organisation for Economic Co-operation and Development

For Emergency Situations



© 2014 Organisation for Economic Co-operation and Development

For Emergency Situations



© 2014 Organisation for Economic Co-operation and Development

Conclusions (Suggestions)

- The ICRP System is robust, however --
- Experience has suggested that the practical application of the system is somewhat different than recommended
  - Stakeholder involvement in protection decisions for any type of exposure situation focuses on prevailing circumstances
  - Individuals are concerned with their specific circumstances
  - Optimisation is central, but this is driven broadly by prevailing circumstances (at work, home, or hosptial)
  - The ICRP system functions as a framework – elements of the system are used as stakeholders feel would most appropriately address prevailing circumstances

© 2014 Organisation for Economic Co-operation and Development

© 2014 Organisation for Economic Co-operation and Development

FEDERAL DIRECTIONS IN RADIATION REGULATIONS

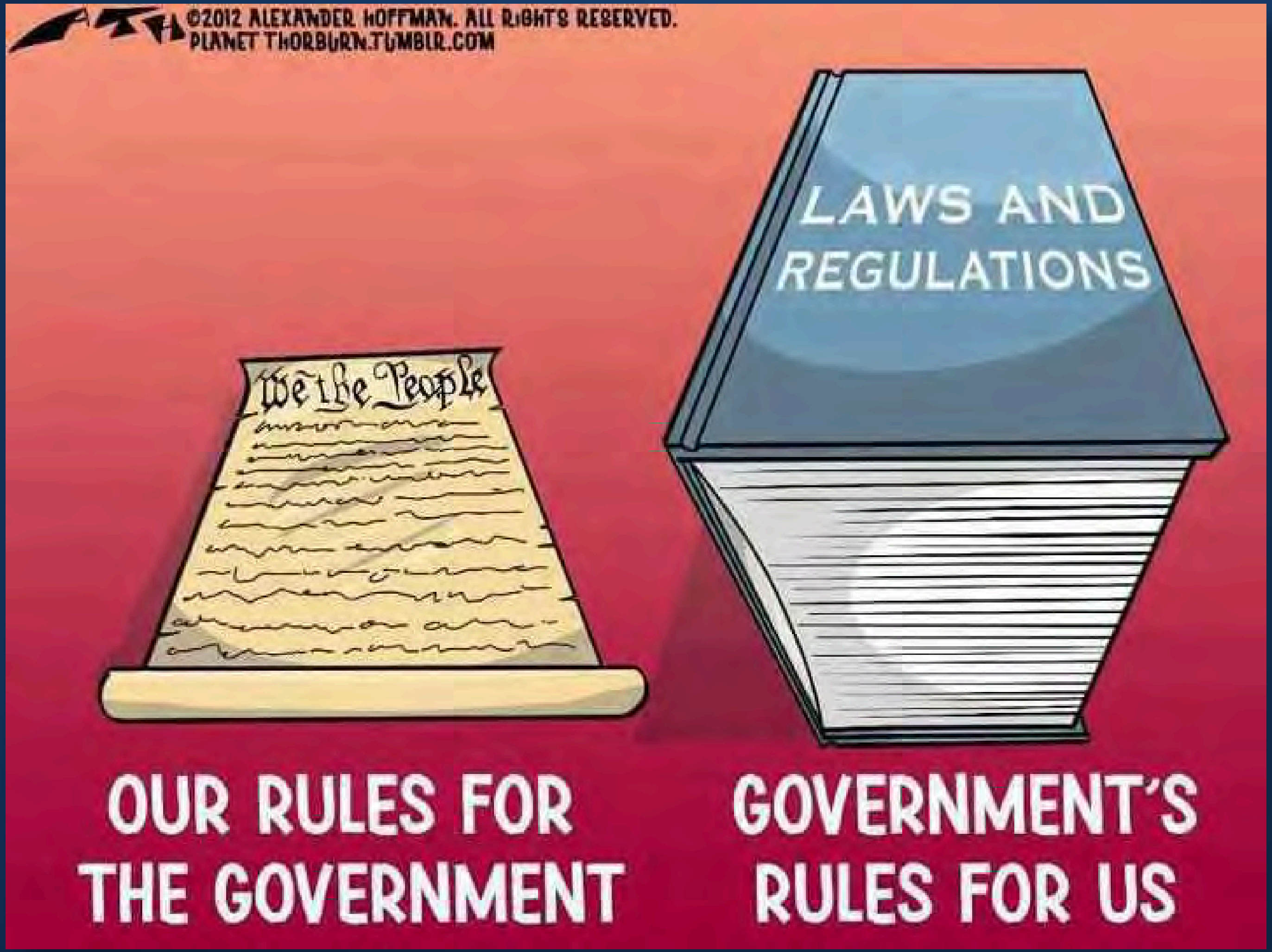
Making The "Old" New Again

NCRP Annual Meeting
Jon Edwards – USEPA – March 2015

Overview

- State Of Things – spring 2015
- "Stressors" Driving Societal / Policy Changes
- What Makes A "Good" Regulation?
- Thorny Issues
- Notable Activities
- Looking Forward

Love For Regulation



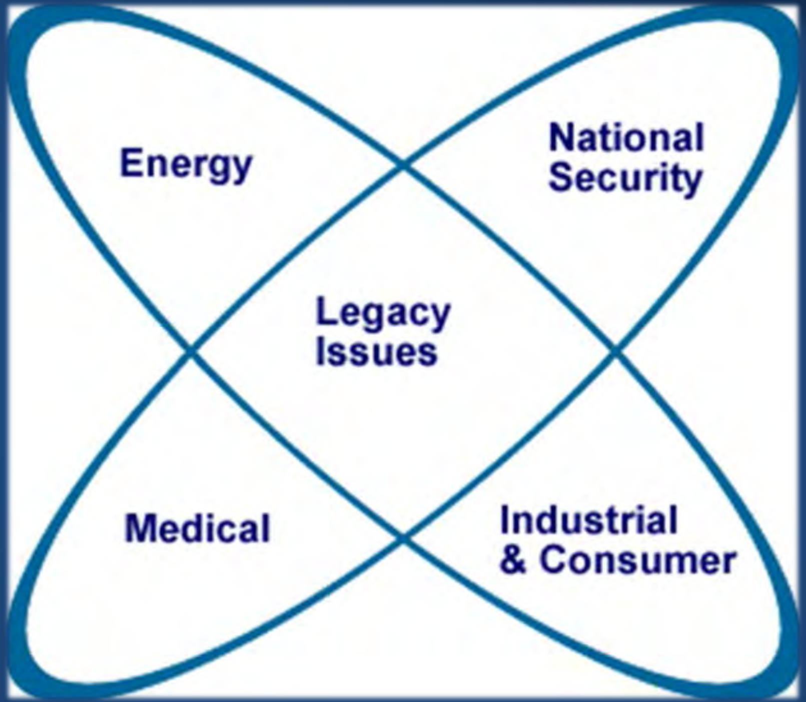
Mark Russell

Federal Coordination

- ISCORS – Interagency Steering Committee On Radiation Standards
  - EPA/NRC Co-chairs
- Preceded by Committee on Interagency Radiation Research and Policy Coordination (CIRRPC-1984) and Federal Radiation Council (1959-1970)

Futures – 2000 to 2025

- Improved Sense Of The Present and Future
  - Is the nature of our work/regulation correct?
- Expanded Set of Stakeholders And Interested Organizations
  - Confident in how we do our work and our partners?
- Develop A Realistic, Useful Approach For The Future
  - Build upon broad input – are we hearing from everyone we should be hearing from?



Examples of Radiation Challenges 2000 to 2025

- ENERGY
  - Decommissioning nuclear power plants
  - Next generation of nuclear power-yes or no
  - Alternative energy sources & strategies to limit global warming
  - Nuclear accidents
  - Radiation issues related to coal, oil and gas, geothermal

- HEALTH AND MEDICAL
  - Radon
  - Changes in technology that increase or reduce medical exposures
  - Training & professional certification to reduce inappropriate medical uses
  - Better understanding of genetics; understanding of genetically sensitive populations
  - Preventive approaches & new modalities for diagnosis & prescription to reduce uses of ionizing radiation
  - Non-ionizing radiation issues: e.g., lasers, UV, EMF

Examples of Radiation Challenges 2000 to 2025

- NATIONAL SECURITY
  - Weapons decommissioning
  - Preventing radiation-related problems in future weapons development
  - Nuclear terrorism – "loose nukes" & nuclear dispersion devices
  - Radioactive materials in former Soviet Union
  - Third world nuclear proliferation/testing/use
  - Emergency response capability
  - What to do with weapons material
- INDUSTRY AND PRODUCTS
  - Orphan sources (materials that end up in unexpected places)
  - Occupational exposures
  - Exposures from consumer products
  - New industries using radioactive materials
  - Proliferation of low level sources – cumulative risks, impact on recycling
  - Building construction
  - Import of contaminated metals/materials
  - Non-ionizing radiation exposures, e.g., rapid growth of wireless communication

Examples of Radiation Challenges 2000 to 2025

- ENVIRONMENTAL
  - Assessment of ecological risks of radiation
  - Synergies between radioactive & chemical toxic wastes
- RADIATION FACILITY CLEANUP
  - Radiological assessment of DOE, Superfund, & other sites
  - Remediation technologies & strategies
  - Remediation standards
- GOVERNMENT OPERATIONS
  - Public/community involvement in radiation protection issues
  - Cooperation between federal agencies
  - Support for state radiation programs
  - Developments in accounting systems (total accounting)
  - Setting standards over long periods of time, revising standards as new knowledge and models arise & assumptions change

Examples of Radiation Challenges 2000 to 2025

- WASTE MANAGEMENT
  - Finding a good solution for managing the increasing volumes of waste – not "saving money" or "blocking nuclear power"
  - Lack of system for low-level waste management
  - High-level waste management & disposal, U.S. & abroad
  - Aligning funding with real risks, avoiding pork barrel waste politics
  - Local economic effects of waste sites
- RESOURCE EXTRACTION
  - Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)
  - Source material for nuclear fuel
- RADIATION MONITORING
  - Cheap, miniature sensor technology
  - National monitoring system
  - Inexpensive, efficient tracking systems
  - Community monitoring
  - Monitoring performance of repositories

Examples of Radiation Challenges 2000 to 2025

- RESEARCH
  - Understanding risks at low doses
  - Risk harmonization/ cumulative risk assessment
  - Effects of radioactive nuclides that cross the placenta on fetuses – non-cancer effects
  - Assuring good science amid controversy & influence of big money from government & industry
- AGRICULTURE
  - Use of contaminated sewage sludge as fertilizer
  - Food irradiation
- PROFESSIONAL EDUCATION
  - Maintaining the professional/technical infrastructure for radiation protection
  - New emphasis on prevention, public health
- TRANSPORTATION
  - Transportation of spent fuel, high-level wastes, mixed- and low-level wastes
- PUBLIC INFORMATION/EDUCATION
  - Public right-to-know - availability of public information about sources & risks
  - Education to increase public understanding of radiation protection issues
  - Public perception of radiation risks vs. scientific assessment

“Stressors” Driving Change – 2015

- Rapid Growth/Expanding Use of New Technologies
- Climate Change Adaptation and GHG Reduction Strategies
- Energy Sector Growth and Independence Strategies
- Aging Nuclear Power Plants
- No Permanent Repository for Used Fuel and HLW
- More Recent Environmental Policies
- Advances in Radiation Science, Biology, Dosimetry and Risk Assessment

"Stressors" Driving Change – 2015

- Rapid Growth/Expanding Use of New Technologies
  - Computed tomography
  - Fracking
  - In-Situ leaching/recovery of uranium
  - Internet age – no longer expert "gatekeepers"
- Climate Change Adaptation and GHG Reduction Strategies
  - Next generation of nuclear plant construction
- Energy Sector Growth and Independence Strategies
  - Growth of nuclear sector?
  - 100+ year outlook?

"Stressors" Driving Change – 2015

- Aging Nuclear Power Plants
  - Extension of some plant licenses beyond 40 years
  - Perhaps plant life that extends to 80+ years
  - Decommissioning as the growth industry?
- No Permanent Repository for Used Fuel and HLW
  - Longer-term storage of used fuel and HLW on site (18 months vs. decades)
  - Transition from pool storage to dry storage

"Stressors" Driving Change – 2015

- More Recent Environmental Policies
  - EPA policy statement in late 1980's and 1990's on water sources and drinking water
- Advances in Radiation Science, Biology, Dosimetry and Risk Assessment
  - Age-specific information
  - Sex-specific information
  - Sensitive subpopulations or individuals

"Rule Effectiveness"

"Rule Effectiveness"

SPEED LIMIT = 75

If between 25 and 85 years old, with at least 5 years of safe driving as defined by an approved state program, and 20/20 vision as determined by a licensed eye professional; or if certified as a professional driver pursuant to 40 CFR 12(b)(2)(ii)(a)(x)(b). Except if driver has had less than 6 hours of sleep the prior night or has been driving for more than 12 hours in the prior 24 hours, then 65 mph, unless following state-approved Best Driving Practices.

SPEED LIMIT = 65

If between 21 and 70 years old with at least 2 years of safe driving as defined by the approved state program

SPEED LIMIT = 55

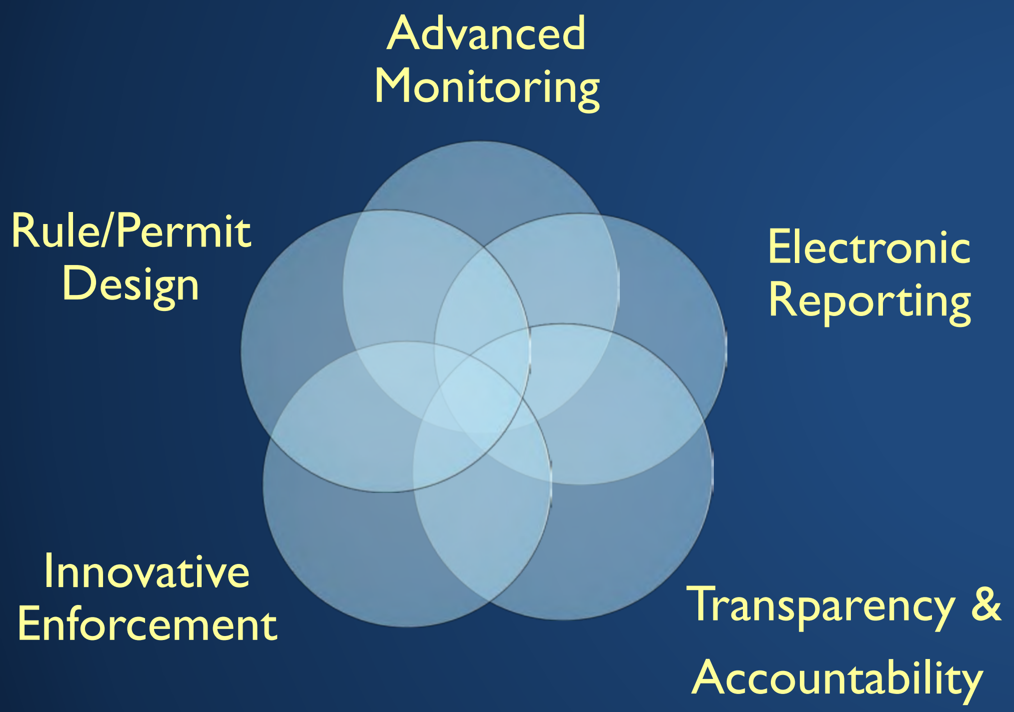
All drivers who do not satisfy conditions for driving at higher speeds.

“Rule Effectiveness”

- Cost ($ and time)
- Too complex and/or ambiguous for:
  - Government
  - Regulated entities (“fair notice defense”)
- Lack of awareness
- Inadequate deterrence
- Disagree with the law
- “I’m special”
- Perceived norm of noncompliance
- Some competitors not covered by rule

Why Noncompliance?

21st Century Rulemaking



- 5 Principles:
  - Applicability and simplicity
  - Structural: compliance easier than noncompliance
  - Self-monitoring and third-party monitoring
  - E-Reporting and transparency
  - Market forces and incentives

What Makes A Good Regulation?

- Protective Yet Flexible and Reasonable
- Clear Requirements
- Achievable and Enforceable
- Sound Science; Peer-Reviewed As Appropriate
- Forward-looking; Anticipate Future Challenges
- Coherent Risk Management Framework – Other Pollutants / Contaminants
- Open and Transparent
- Public Review and Input

What Makes A Good Regulation?

- Protective Yet Flexible and Reasonable
  - Weighing public health concerns, environmental protections, and economic impacts
- Clear Requirements
  - Promote compliance with clarity
    - to whom the rules apply
    - what entities must do
    - whether they are doing it correctly

What Makes A Good Regulation?

- Achievable and Enforceable
  - Successful implementation with available resources (reduce complexity, administrative burdens if appropriate)
  - Effective incentives for requirements (when possible, for better-than-required performance or voluntary actions)
  - Generates data needed to measure outcomes and evaluate effectiveness
- Sound Science; Peer-Reviewed As Appropriate
  - The foundation for understanding the key considerations of public health, environment, and economy

What Makes A Good Regulation?

- Forward-looking; Anticipate Future Challenges
  - Regulations with 30, 40, 50+ year lifespans
  - Process to revise regulations is complex and lengthy
- Coherent Risk Management Framework – Other Pollutants / Contaminants
  - Radiation, Chemicals
    - Statutory language
    - Nature of the hazard
    - Number of people affected

What Makes A Good Regulation?

- Open and Transparent
  - Must be able to explain reasoning, considerations, priorities, criteria and the myriad of elements involved in regulation
  - Underlying rationale should be able to be scrutinized
  - Documents available for public scrutiny
- Public Review and Input
  - The spirit of democracy and republics

Thorny Issues

- How best to incorporate gender, age, individual risk information?
- Are regulatory standards best as dose or risk standards?
- How best to achieve desired ALARA planning?
- In the move toward higher emphasis on individual exposure, is collective exposure still a useful consideration?
- How best to protect key potential exposure pathways, in particular groundwater, and on what basis?
- How clean is clean? Is it "safe"?
- How should international approaches and principles be reflected in U.S. regulations?
- How best to reflect SI measurement units and accommodate U.S. units as necessary?

Notable Activities – USEPA

- EPA
  - 40 CFR 190 – Nuclear power operations
  - 40 CFR 192 – Uranium milling (in-situ)
  - PAGS – Protective Actions
  - WIPP – TRU waste geologic disposal
  - NESHAPS – Air emissions
  - Medical Guidance – FGR-14
  - 40 CFR 191 – Deep geologic disposal
  - TENORM
  - FGRs

Notable Activities – NRC

- NRC
  - 10 CFR 20 – Radiation protection, ANPR
  - 10 CFR 61 – Land disposal of radioactive waste
  - 10 CFR 35 – Medical
  - 10 CFR 37 – Physical Protection
  - 10 CFR 50 App. I – Design objectives, gaseous and liquid effluents
  - Waste Confidence – now “Continued Storage”
  - Source Protection / Unwanted Sources – Taskforce

Notable Activities – DOE, OSHA, FDA

- DOE
  - 10 CFR 835 – Worker protection (2007 revision)
  - Order 458.1 – Public protection, dose limits
  - 10 CFR 830 -- Tech standards, nuclear safety management
  - Blue Ribbon Commission Follow-Up
  - Operational Guidelines
- OSHA
  - No current regulatory initiatives. Monitoring worker exposures to x-rays and TENORM.
- FDA
  - No notable regulatory actions currently. (2012 – illegal sale of unreviewed handheld devices)

Notable Activities – DHS, NASA, DOD, DOT

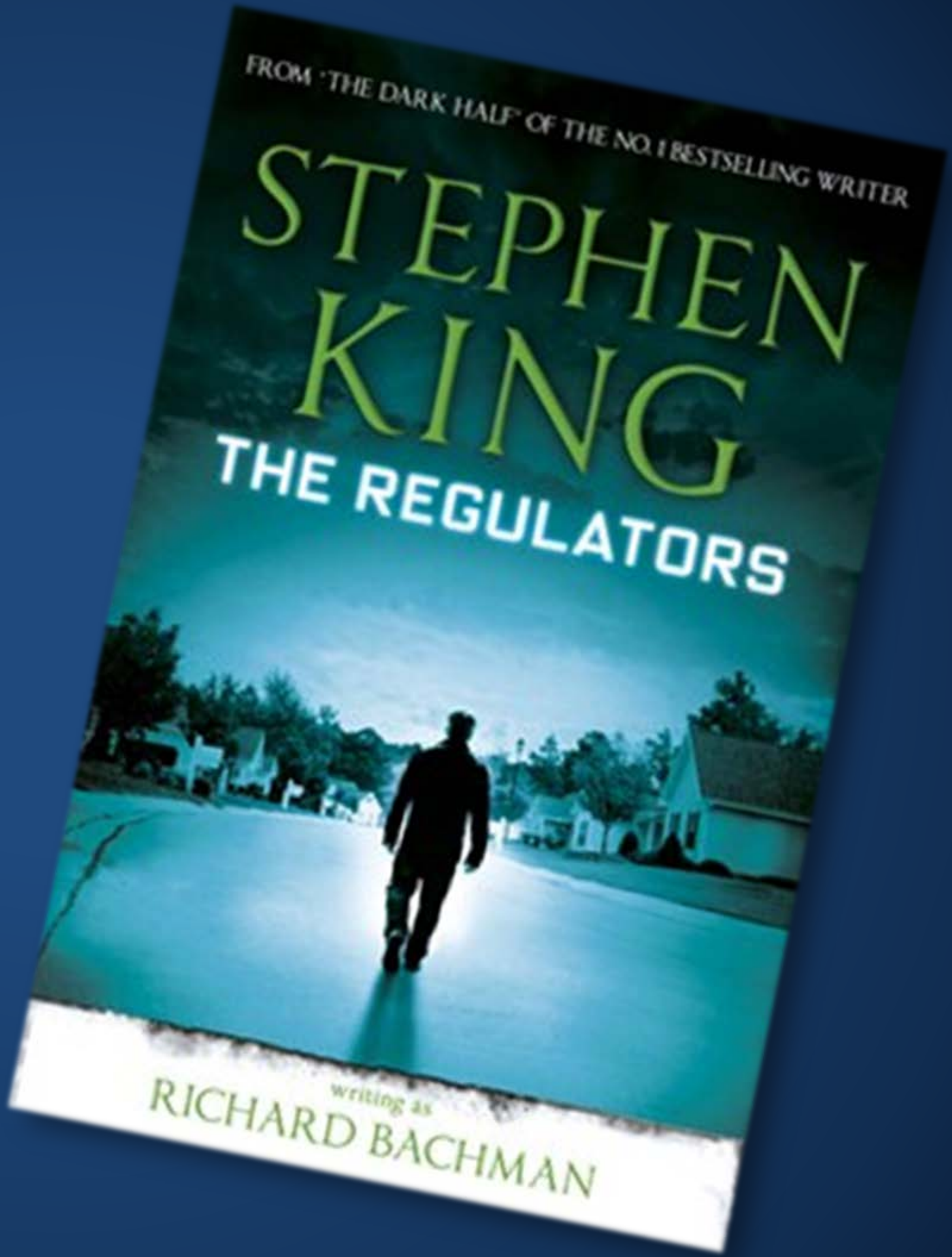
- DHS
  - Response and Recovery Guidance for Terrorism and Stafford Act Responses
  - Worker Health and Safety Guidance for Terrorism and Stafford Act Responses (Justification process for dangerous environments)
- NASA
  - Prolonged Space Missions (Mars Journey, etc.)
- DOD, DOT, others…
  - Ongoing interactions through ISCORS

Looking Forward

- EPA, NRC, DOE, DOD, FDA, DHS, DOT, NASA, OSHA and other federal agencies with radiation protection responsibilities must:
  - Be genuinely attentive of all the various factors and considerations due in effective rulemaking, and
  - Strive to achieve the proper balance of these elements in renewed radiation protection regulations
- Moving toward more consistency with ICRP-103 and Basic Safety Standards
- Better, simpler, straightforward regulation
- Openness to both regulatory advances and non-regulatory tools and approaches
- Safety culture

Stephen King's

Horror
Story



Enhanced Radioactive Material Source Security

Joseph Klinger, Assistant Director

Illinois Emergency Management Agency

Lets Begin at 1998

- Life was good. 31 Agreement States with NRC
- Source Security regulated as part of the "Public Health and Safety" provisions in the Atomic Energy Act
- Globally, since 1955, 50+ severe* radiological accidents involving lost, stolen, abandoned "orphan" sources
- Common problem-Disused sources not properly controlled
- Since 1982 60 reported inadvertent meltings globally. 29 in U.S.
- $12 Million average cleanup!

- *Severe: $\geq$ 0.25 Gy whole body or $\geq$ 5 Gy local/extremity

CRCPD Efforts

- 2 million sources in US. Tens of thousands disused
- CRCPD E-34 Working Group established
  - Develop Orphan source strategy for U.S.
- Funded by USEPA
- Pilot Project in CO
- Proven success
- Just needed funding for a National Orphan Source Program
- CRCPD requested by federal agencies but was unsuccessful due to other budgetary priorities

Meanwhile

- 2000-Thailand
  - 3 disused Co-60 Teletherapy sources not stored securely. Machine dismantled source containers at scrap yard
  - 10 people severely exposed, 3 fatalities

Problems Continue

- 2000-Egypt
- Industrial Radiography Ir-192 source lost in field
- Found by child-Father and son die. 5 family members severely exposed

<u>Surely no one would intentionally try to harm the general public! Right?!</u>

September 11, 2001 Attacks

September 11, 2001

- Heightened concerns for source security.
  - Potential for malevolent use profound. Additional measures to enhance security deemed necessary

- October 2001-NRC agrees to fund the CRCPD National Orphan Source Program! Still does. Dispositioned 448 sealed sources to date

NRC Actions

- July 2002, DoE/NRC RDD WG. May 2003 Report
- Recognized potential for use of risk-significant ram in a malevolent act. (RDD, RED)
  - Established Radionuclides of Concern
  - Need for greater control and tracking (cradle to grave) NSTS recommended.
- NRC Identified need for:
  - Enhanced security reqts and safeguards during transport
  - Background investigations for individuals with unescorted access

NRC Actions Continued

- June 2003-ASM Orders issued to irradiators > 10,000 Ci. AEA Common Defense and Security
- July 2003-IAEA issues Categorization of Radioactive Sources. TECDOC-1344
- Jan 2004-Orders issued to certain M&D licensees for ASMs and Protection of SGI-M
- Jan 2004-IAEA issued “Code of Conduct on the Safety and Security of Radioactive Sources” referenced TECDOC-1344
- NRC adopted IAEA Cat 2 as Quantities of Concern for consistency

Part 37 – Radionuclides of Concern - Category 1 and Category 2

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Americium-241	60	1,620	0.6	16.2
Americium-241/Be	60	1,620	0.6	16.2
Californium-252	20	540	0.2	5.4
Cobalt-60	30	810	0.3	8.1
Curium-244	50	1,350	0.5	13.5
Cesium-137	100	2,700	1	27
Gadolinium-153	1,000	27,000	10	270
Iridium-192	80	2,160	0.8	21.6
Plutonium-238	60	1,620	0.6	16.2
Plutonium-239/Be	60	1,620	0.6	16.2
Promethium-147	40,000	1,080,000	400	10,800
Radium-226	40	1,080	0.4	10.8
Selenium-75	200	5,400	2	54
Strontium-90	1,000	27,000	10	270
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81

NRC Actions Continued

- Nov 2005-IC Orders under Public Health and Safety measures. No SGI-M. For nationwide application, AS issued legally binding reqts to impose these ICs
- Reqts included
  - License verification before transfer
  - Access control
  - Intrusion Detection/ Armed Response
  - Coordination with LLEA

NRC Actions Continued

- Trustworthy & Reliability reqts for individuals permitted unescorted access
  - Bkg investigation limited to local criminal history records checks, employment history verification, education, personal references, legal immigration status, etc.

Trustworthy & Reliability Decision

Who would you deem more trustworthy?

Energy Policy Act of 2005

- Authorized the NRC Commission to require fingerprinting individuals with unescorted access (Cat 1 & 2) and FBI criminal history records check
- Authorized the National Source Tracking System (NSTS)

NRC Actions Continued

- Oct 2006-NRC orders to do so for NRC and AS panoramic and underwater irradiator, M&D, and shipping licensees of cat 1 quantities under AEA "common defense and security" provisions
- Dec 2007-NRC orders all other cat 1&2 NRC licensees requiring same under "public health and safety."(e.g., blood irradiators, industrial radiographers, Gamma-Knife)
- AS issued legally binding requirements for the rest of cat 1&2 licensees

10 CFR 37-Physical Protection of Byproduct Material

- Incorporated all the security requirements into rules
- All requirements under "public health and safety"
- Affects approx. 1400 ram licensees
- Provided opportunity for comment
- Published in 78 FR 16822 on March 19, 2013
- NUREG-2155-Q&A Implementation Guidance published in Feb 2013. Rev 1, Jan 2015 (FAQ)
- Effective May 20, 2013
- NRC licensees required to comply by March 19, 2014

New Reqts in 10 CFR 37

- 37.23-T&R Official now required to be fingerprinted. Licensee approves the reviewing official (RO) and submits name under oath and affirmation
- RO fingerprints must be taken by a:
  - LEA
  - fed/state agencies that provide the svcs to the public, or
  - commercial svcs authorized by the state

New Reqts Continued

- 37.25-Verification of true identity of UA applicants to assure applicant is who he or she claims. Detailed review and written certification by licensee
- 37.29-Provides relief from fingerprinting, id, criminal history record checks for additional categories (emergency response personnel, commercial vehicle drivers, package handlers at transportation facilities)

New Reqts Continued

- 37.43-Security plan approval by individual responsible for the security program. Also instruction required on plan before implementation
- 37.45-Prearranged plan with LLEA not required but detailed coordination with LLEA at least annually
- 37.49-Additional details on monitoring and detection system

New Reqts Continued

- 37.57-Requires licensee to report to LLEA immediately and to NRC within 1 hour when actual or attempted theft, sabotage or diversion
- Also requires licensees to assess suspicious activity and report to LLEA asap and to NRC within 4 hours
  - NRC database = Protected Web Server (PWS)

New Reqts Continued

- 37.71-Requires use of License Verification System (LVS). Required for each shipment not just new recipients and unusual orders
- 37.81- Details regarding reporting of lost or missing shipments
  – NRC Regulatory Issues Summary (RIS) 2015-03 provides additional details on exact time frames for reporting, to whom, when, etc.

Agreement State Status

- Now have 37 Agreement States
- Agreement State Adoption due by March 19, 2016
- Some have already approved, e.g., Ohio, Iowa
  - Adopt by reference
- Most other states must promulgate specific rules
  - Long process to meet March 19, 2016 deadline
- CRCPD has a Suggested State Rule, SSR-V, available for state use to help facilitate promulgation

Meanwhile DoE, NNSA, GTRI Has Been Busy

- Voluntary Security Enhancements for Cat 1&2
- Cooperative efforts with NRC, OAS and endorsements from DHS and FBI, has provided enhancements to >734 facilities in U.S.
- No longer GTRI. Now NNSA, Radiological Security Program (RSP)

DoE NNSA RSP Continued

- Typical Security Enhancements include:
  - Automated access control
  - Motion and radiation sensors
  - Electronic seals
  - Alarm control and display systems
  - Remote monitoring of facilities
  - Enhanced security force communications and protection equipment
  - Delay elements and transportation security enhancements

DoE/NNSA/RSP Continued

- Working with Los Alamos OSR just removed the one-millionth Curie in its mission to remove excess, unwanted, abandoned, or orphan RAM that pose a potential risk to health, safety, and national security!

Today

- Extraordinary measures since 2001 and our RAM sources are much more secure
- A lot more work still needed
- Kathy Pryor will now tell “the rest of the story!”

Pacific Northwest NATIONAL LABORATORY

Proudly Operated by Battelle Since 1965

End of Life Decisions for Sealed Radioactive Sources

KATHRYN H. PRYOR, CHP

Pacific Northwest National Laboratory

NCRP 2015 Annual Meeting
Bethesda, MD

March 16, 2015

PNNL-SA-108314

U.S. DEPARTMENT OF ENERGY

Introduction

- Sealed radioactive sources are used in a variety of settings –
  - Manufacturing, oil and gas, nuclear power, medicine, research, academic institutions
- Approximately 2 million sealed sources in the US; tens of thousands are estimated to be disused
- Subject to differing levels of regulatory control depending on activity, confinement/encapsulation, design of device
- Radioactive materials decay; devices get old; at some point sealed sources come to the end of their useful life. What should their fate be?
  - Return to manufacturer for recycle/reuse if possible
  - Ultimately, should be legally disposed in a licensed radioactive waste disposal site

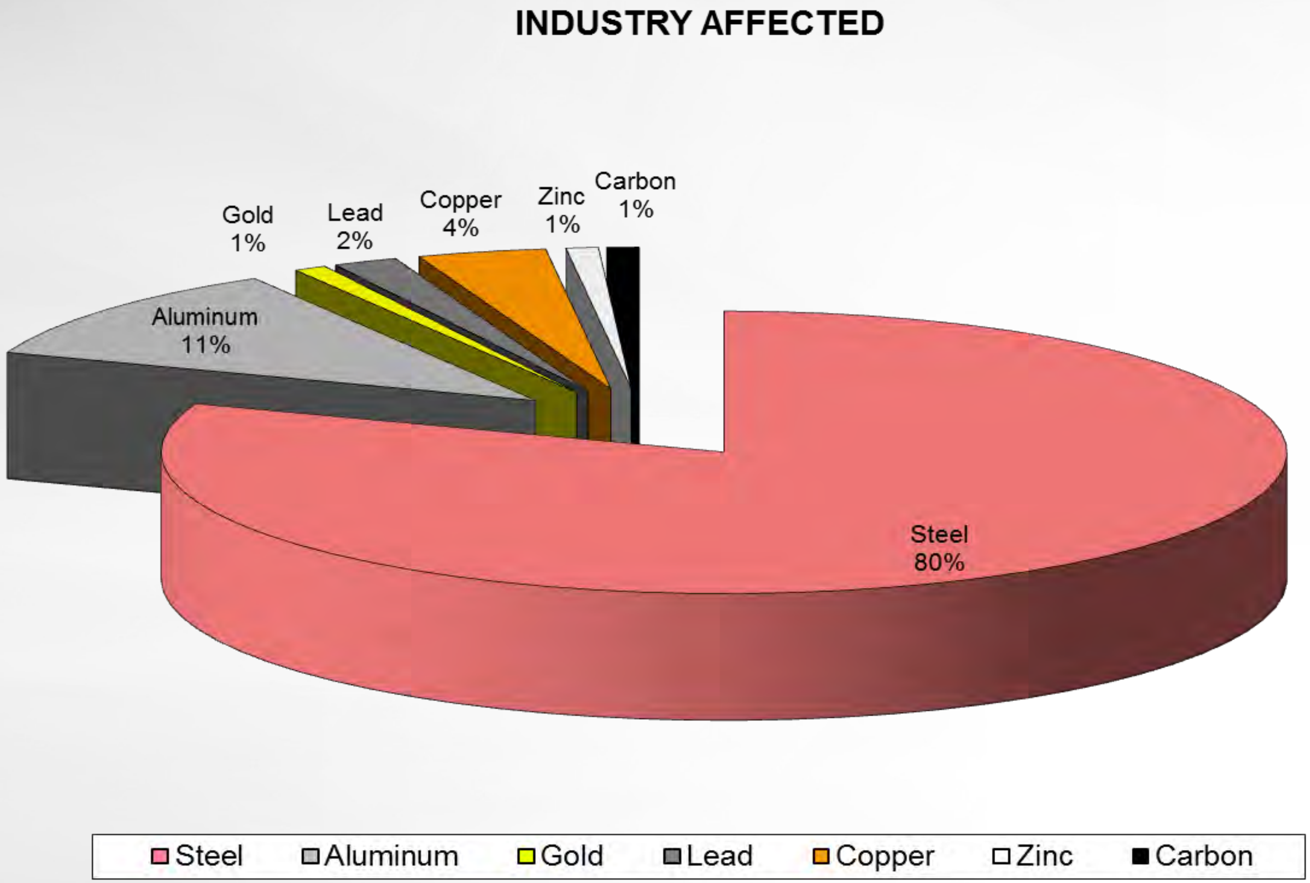
Things Can and Do Go Wrong

- Sealed sources can end up in the wrong place:
  - Abandoned in place
  - Stockpiled in storage
  - Improperly disposed in sanitary landfills

Inadvertent Melting of Sealed Sources

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Over 100 reported instances since 1982; 30+ in US, 70+ internationally (through 2011)
- >90% occurred in steel mills and aluminum recyclers
- Scrap metal recyclers - monitoring of incoming/outgoing material

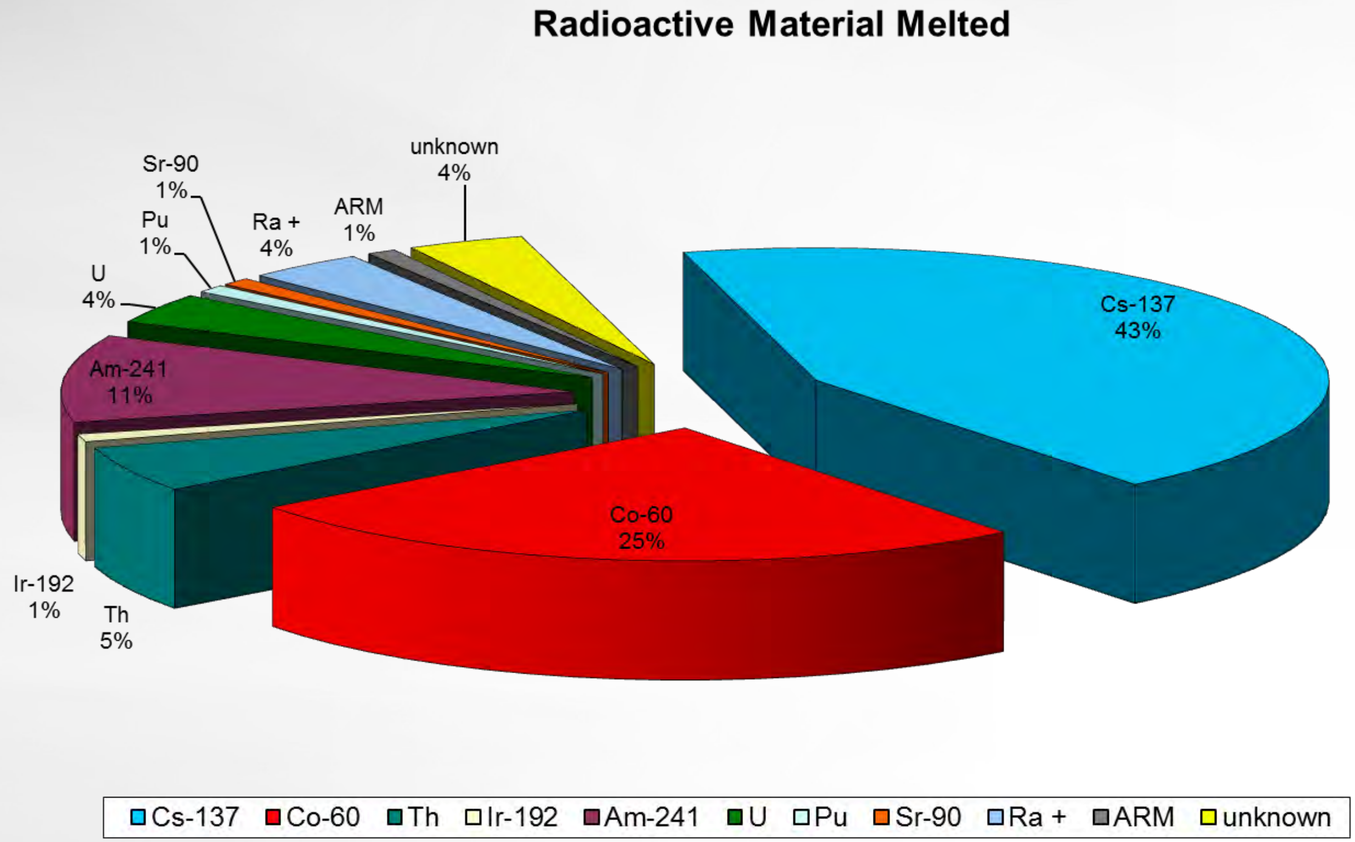


From: J. G. Yusko.

Inadvertent Melting of Sealed Sources

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Predominantly Cs-137 and Co-60 sources
- Average clean-up costs - > $12M
- Charts are reported and confirmed cases; more go unreported



From: J. G. Yusko.

Inadvertent Melting of Sealed Sources

- Contaminated Consumer Products
  - Inadvertent meltings discovered by detecting abnormal radiation levels from the manufactured metal products or by-products
  - Some examples:
    - Co-60-contaminated rebar (Juarez, Mexico and Taiwan, 1980’s)
    - Steel shovels from contaminated steel coils (PA and OH, 1997)
    - Co-60-contaminated tissue box holders and pet food bowls (India, distributed in the US, 2011)
  - Most products collected and disposed



Potential Consequences

- Loss of control of sealed sources can potentially result in:
  - Serious injuries to unsuspecting members of the public
  - Diversion and use in a Radiological Dispersal Device (RDD)
  - Environmental contamination

From: IAEA

From: http://emergency.cdc.gov/radiation

Contributing Factors - General Licenses

- No specific activity limits for GL devices; can contain significant quantities of radioactive material (i.e., Category 3)
- Individual entities can possess large numbers of GL devices
- Higher activity GL sources/devices must be registered with NRC/Agreement State (10 CFR 31.5)
  - Registration is not licensing; less information required for submission
  - Annual reporting to NRC or Agreement State is required
- Receive very limited regulatory oversight
- Two year limit on storage of GL sources/devices; not actively monitored or enforced

Contributing Factors – Source Tracking

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- National Source Tracking System (NSTS)
  - NRC system designed to track certain sources from manufacture (or importation) through ultimate disposition (or exportation)
  - Currently only Category 1 and 2 sources are entered into NSTS
  - No requirement to track Category 3 sources
  - NSTS sources represent ~4% of all sealed sources licensed in the US
- DOE Radiological Source Registry and Tracking System (RSRT)
  - DOE reports all Category 1 and 2 sources into NSTS
  - DOE contractors report all accountable sources to RSRT on an annual basis; transactions involving Category 1 and 2 sources within 5 days

Contributing Factors – Financial Issues

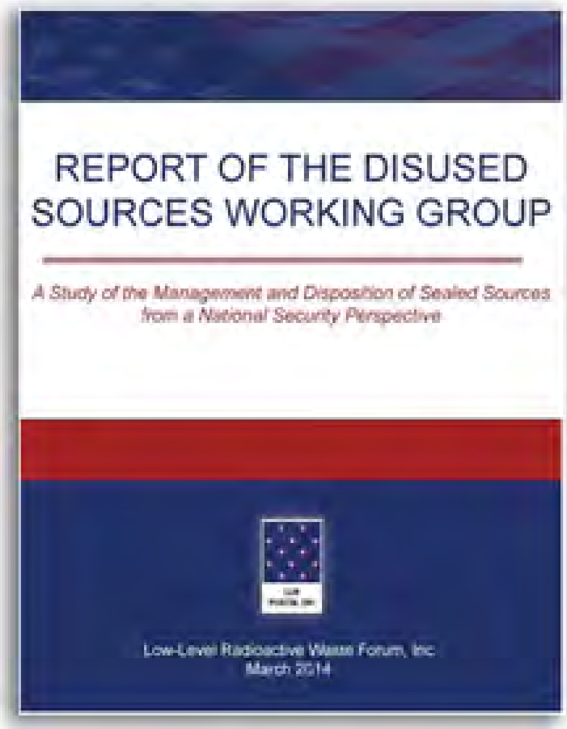
Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Users do not consider life-cycle costs of sealed sources
  - Relatively easy to purchase sealed sources
  - Not required to consider the full life-cycle costs, including packaging and transport costs to dispose or return to manufacturer
  - Disposal of sources can cost many thousands of dollars
  - Type B shipping containers – expensive and in short supply
- Financial assurance requirements
  - 10 CFR 30.35 - $113K in financial assurance for sealed sources
  - Not adequate to cover full costs of packaging, transport and disposal
- No incentives to reuse, recycle or dispose of disused sources
  - No annual possession fee per source
  - Storage is cheap; disposal is expensive
  - Lack of regulatory authority to require disposal of long-term stored sources
  - Limited reuse and recycling opportunities

Potential Solutions

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by **Battelle** *Since 1965*

- Low Level Radioactive Waste Forum Disused Source Working Group (DSWG) Report
  - Published in March 2014, details the issues and potential solutions
  - Working Group began implementation phase in June 2014
    - Chair – Ray Fleming, Texas Department of State Health Services
    - Representation by LLRW compacts and State Radiation Control programs
  - Goals
    - Educational outreach to regulators and stakeholders on life-cycle costs of sources; reuse, recycle and disposal opportunities
    - Discussions with regulatory agencies, private organizations and stakeholders on implementation of recommendations
  - DSWG website established at www.disusedsources.org


REPORT OF THE DISUSED SOURCES WORKING GROUP

A Study of the Management and Disposition of Sealed Sources from a National Security Perspective

Low-Level Radioactive Waste Forum, Inc
March 2014

Potential Solutions

- Some Agreement States have developed more comprehensive regulations for sealed sources
  - Oregon – comprehensive GL requirements, possession fees for each source that a licensee possesses
  - Texas – fees on licensees fund a perpetual care account to cover cost of abandoned source recovery
  - Florida – radiation protection trust fund for licensee bankruptcy and abandoned sources

Potential Solutions

- Financial assurance requirements
  - Need to accurately reflect costs for packaging, transport and disposal
  - Some State programs require more financial assurance for sealed sources than required by 10 CFR 30.35
    - Illinois – requires a reclamation plan and cost estimate for licensees holding sealed sources in aggregate quantities greater than 37 GBq (1 Ci)
  - CRCPD working group SR-S – developing revised criteria for financial surety for cradle-to-grave accountability
- Consider imposing annual possession fees to discourage long-term storage

Potential Solutions

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*

- Increased regulatory control over Category 3 sources
  - Previous proposals - expand NSTS to Category 3 sources, including fixed industrial gauges, well-logging sources, radiography devices
  - Limit the activity allowed in GL devices
  - DSWG recommends SL for all Category 3 sources
- Storage Time Limits
  - Enforce 2 year limit on GL sources
  - Expand limit to apply to all Category 1 through 3 sources
  - Manufacturers and suppliers – dispose of sources with no recycle or reuse value on an annual basis
- Support and expand opportunities for reuse and recycling
  - Establish a source exchange program
  - Conduct formal study of reuse and recycling opportunities

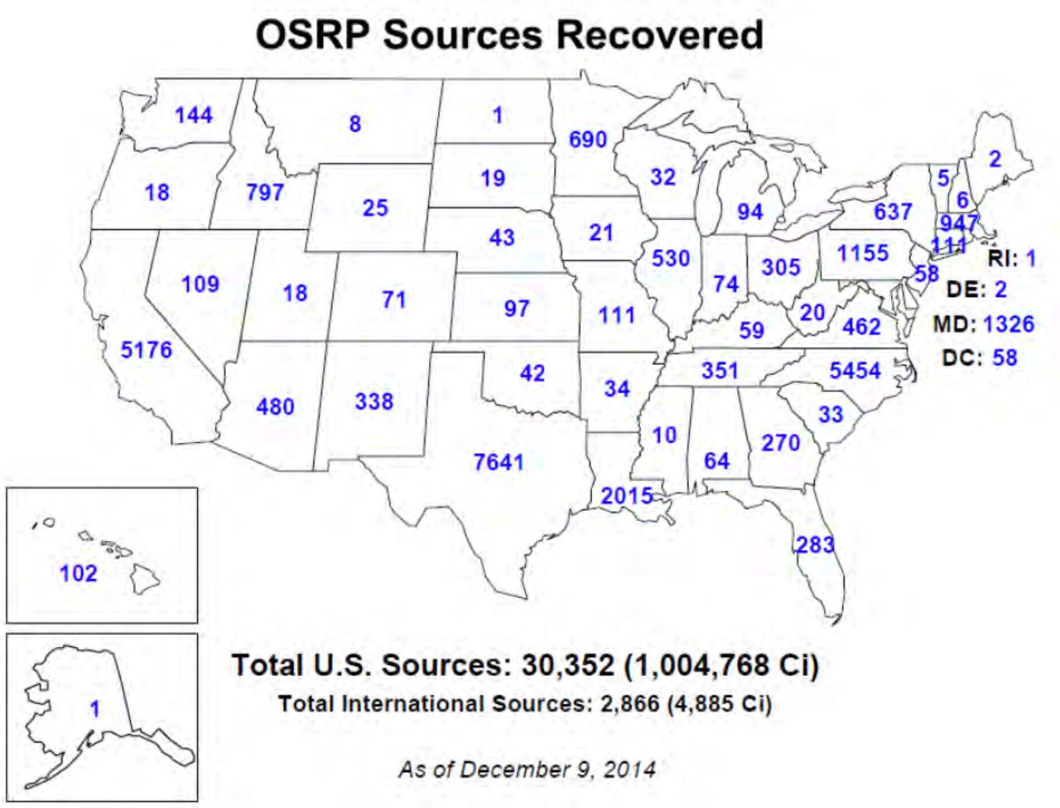
Potential Solutions

- Waste disposal
  - WCS Texas – accepts out-of-compact waste
  - Energy Solutions, UT - limited variance for out-of-compact Class A sources
  - Implement revised concentration averaging BTP – issued Feb. 2015
  - GTCC disposal capability still needed
- Improve availability of Type B shipping containers
  - Expedite review and approval process of Type B containers
  - Approve existing foreign package designs for domestic use
  - Conduct market study on demand for Type B containers
- Encourage use of alternative technologies where appropriate
- Programs to assist in recovery and disposal of disused and orphan sources
  - Off-Site Source Recovery Project (OSRP)
  - Source Collection and Threat Reduction (SCATR) Program

Off-Site Source Recovery Project (OSRP)

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by **Battelle** *Since 1965*

- Sponsored by NNSA Office of Global Material Security, managed by Los Alamos National Laboratory
- Mission - to remove excess, unwanted, abandoned, or orphan sealed sources that pose a potential risk to health, safety, and national security



- Primarily Transuranic; high activity beta/gamma sources
- Prioritized based on activity and security threat
- Recovered over 38,000 sources as of December 2014 (including SCATR program), both domestically and internationally

SCATR Program

- Program is a partnership between CRCPD and NNSA
- Initiated in 2007 to provide pathway for disposal of disused sources that do not meet criteria for Category 1 or 2
- Licensees must register disused sources with OSRP
- CRCPD works with waste brokers to collect, package, transport and dispose of sources
- Grant from NNSA Office of Global Material Security provides financial assistance; costs are shared with the licensees – 45% for the 2014-2015 collection; but expected to decrease
- Collected and disposed of nearly 14,000 sources over the life of the program to date

Acknowledgements

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Jim Yusko - NCRP PAC-2
- Russ Meyer - CRCPD/SCATR Program
- Ray Fleming - Chair, DSWG
- Todd Lovinger - Executive Director, LLW Forum
- Anine Grumbles - Chair, CRCPD SR-S Working Group

Factors Important to Long-Term Waste Management of Depleted Uranium

Michael T. Ryan, Ph.D., C.H.P.

Health Physics Journal
Editor-in-Chief
Charleston, SC 29492

Monday, March 16, 2015

Disclaimer

The views being expressed are my own and do not represent an official position of the National Council of Radiation Protection and Measurements, the Advisory Committee on Reactor Safeguards, the U.S. Nuclear Regulatory Commission, or the NRC staff.

Uranium

- http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Uranium-Resources/Uranium-and-Depleted-Uranium/

Current and Future Radioactive Waste Management in the U.S. Depleted Uranium

- **Depleted uranium** (DU; also referred to in the past as Q-metal, depletalloy or D-38) is **uranium** with a lower content of the fissile isotope U-235 than natural **uranium**. (Natural **uranium** is about 0.72% U-235—the fissile isotope, and the DU used by the U.S. Department of Defense contain less than 0.3% U-235).

Uranium

- **Health aspects of DU**
- Depleted uranium is not classified as a dangerous substance radiologically, though it is a potential hazard in large quantities, beyond what could conceivably be breathed. Its emissions are very low, since the half-life of U-238 is the same as the age of the Earth (4.5 billion years)

Uranium

- .There are no reputable reports of cancer or other negative health effects from radiation exposure to ingested or inhaled natural or depleted uranium, despite much study.

Uranium

- However, uranium does have a chemical toxicity about the same as that of lead, so inhaled fume or ingested oxide is considered a health hazard. Most uranium actually absorbed into the body is excreted within days, the balance being laid down in bone and kidneys. Its biological effect is principally kidney damage.

Uranium

- The World Health Organization (WHO) has set a tolerable daily intake level for uranium of 0.6 microgram/kg body weight, orally. (This is about eight times our normal background intake from natural sources.) Standards for drinking water and concentrations in air are set accordingly.

Uranium

- **Uranium and Depleted Uranium**
- (*Updated December 2014*)
- **The basic fuel for a nuclear power reactor is uranium – a heavy metal able to release abundant concentrated energy.**

Uranium

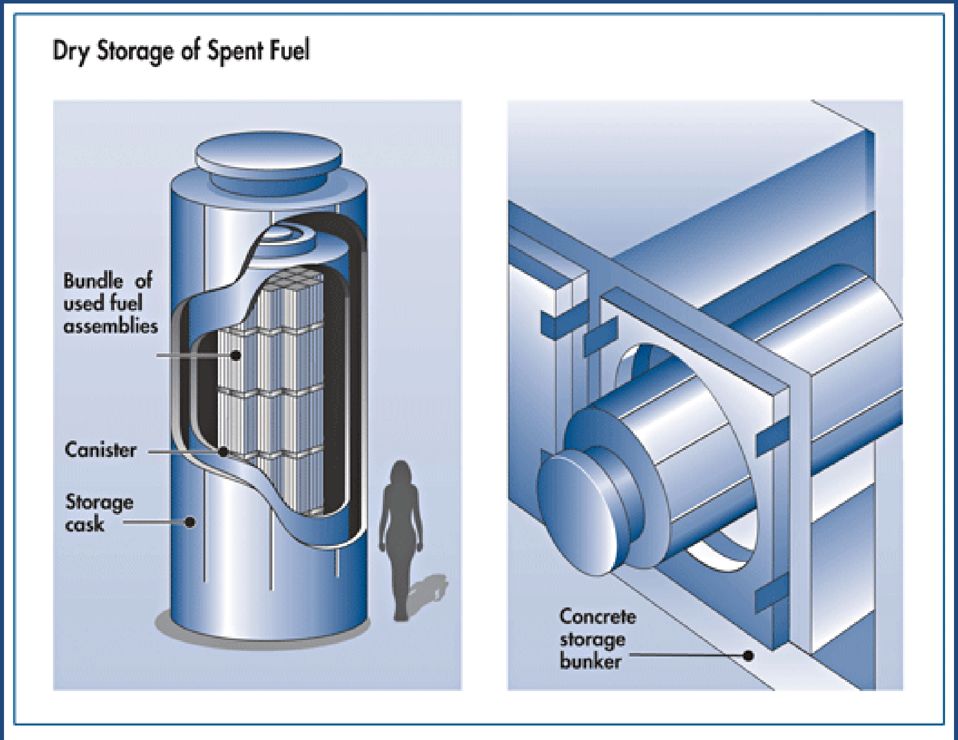
- **Uranium occurs naturally in the Earth's crust and is mildly radioactive.**
- **Depleted uranium is a by-product from uranium enrichment.**
- **The health hazards associated with any uranium are much the same as those for lead.**

Current Status of Radioactive Waste Management

Dry Storage Casks for SNF

- DOE required by law to take title to spent nuclear fuel (SNF) and other HLW
- Since 1986, NRC has issued licenses at 65 sites to store SNF on-site in dry cask canisters
  - Intended as temporary solution until disposal facility becomes available

Dry Storage Casks Configurations



http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/dry-cask-storage.html

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management

- **Low-level radioactive waste is defined by what it is not**

- **It is not …**
  - Spent nuclear fuel
  - High-level radioactive waste
  - AEA 11e(2) material
  - Transuranic radioactive waste
  - Naturally-occurring radioactive material

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management

- **Characteristics**
  - Generally includes short-lived isotopes
    - Classes (A, B, C, and GTCC) differentiated by concentrations
  - Variety of physical forms
  - Different waste stream origins
  - Managed in near-surface disposal facilities
  - States generally organized into Compacts
  - Disposal sites regulated by Agreement States
    - Consistent with NRC-developed regulations

Key Radionuclides in LLRW

Radionuclide	Half-Life (years)	Decay Corrected inventory (Curies as of 7/12/2011)
141Ce	0.09	0
144Ce	0.78	32.94
58Co	0.19	115.11
60Co	5.27	1,116,607.98
51Cr	0.08	3.12
134Cs	2.06	1,541.46
137Cs	30.00	242,998.69
55Fe	2.70	385,190.39
59Fr	0.12	0.19
3H	12.35	270,490.14
125I	0.17	0.00
85Kr	10.72	373.16
54Mn	0.86	1,600.34
103Ru	0.11	0.00
89Sr	0.14	0.03
90Sr	29.12	9,736.61
65Zn	0.67	74.63
95Zr	0.18	1.74

Current Status of Radioactive Waste Management

Key LLRW Radionuclides Remaining After 300 years

Radionuclide	Half-Life (years)	Decay Corrected inventory (Curies as of 7/12/2011)
63Ni	96.00	440,154.65
238U	4.5 E+09	5,246.92
C-14	5730	3,378.35
I-129	15700	9.76
Tc-99	213000	117.96

Radionuclides that outlive 300 years of decay

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management

- **Barnwell, SC**
  - In operation since1969
  - Licensed to receive wastes in Classes A, B, and C
  - Facility accepts waste from Connecticut, New Jersey and South Carolina

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management

- **Richland, WA**
  - In operation since 1965
  - Licensed to receive wastes in Classes A, B, and C
  - Accepts waste from states that belong to the Northwest Compact (Washington, Alaska, Hawaii, Idaho, Montana, Oregon and Wyoming) and the Rocky Mountain Compact (Colorado, Nevada and New Mexico)

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management

- **Clive, UT**
  - In operation since 1991
  - Licensed to accept Class A waste only
  - Facility accepts waste from all regions of the United States
  - License amendments in past to receive NORM, LAW, chemically-mixed LLW, and AEA 11e(2) materials

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management

- **Andrews County, TX**
  - In operation since 2012
  - Licensed by the Texas Commission on Environmental Quality
  - Licensed to receive wastes in Classes A, B, and C from Texas and Vermont
  - Site also accepts DOE LLRW

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management

- Active LLRW disposal facilities are located in NRC Agreement States

- NRC activities (ongoing)
  - Branch Technical Position on Concentration and Encapsulation Update
  - Site-Specific Analysis Rulemaking
    - Includes update/revision to Uniform Waste Manifest
  - NRC LLRW Strategic Assessment (update to SECY-07-0180)

Current Status of Radioactive Waste Management

Low-Level Radioactive Waste Management including DU

- DOE activities (ongoing) … GTCC LLRW
  - Department required to dispose of commercial GTCC
    - Geologic repository (non-limiting case)
    - Facility design approved by NRC (limiting case)
  - Government-owned TRU Waste disposed at WIPP
  - Draft GTCC EIS issued for public comment in 2011
    - Final not issued
    - DOE to identify preferred disposal alternative

Good LLRW References

The Road to Yucca Mountain. *The Development of Radioactive Waste Policy in the United States.*

J. Samuel Walker

ACNW White Paper NUREG-1853 History and Framework of Commercial Low-Level Radioactive Waste Management in the United States

Date Published: January 2007.

Prepared by M.T. Ryan, M.P. Lee, and H.J. Larson

How Can We Help?

- Be the expert source for information
- Accurate, credible information is key
- Know your audience
  - Provide information at the proper level of detail
  - Respond to all inquiries for information

How Can We Help? *(con't.)*

- Design and maintain outreach materials
  - Technically accurate
  - Easy to use
  - Encourage participation and feedback
  - Routinely updated!

- Provide NRC staff with feedback on its regulatory activities

U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Alternative Disposal Strategies for High-Level Radioactive Waste and Spent Nuclear Fuel

John W. Herczeg
Deputy Assistant Secretary
Office of Fuel Cycle Technologies
Office of Nuclear Energy
Department of Energy

Presentation to
2015 Annual Meeting of the National Council on Radiation Protection and Measurements
"Changing Regulations and Radiation Guidance – What does the Future Hold?"

March 16, 2015

Two Primary Waste Streams: Commercial SNF and DOE-managed wastes

Commercial Nuclear Energy

Ongoing Defense Programs

Wastes from the Production of Nuclear Weapons

Nuclear Energy

A Comprehensive National Nuclear Fuel Cycle Strategy Requires Analyses and Understanding of the Waste Stream Characteristics

- **In 2012, Oak Ridge National Laboratory led a team that identified and categorized the commercial and DOE managed spent nuclear fuel requiring management and disposition**

- **In 2014, Sandia National Laboratories led a team that built upon the ORNL work to develop a comprehensive inventory of spent nuclear fuel and high level waste requiring geologic disposal and identified potential disposal options for each of the waste forms in the inventory.**


Categorization of Used Nuclear Fuel Inventory in Support of a Comprehensive National Nuclear Fuel Cycle Strategy

December 2012

Evaluation of Options for Permanent Geologic Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste in Support of a Comprehensive National Nuclear Fuel Cycle Strategy

Volume I

Fuel Cycle Research & Development

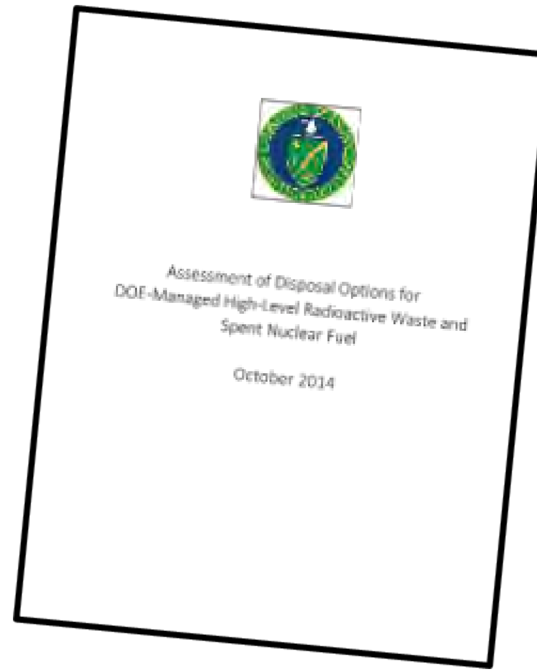
Prepared for U.S. Department of Energy Used Fuel Disposition Campaign by Sandia National Laboratories

April 15, 2014

Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

- Over the last year, the Department has done a technical assessment of options for disposal of its inventory of DOE-managed high-level radioactive waste and spent nuclear fuel.
- This assessment considered whether DOE- managed HLW and SNF should be disposed of with commercial SNF and HLW in one geologic repository, or whether there are advantages to developing separate geologic disposal pathways for some DOE-managed HLW and SNF.
- Disposal options analyzed --
  - Dispose of all HLW and SNF waste, regardless of origin, in a common repository
  - Disposal of some DOE-managed HLW and SNF in a separate mined repository
  - Disposal of smaller waste forms in deep boreholes


Assessment of Disposal Options for
DOE-Managed High-Level Radioactive Waste and
Spent Nuclear Fuel

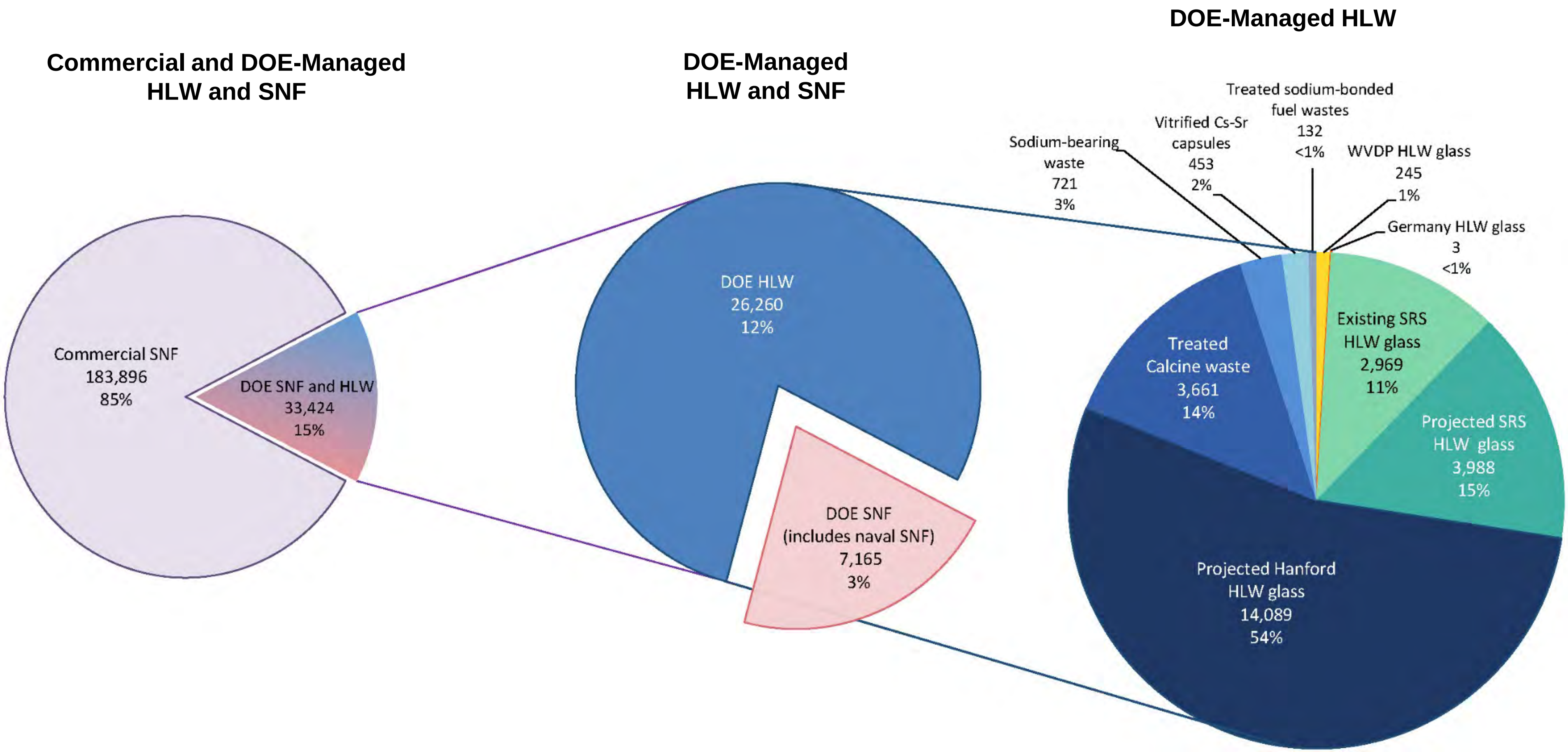
October 2014

U.S. DEPARTMENT OF ENERGY

Nuclear Energy

Projected Volumes of HLW and SNF in 2048

Projected volumes in m^3



Physical Characteristics of Waste Can be a Factor When Considering Disposal Options

Commercial SNF

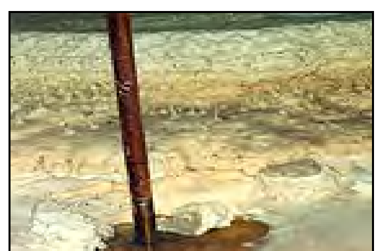
- Essentially all U0x fuel of various types
- Presently being loaded in large dual-purpose dry storage canisters; *significant thermal management issues*
- Most repository concepts call for repackaging

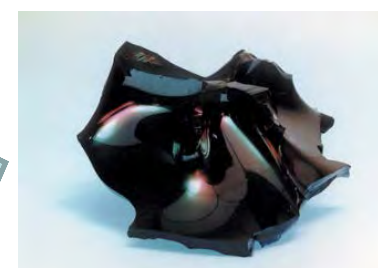
DOE-managed HLW

- Vitrified wastes at Savannah River Site, projected at Hanford and Idaho sites
- Projected other engineered forms
  - e.g., electrometallurgical treatment wastes, solids created by hot isostatic pressing of granular calcine at Idaho site
- Salts, granular solids, and powders

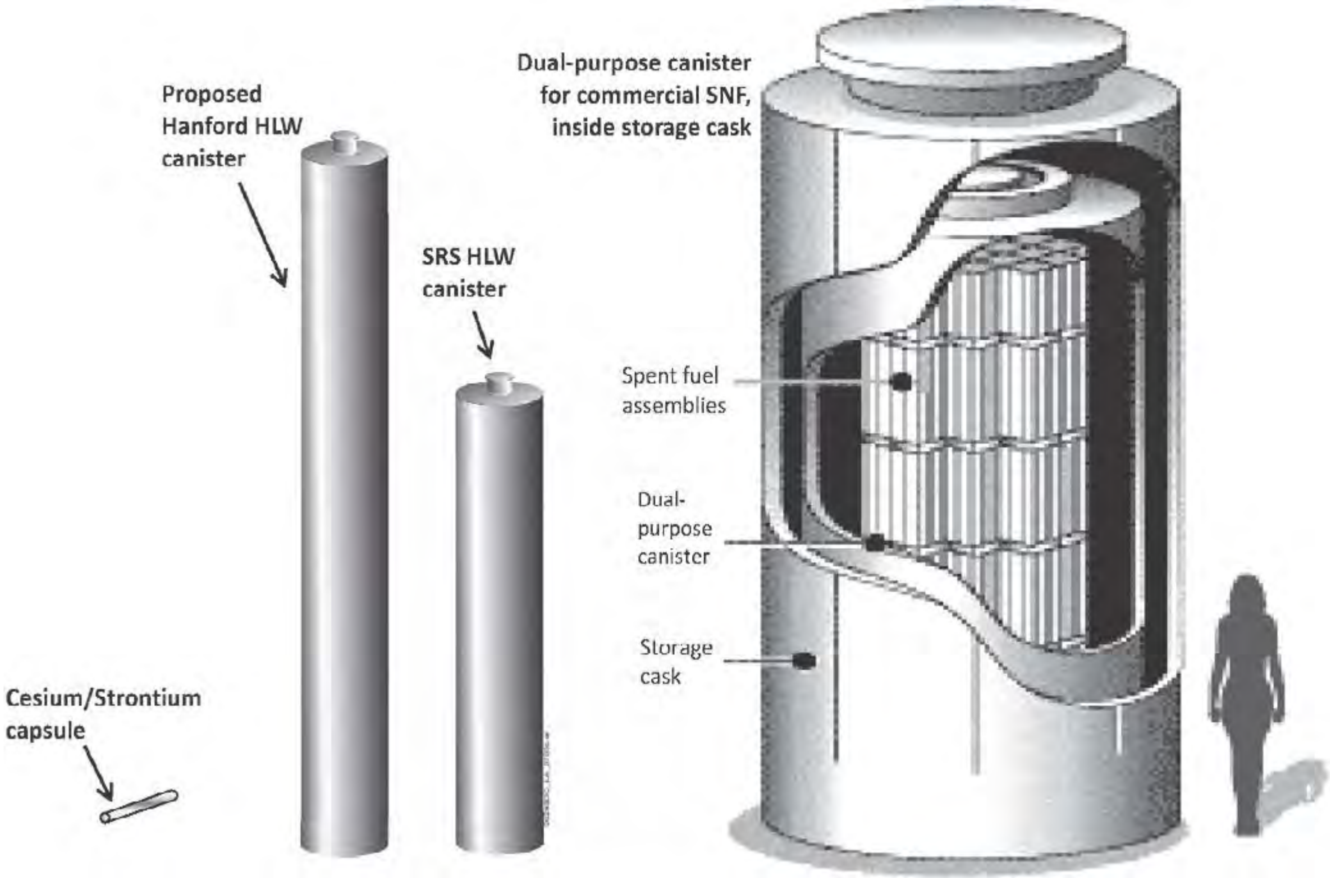
DOE-managed SNF

- Metallic and non-oxide SNF
- Sodium-bonded SNF
- U and Pu oxide SNF
- Coated particle SNF
- Naval SNF





Relative Size of Waste Packaging May Have an Impact on Disposal Options



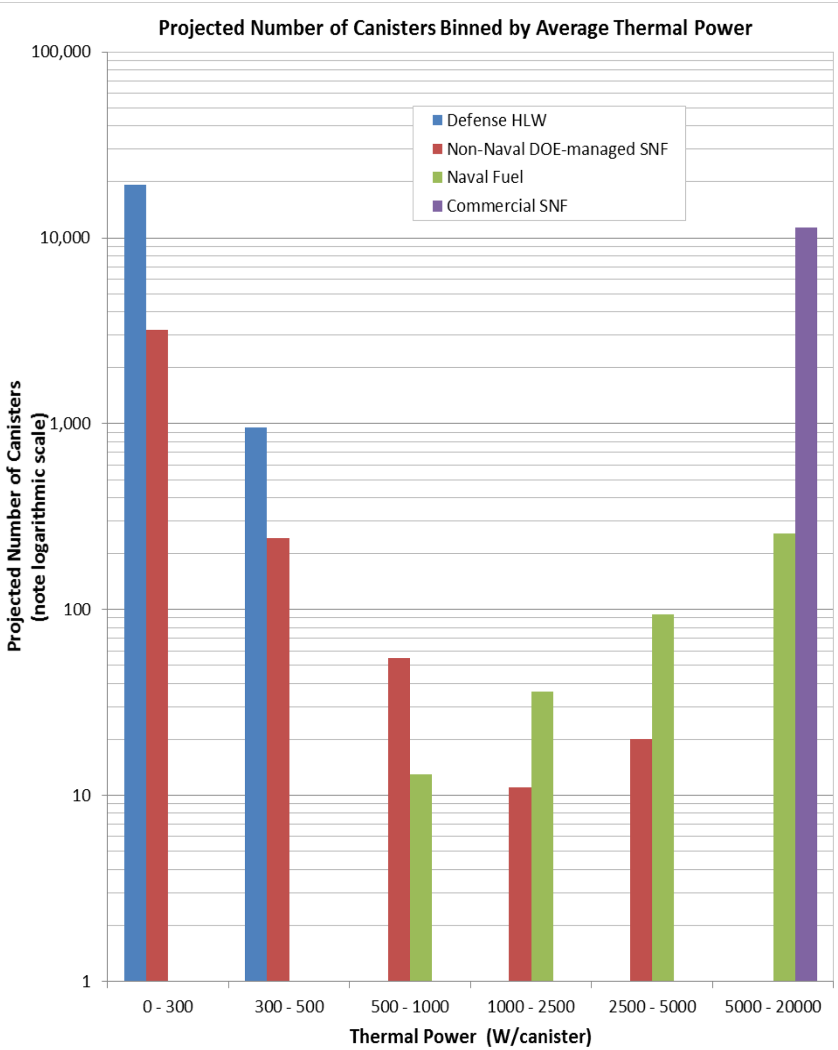
The smallest forms of HLW and SNF that can fit into small diameter canisters could be candidates for deep borehole disposal

Approximate Scale

U.S. DEPARTMENT OF ENERGY

Nuclear Energy

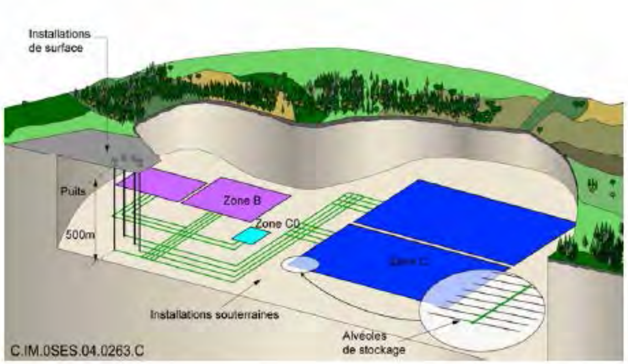
Thermal Characteristics of HLW and SNF Affects Disposal Strategies



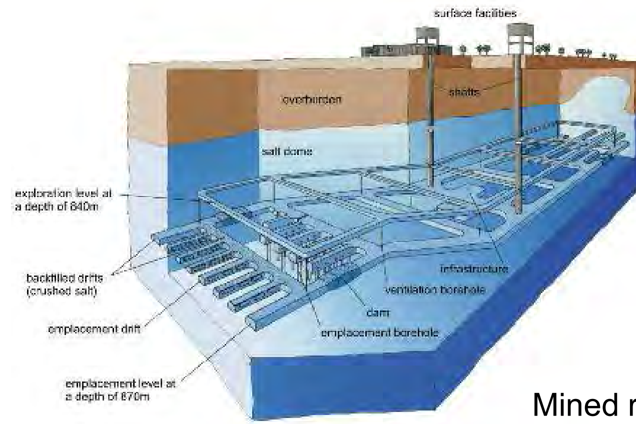
- All defense HLW is relatively cold: less than 500 W per canister
- Most DOE-managed SNF is relatively cold: less than 1000 W per canister
- All commercial SNF has comparatively high thermal output
- Some naval SNF is comparable in thermal power to commercial SNF
- Repository designs and operational concepts can be engineered to address waste form thermal characteristics

U.S. DEPARTMENT OF
ENERGY
Nuclear Energy

Disposal Concepts

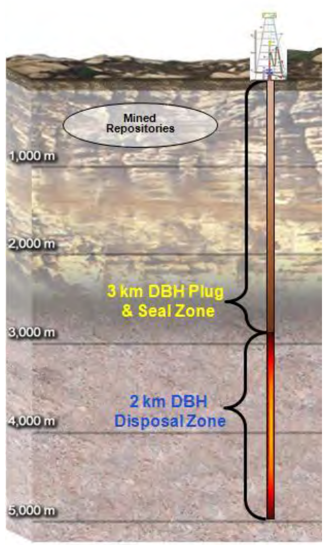


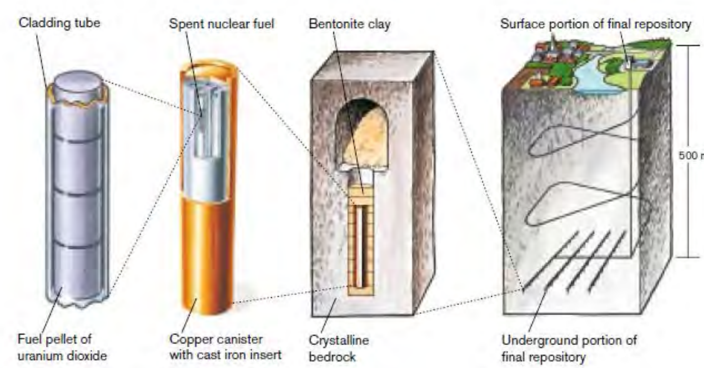
Mined repositories in clay/shale



Mined repositories in salt

Deep boreholes in crystalline rock

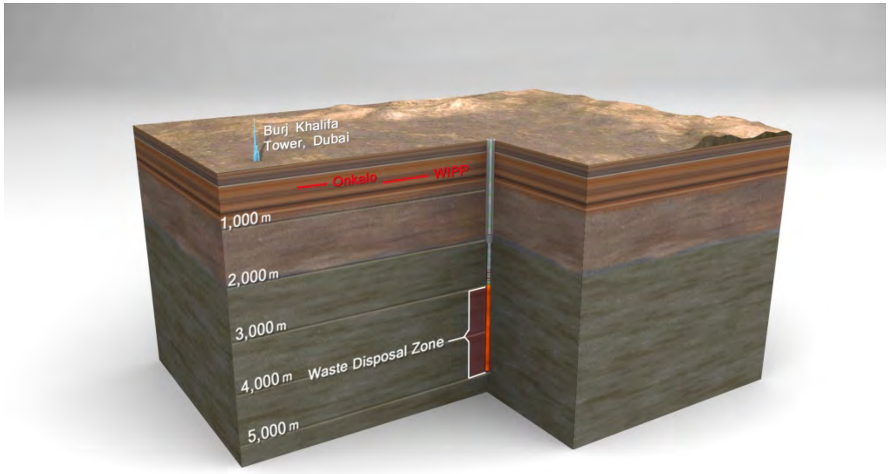


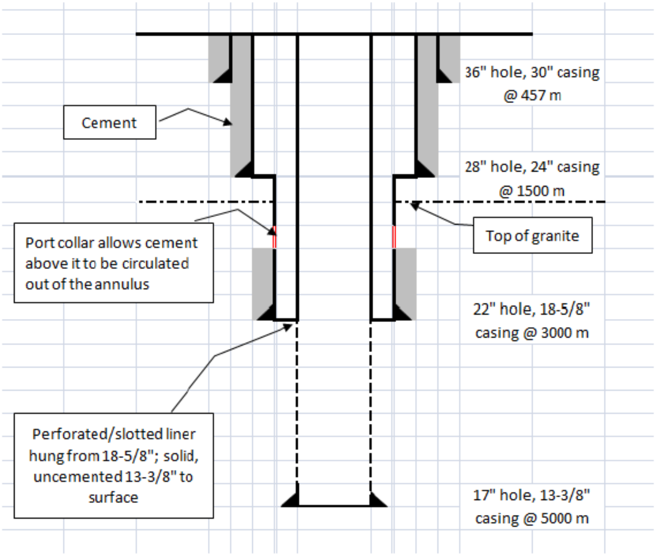


Mined repositories in crystalline rock

Deep Borehole Concept: Improving Scientific Understanding with a Field Experiment

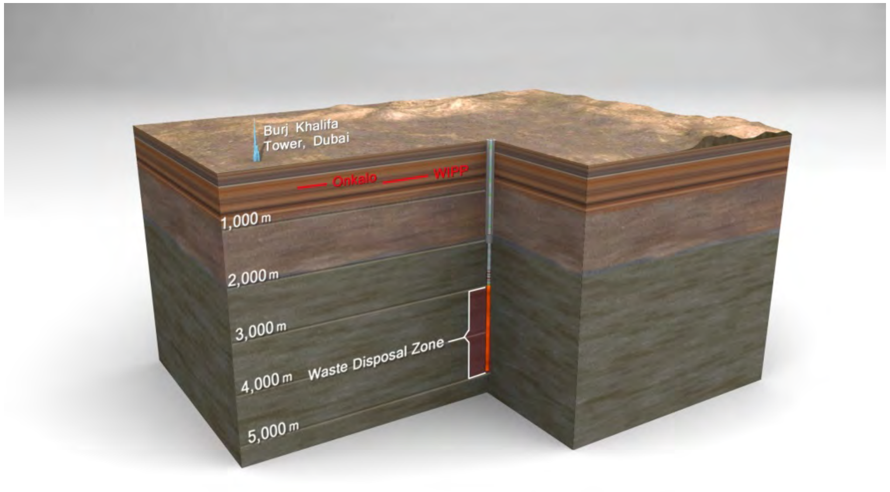
- **Several factors suggest the disposal concept is viable and safe:**
  - Crystalline basement rocks are common in many stable continental regions
  - Existing drilling technology permits dependable construction at acceptable cost
  - Low permeability and long residence time of high-salinity groundwater in deep continental crystalline basement at many locations suggests very limited interaction with shallow fresh groundwater resources





Deep Borehole Concept: Improving Scientific Understanding with a Field Experiment

- **DOE's proposed Deep Borehole field test is the next logical step in evaluating the DBH concept and is part of the Department's cross cut in subsurface research.**
  - No radioactive waste will be used during the field test.



- **The DBH Field Test will:**
  - Demonstrate the feasibility of characterizing and engineering deep boreholes
  - Demonstrate safe processes and operations for safe waste emplacement downhole

Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel

- **Key Conclusions and Recommendations**
  - Concludes that there are multiple options for disposal of DOE-managed HLW and SNF that are technically feasible and have the potential to provide long-term isolation of this waste.
  - Concludes there are potential programmatic advantages to a phased strategy that allows for flexibility in disposal pathways for some DOE- managed HLW and SNF.
  - Recommends the Department begin implementation of a phased, adaptive, and consent-based strategy with development of a separate repository for some DOE-managed HLW and SNF.
  - Recommends the Department retain the flexibility to consider options for disposal of some smaller DOE-managed waste forms in deep boreholes rather than in a mined geologic repository.

Conclusions

- **The Department is moving forward with**
  - Evaluations of alternative disposal options, including
    - Consideration of mined repositories in multiple geologic media
    - Evaluation of the feasibility of disposing of commercial SNF in existing dual purpose canisters
  - Implementation of a deep borehole field test that will provide the basis for determining the feasibility of borehole disposal of smaller waste forms
- **The Department's budget request for FY16 includes $3M for activities associated with exploring potential alternative disposal options for some DOE-managed HLW and SNF**

SR-F Suggested Regulations
Medical Diagnostic and Interventional X-ray and Imaging Systems

John P Winston, Chair
CRCPD SR-F Committee

National Council on Radiation Protection and Measurements
2015

Disclaimer

- NOTE: Any products or manufacturers mentioned or shown in photographs or text of this presentation, does not represent an endorsement by the author, PA DEP, or CRCPD.

Mission of the Conference of Radiation Control Program Directors (CRCPD)

- To “promote consistency” in addressing and resolving radiation protection issues.
- Suggest State Regulations for Control of Radiation

CRCPD
Suggested State Regulations for Control of Radiation (SSR)

- Currently 25 working groups in the SSR Council

- SR-F Suggested State Regulations – Medical Diagnostic and Interventional X-ray and Imaging Systems

How are suggested state regulations developed?

- National Issue
- New Technology
- Crisis
- Special Interest Groups
- Moral Consciousness
- Federal Mandates

The CRCPD SSR Process

Identify need for new regulations

Assign the task of developing the new regulation to a new or existing SSR Committee

SSR Counsel Chair develops and CRCPD Board approves charges & timelines

Identify committee members and areas of expertise

SSR Committee drafts the new suggested regulation & rationale

SR-F Committee

- Members
  - Bradley Grinstead (AL)
  - Mary Ann Spohrer (IL)
  - Russell Takata (HI-Life)
  - John Winston (PA)
- Resource Individuals
  - Kyle Jones, Melissa Martin & Lynne Fairobent (AAPM)
  - Doug Pfeiffer (ACR)
  - Thalia Mills & Donald Miller (CDRH)

SR-F Committee (cont.)

- Advisors
  - Tracey Luty (CO)
  - Laura Pring (NC)
  - Herbert Mower (MA / Affil.)
  - Ed Bailey (TX-Life)
  - Reed Best (UT-Affil.)
  - Augustinus Ong (NH)
  - Jane Van Valkenberg (WY-Affil.)
  - Chris Martel (MA-Affil.)
- OED

  Bruce Hirschler

The CRCPD SSR Process

Identify need for new regulations

↓

Assign the task of developing the new regulation to a new or existing SSR Committee

↓

SSR Counsel Chair develops and CRCPD Board approves charges & timelines

↓

Identify committee members and areas of expertise

↓

SSR Committee drafts the new suggested regulation & rationale

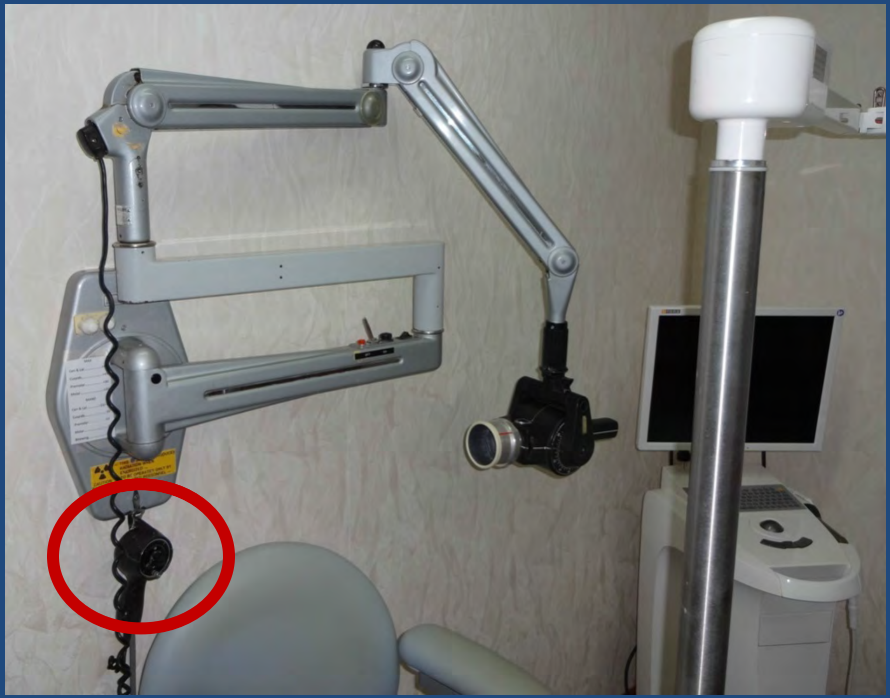
↓

SR-F
Working Group Resources

- Current State Regulations
  (CO, MI, NY, PA, TX, WA)
- (Draft) Federal Guidance Report No. 14
- NCRP Reports (168, 172)
- AAPM Reports (96, TG-151, TG-175)
- ACR Publications

SR-F
Working Group Resources

- Using or Referencing 21 CFR
- 21 CFR vs. International Electrotechnical Commission (IEC)



SR-F
A New Name

- Former:

Diagnostic X-Rays and Imaging Systems in the Healing Arts

- Current:

Medical Diagnostic and Interventional X-ray and Imaging Systems

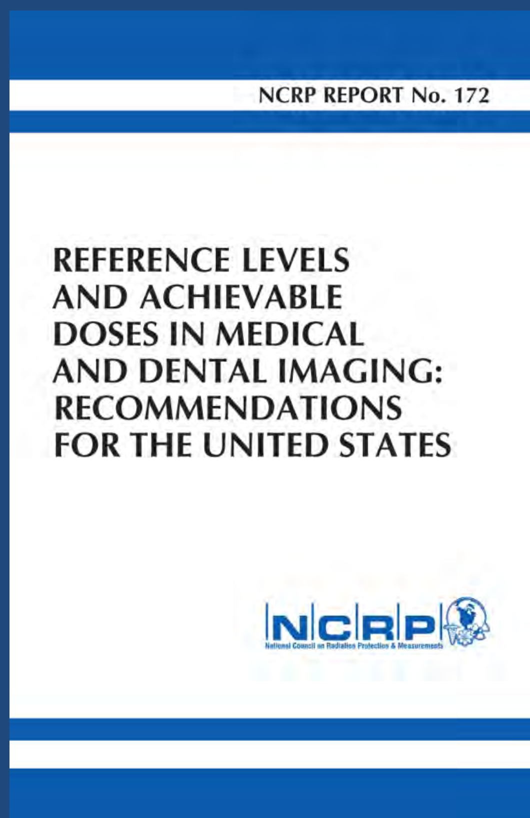
SR-F
General and Administrative Requirements

- Diagnostic Medical Events
  - Unintended skin dose
  - Unintended dose other than skin
  - Wrong patient or wrong site

- *Unintended*
  "… resulting from human error
  or equipment malfunction"

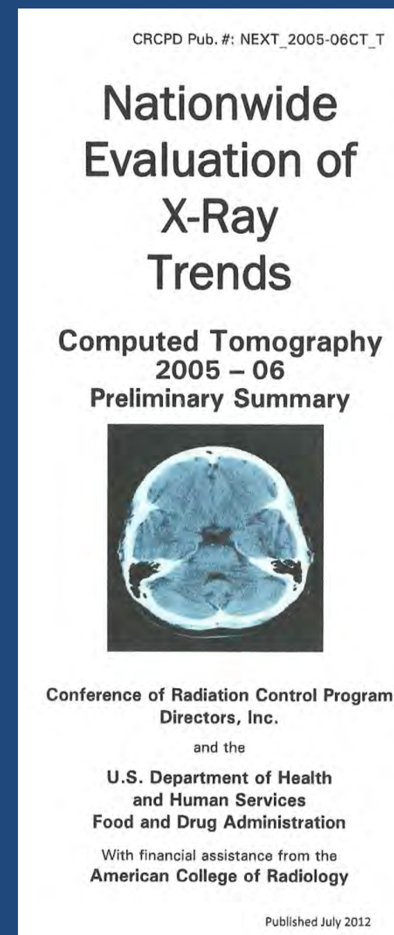
SR-F
General and Administrative Requirements

- Diagnostic Reference Levels


NCRP REPORT No. 172

REFERENCE LEVELS AND ACHIEVABLE DOSES IN MEDICAL AND DENTAL IMAGING: RECOMMENDATIONS FOR THE UNITED STATES

NCRP


CRCPD Pub. #: NEXT_2005-06CT_T

Nationwide Evaluation of X-Ray Trends

Computed Tomography 2005 – 06 Preliminary Summary

Conference of Radiation Control Program Directors, Inc.

and the

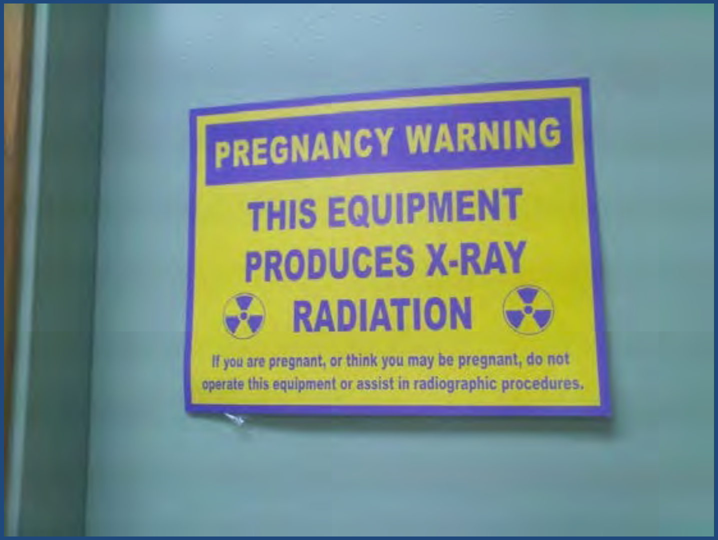
U.S. Department of Health and Human Services Food and Drug Administration

With financial assistance from the American College of Radiology

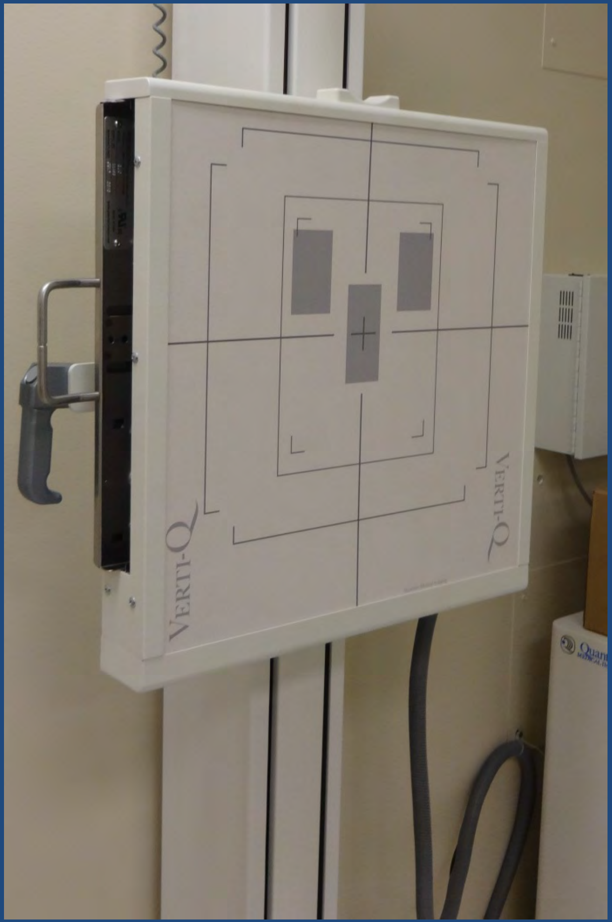
Published July 2012

SR-F
General and Administrative Requirements

- Radiation Safety
- Quality Assurance



SR-F
General Requirements for All Diagnostic and Interventional X-ray Systems



SR-F
General Requirements for All Diagnostic and Interventional X-ray Systems

SR-F
Fluoroscopy Systems

- Minimum operational standards for procedures where sterile fields or special procedures prohibit the use of normal protective barriers
- Minimum operator qualifications and training for those using or supervising the use of fluoroscopy equipment

SR-F
Fluoroscopy Systems

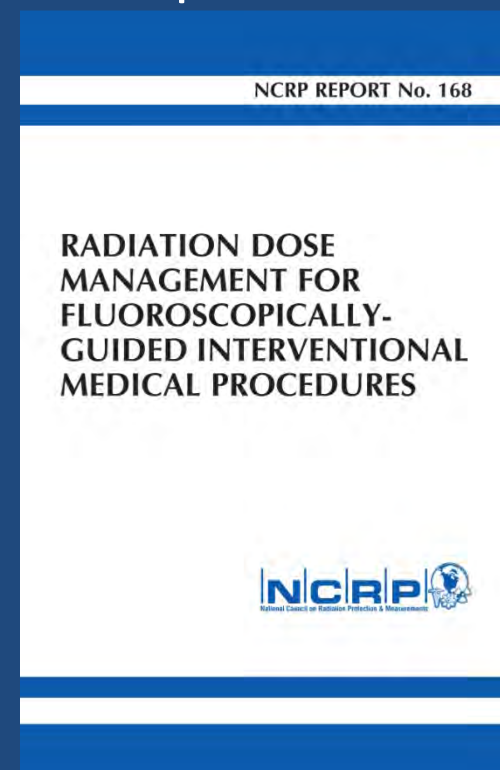
- A physicist evaluates all modes clinically used on each fluoroscopic unit at intervals not to exceed 12 months

SR-F
Fluoroscopy Systems

- Additional requirements for facilities performing Fluoroscopically Guided Interventional (FGI) procedures:
  - Training on:
    - Methods to reduce patient dose
    - Procedures for recording pertinent dose data
    - Minimum of one hour hands on training on the fluoroscopy machine

SR-F
Fluoroscopy Systems

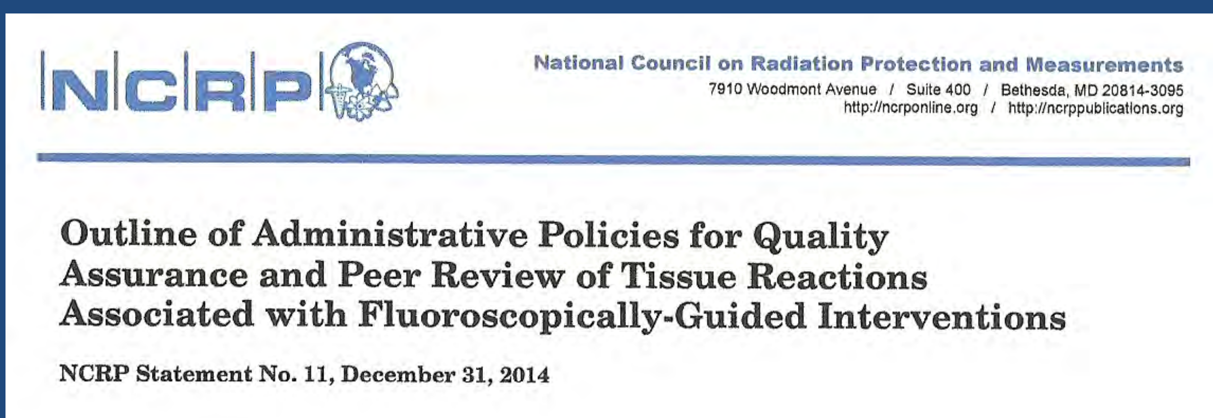
- Additional requirements for facilities performing FGI:
  - Radiation Protocol Committee (RPC)
    - Methods used to monitor, manage, and record patient dose
    - Dose notification levels
    - Substantial Radiation Dose Levels (SRDL)



NCRP REPORT No. 168

RADIATION DOSE MANAGEMENT FOR FLUOROSCOPICALLY-GUIDED INTERVENTIONAL MEDICAL PROCEDURES

NCRP



NCRP

National Council on Radiation Protection and Measurements
7910 Woodmont Avenue / Suite 400 / Bethesda, MD 20814-3095
http://ncrponline.org / http://ncrppublications.org

Outline of Administrative Policies for Quality Assurance and Peer Review of Tissue Reactions Associated with Fluoroscopically-Guided Interventions

NCRP Statement No. 11, December 31, 2014

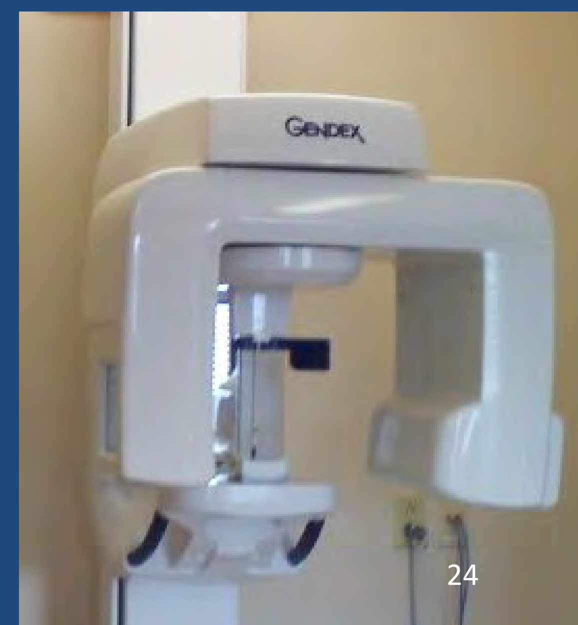
SR-F
Radiographic Equipment

- Evaluation of digital radiographic equipment by a QMP [QE]
  - ✓ Dental, Podiatric, and Veterinary exempt

SR-F
Radiographic Equipment

SR-F
Dental Facilities

- Developed as a stand alone chapter for dental facilities using traditional intraoral, panoramic, and cephalometric equipment
- Hand-held Intraoral Equipment



SR-F
Computed Tomography

- Accreditation
  - By an accrediting organization recognized by the state Agency
- Annual evaluation by a QMP [QE]
  - Meet nationally recognized standards and tolerances

SR-F
Computed Tomography

- Radiation Protocol Committee (RPC)
  - Method to monitor CT radiation output
  - Standardized protocol naming policy
  - Method to prevent unauthorized changes to CT protocols
  - Method to maintain a record of clinical radiation output so a patient's dose can be estimated
  - DRLs, Notification values, Alert values

SR-F
Computed Tomography

- Specific Requirements / Exemptions:
  - CT systems solely for treatment planning
  - PET & SPECT CT
  - Veterinary

SR-F
Computed Tomography

- Cone Beam Computed Tomography (CBCT)
  - Quality Control
  - Annual evaluation by a QMP [QE]
    - Exempt if not capable of operating above 100 kV or 20 mA

The CRCPD SSR Process

Identify need for new regulations

Assign the task of developing the new regulation to a new or existing SSR Committee

SSR Counsel Chair develops and CRCPD Board approves charges & timelines

Identify committee members and areas of expertise

SSR Committee drafts the new suggested regulation & rationale

The CRCPD SSR Process

OED performs technical review

Suggested Regulations are Peer Reviewed

SSR Committee Addressed Peer Review comments

Document sent to the CRCPD Board for approval

Regulations sent to federal partners for concurrence

Publish Revised SSRCR

The CRCPD SSR Process

OED performs technical review

↓

Suggested Regulations are Peer Reviewed

↓

SSR Committee Addressed Peer Review comments

↓

Document sent to the CRCPD Board for approval

↓

Regulations sent to federal partners for concurrence

↓

Publish Revised SSRCR

SR-F Peer Reviewers

- Lisa Bruedigan (TX)
- Jennifer Elee (LA)

- Steve Balter
- Penny Butler
- Diana Cody
- Debbie Gilley
- Joel Gray
- Tom Ruckdeschel
- Keith Strauss

- The State Radiation Control Programs
- FDA

The CRCPD SSR Process

OED performs technical review

↓

Suggested Regulations are Peer Reviewed

↓

SSR Committee Addressed Peer Review comments

↓

Document sent to the CRCPD Board for approval

↓

Regulations sent to federal partners for concurrence

↓

Publish Revised SSRCR

CRCPD SSR
Bracketed Language

- Language that is optional for state regulators.
- Committee felt useful enough to suggest as a possible approach.
- Also used for language that may not apply to all states.
- Everything else has met full federal concurrence through our process, and may even be required by federal rules.

The CRCPD SSR Process

OED performs technical review

↓

Suggested Regulations are Peer Reviewed

↓

SSR Committee Addressed Peer Review comments

↓

Document sent to the CRCPD Board for approval

↓

Regulations sent to federal partners for concurrence

↓

Publish Revised SSRCR

Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

-MEDICAL-

LAWRENCE T. DAUER & ELEANOR BLAKELY

NCRP 51st Annual Meeting:
Changing Regulations and Radiation Guidance:
What Does the Future Hold?
16-17 March 2015
Bethesda, MD

NCRP
National Council on Radiation Protection & Measurements

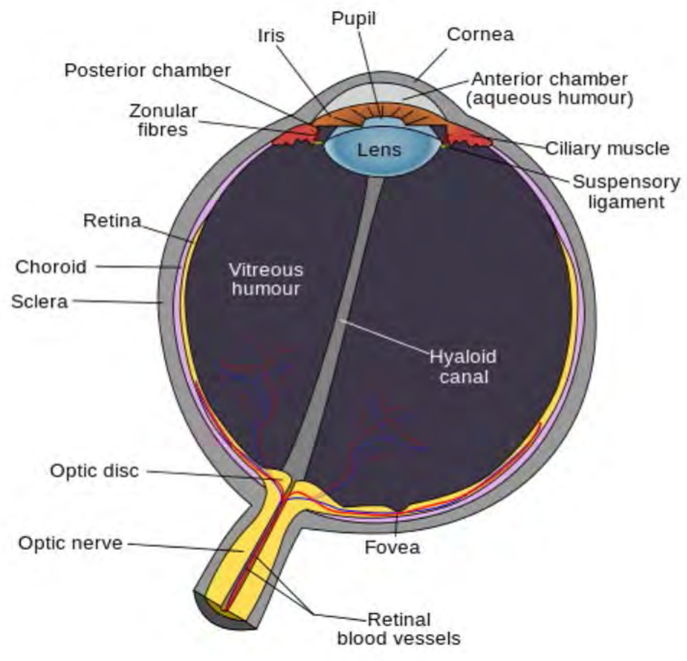
Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

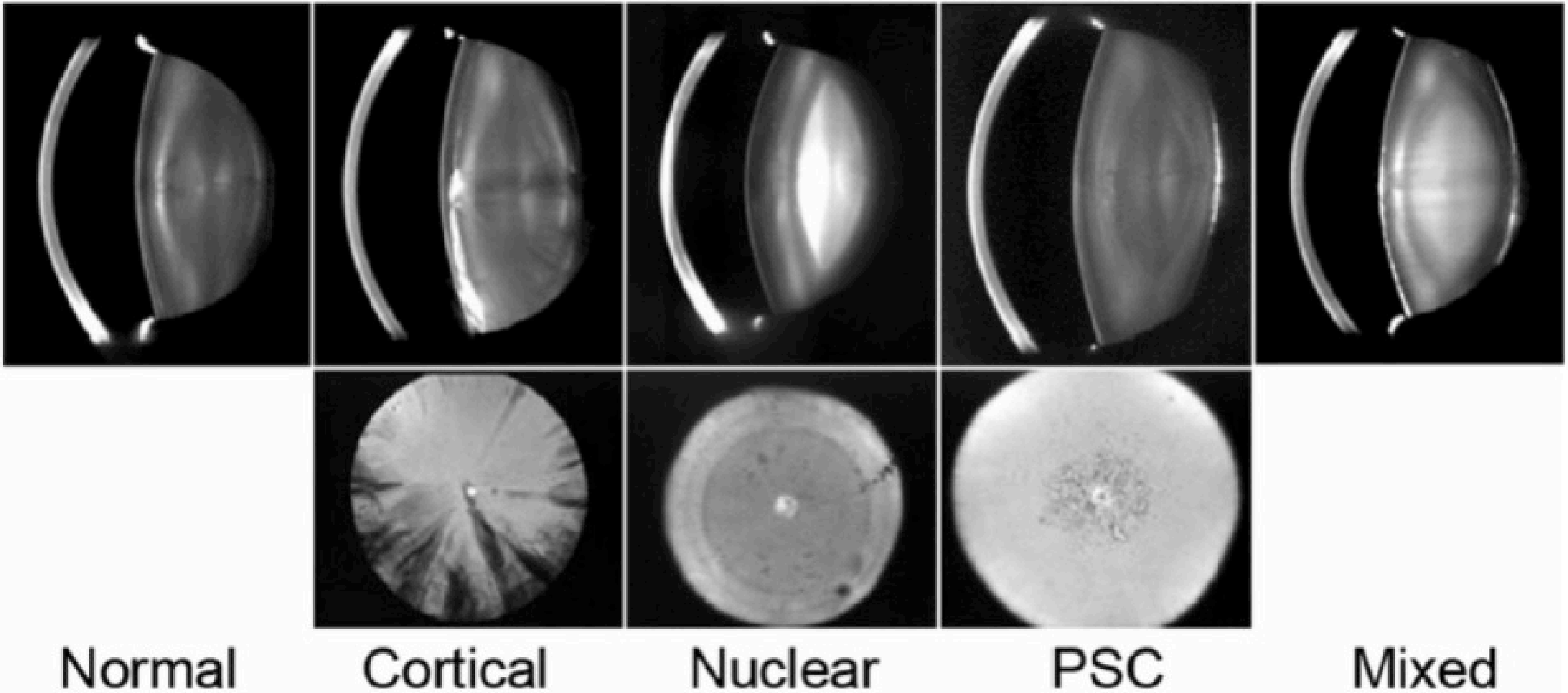
- **SC 1-23**
- **CORE QUESTIONS**
- **CURRENT NCRP GUIDANCE**
- **OTHER RECENT REVIEWS**
- **EYE BIOLOGY & LENS EFFECTS**
- **EPIDEMIOLOGY**
- **POPULATIONS/PROTECTION**
- **DRAFT CONCLUSIONS**
- **DRAFT RECOMMENDATIONS**

Guidance on Radiation Dose Limits for the Lens of the Eye

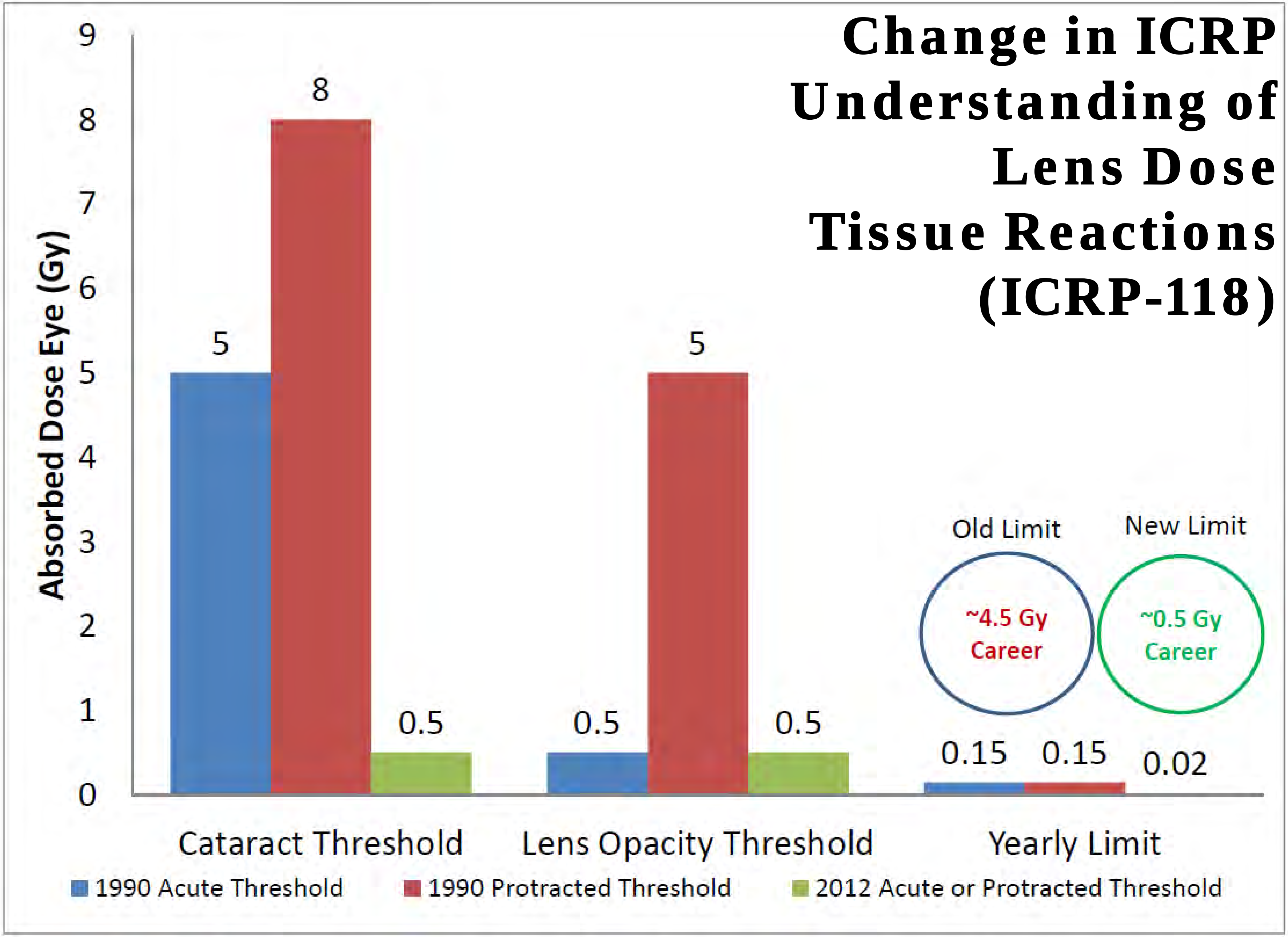
Status of NCRP SC 1-23 Commentary



Cataract Types



NCRP SC-123, Fig 4.3



Change in ICRP Understanding of Lens Dose Tissue Reactions (ICRP-118)
Absorbed Dose Eye (Gy)
9
8
7
6
5
4
3
2
1
0
5
8
0.5
0.5
5
0.5
0.15
0.15
0.02
Old Limit
New Limit
~4.5 Gy Career
~0.5 Gy Career
Cataract Threshold
Lens Opacity Threshold
Yearly Limit
1990 Acute Threshold
1990 Protracted Threshold
2012 Acute or Protracted Threshold

NCRP SC 1-23

Members

- Eleanor Blakely (Co-Chair)
- Lawrence Dauer (Co-chair)
- Elizabeth Ainsbury
- Joseph Dynlacht
- David Hoel
- Barbara Klein
- Don Mayer
- Christina Prescott
- Raymond Thornton
- Eliseo Vano
- Gayle Woloschak

Consultants

- Cynthia Flannery
- Lee Goldstein
- Nobuyuki Hamada
- Phung Tran

NCRP Staff Consultant

- Michael Grissom

Purpose

- 01/14/14 1st teleconference.
- NCRP Commentary by early 2015.

U.S.NRC

Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

CORE QUESTIONS

SC 1-23 Core Questions

- Should radiation-induced cataracts be characterized as stochastic or deterministic effects?
- What effects do LET, dose rate, acute and/or protracted dose delivery have on cataract induction and progression?
- How should detriment be evaluated for cataracts?
- Based on current evidence, should NCRP change the recommended limit for the lens of the eye at this time?

Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

CURRENT NCRP GUIDANCE

National Council on Radiation Protection & Measurements

Objectives of Radiation Protection

- To prevent the occurrence of clinically significant radiation induced **deterministic effects** by adhering to dose limits that are below the apparent threshold levels and...
- To limit the risk of **stochastic effects, cancer and genetic effects** to a reasonable level in relation to societal needs, values, benefits gained and economic factors.

NCRP-116 (1993)

Principles of Radiation Protection

- **Justification** – on the basis that the expected benefits to society exceed the overall societal cost.
- **Optimization** – to ensure that the total societal detriment from justifiable activities is maintained ALARA, economic and social factors being taken into account.
- **Limitation** – application of individual limits to ensure that procedures of justification and ALARA do not result in individuals or groups exceeding levels of acceptable risk.

NCRP-91 (1987) & NCRP-116 (1993)

Occupational Dose Limits (mSv)

Limit	NCRP-116	ICRP-103/118
Effective Dose		
- Annual	50 /y	20 /y
- Cumulative	10 x Age	Avg of 5 y, no y > 50
Equivalent Dose		
- Lens	150 /y	20/y
		Avg of 5 y, no y > 50
- Skin, Hands, Feet	500 /y	500 /y

Relevant NCRP Documents

- NCRP-91: Lens opacification ID as nonstochastic.
- NCRP-115: Cataract as late somatic effect.
- NCRP-116: Lens of eye limit for deterministic effects.
- NCRP-132: Limit scatter dose to lens to ~1-3 Gy.
- NCRP-153: Likely unidirectional nature of cataracts.
- NCRP-167: New research questioning threshold?
- NCRP-168: Emphasizes ALARA principle for eye.

NCRP
National Council on Radiation Protection & Measurements

Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

OTHER RECENT REVIEWS

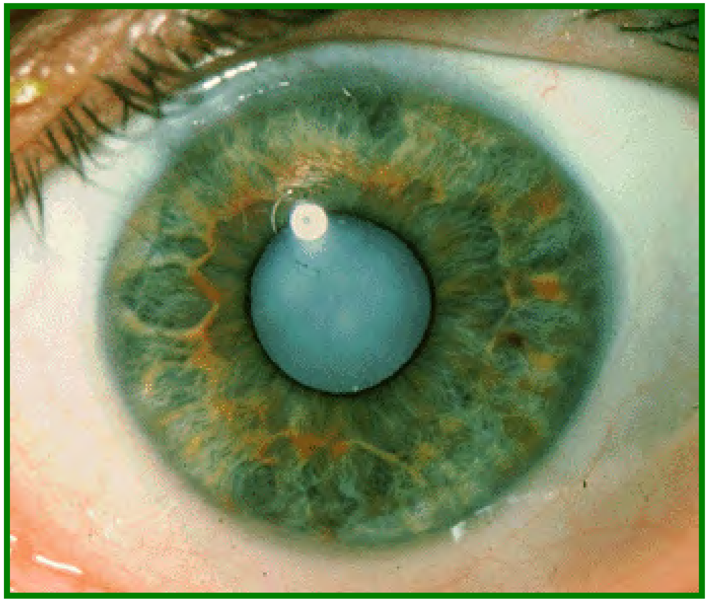
Other Recent Lens of Eye Reviews

- ICRP-118: Nominal threshold of 0.5 Gy acute or protracted.
- UNSCEAR (2008, 2011, 2013): pre-clinical lens opacity lesions possible < 1 Gy, additional follow-up of cohorts is needed. Weak evidence for 2x sensitivity in children.
- IAEA BSS/EC Directive: incorporated ICRP-118.
- UKHPA/PHE: endorsed conclusion of ICRP-118.
- CNSC: proposed new recommendations in alignment.
- IRPA: causality should be verified. Concerned with treating fatal and non-fatal effects similarly.
- HPS: need to delineate the scientific basis for cataract development from chronic exposures before changing the annual eye dose limit.
- EPRI: recent review of radiobiology and radioepidemiological literature.

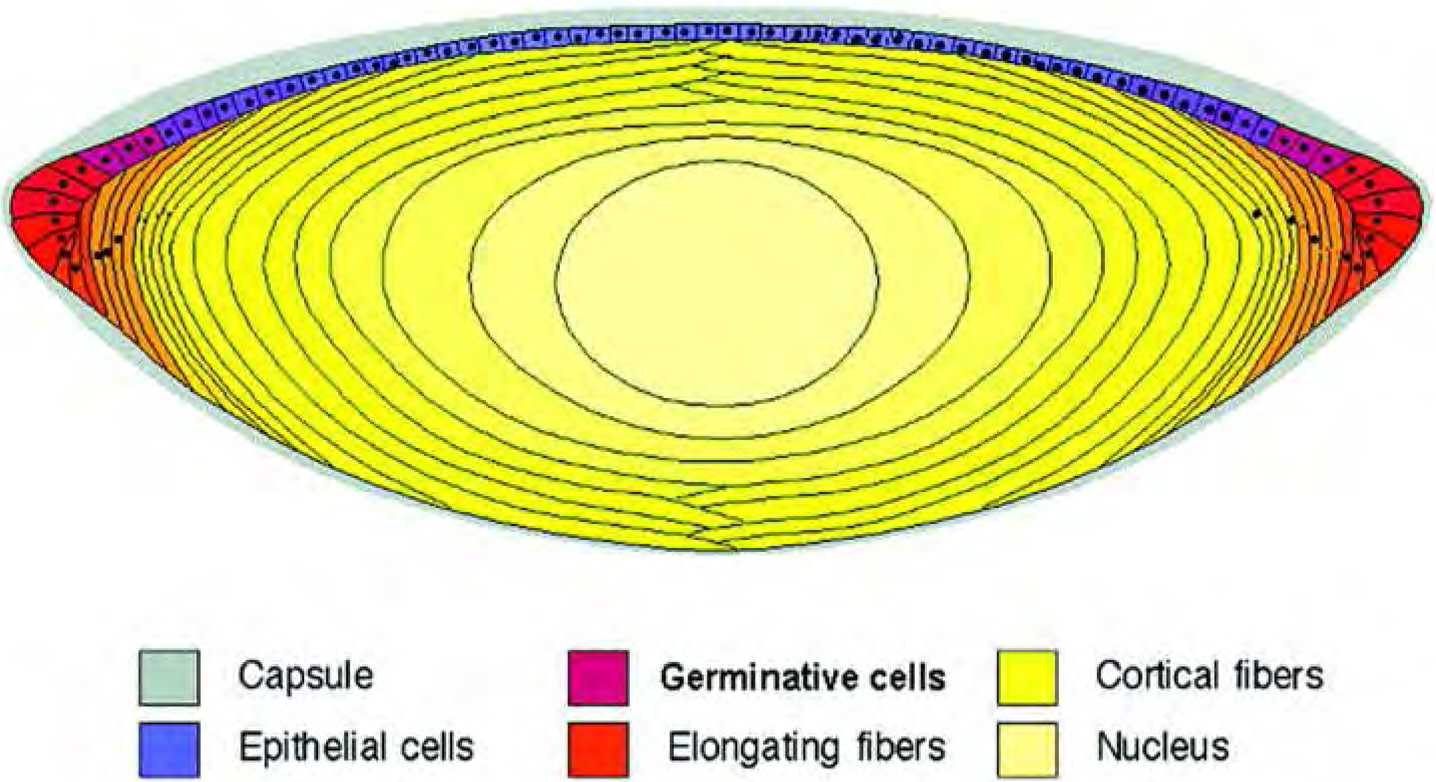
Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

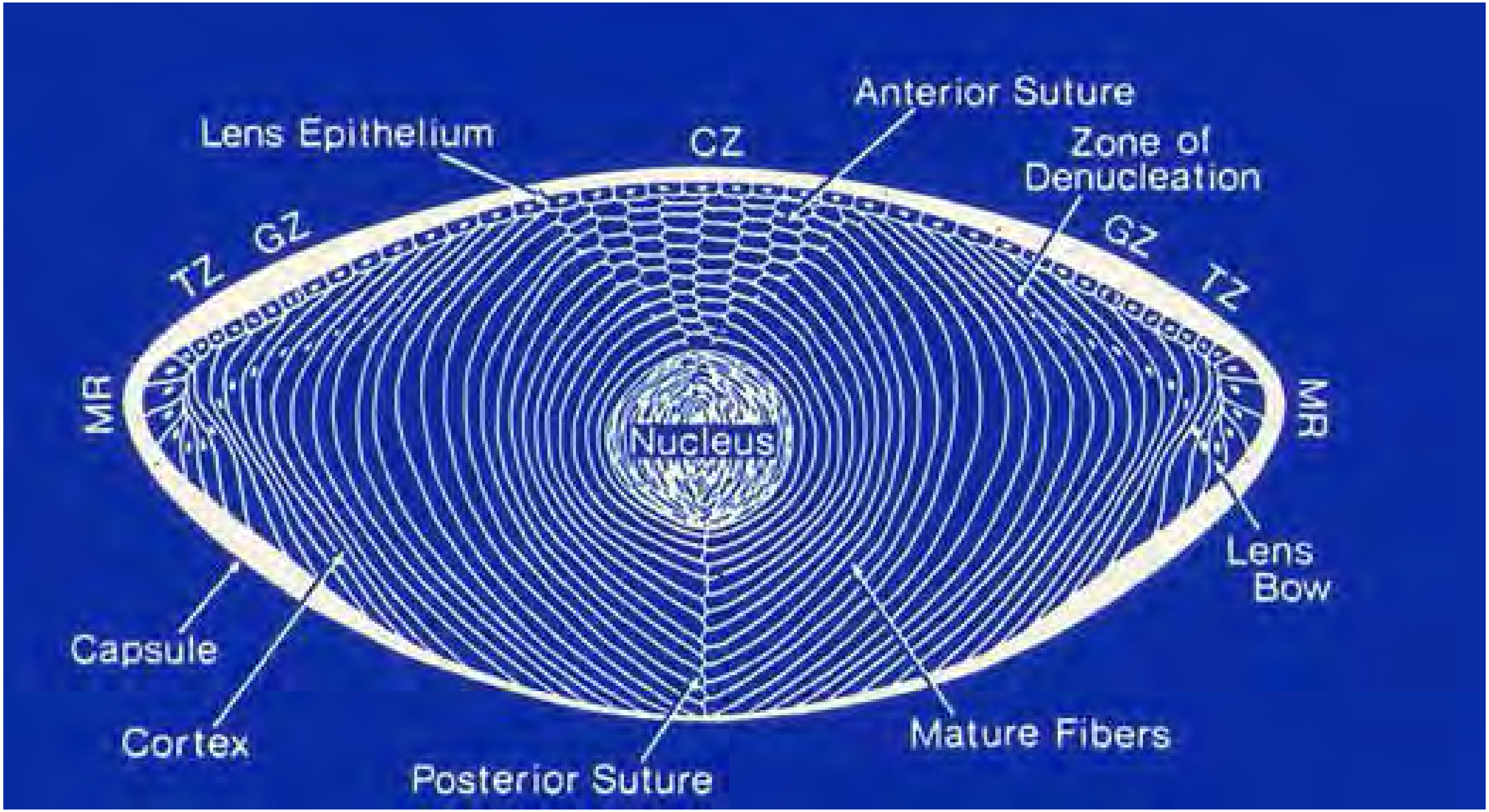
EYE BIOLOGY & LENS EFFECTS



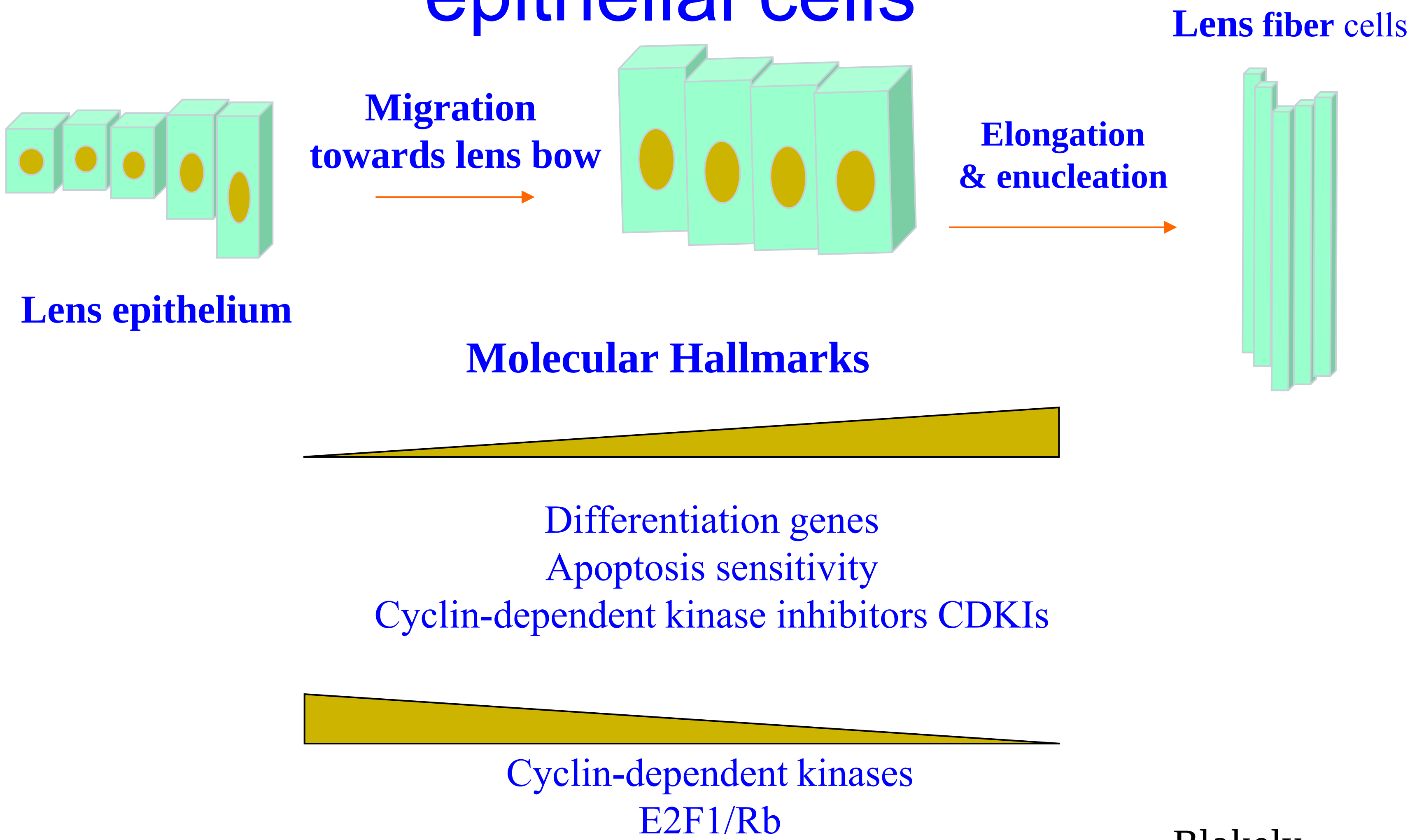
Cross-section of Human Lens



Cross-section of Human Lens

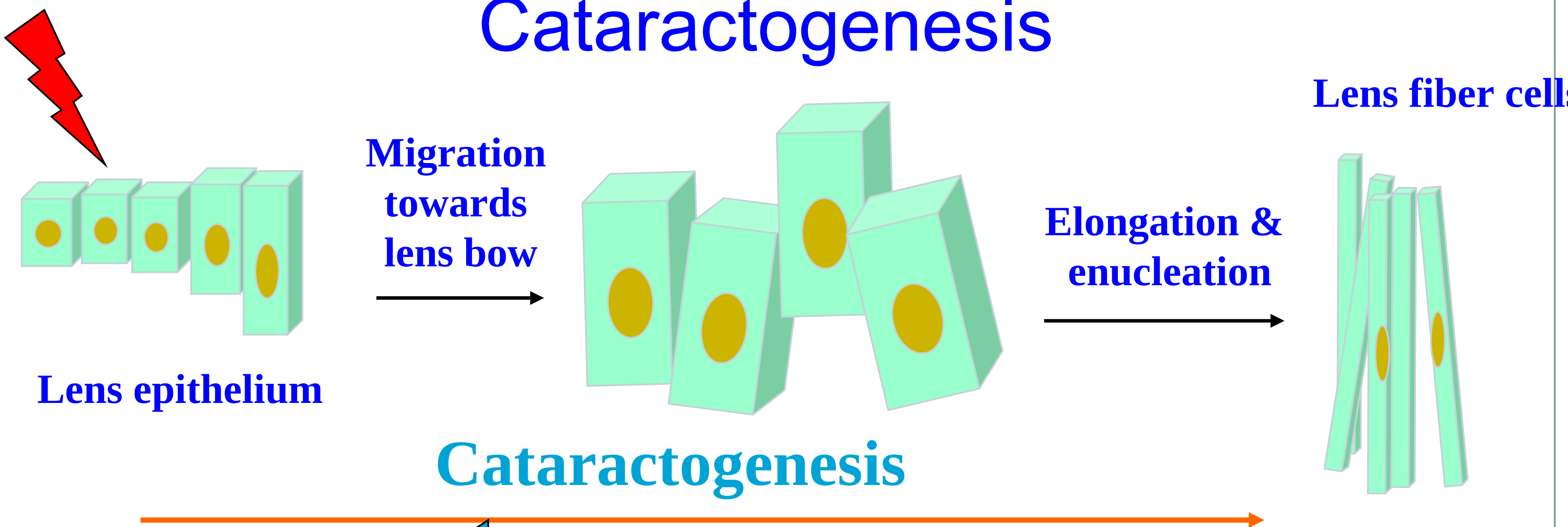


Normal Differentiation of Lens epithelial cells



Blakely, 2014

Underlying Mechanism of Radiation-induced Cataractogenesis



Etiology still not fully known – multifactorial.

Differentiation genes
Apoptosis sensitivity
Cyclin-dependent kinase inhibitor CDKI (p21)

Cyclin dependent kinases E2F1/Rb

Blakely, 2014

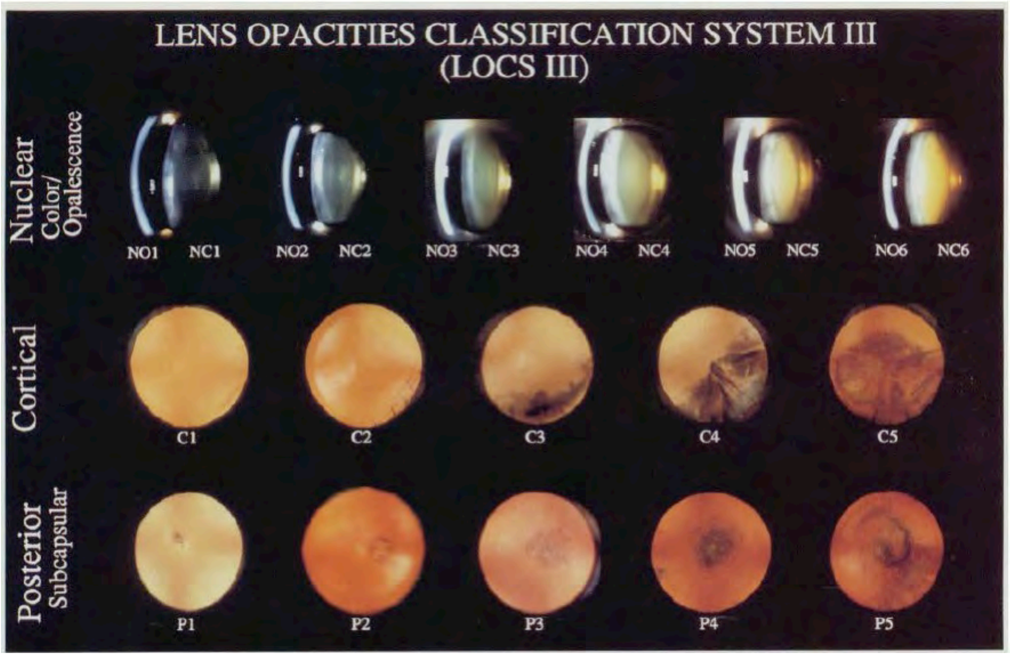
Review and Summary of Eye Biology & Lens Effects

- Lens Anatomy & Proliferative Organization
- Cataracts
  - Cataracts / Opacifications
  - Types / Severity
  - Causes / Mechanisms
  - Examination and Quantification of Lens Changes (scoring)
- Radiation Effects
  - NTCP for eye
- Radiation Cataractogenesis
  - Dose / Dose Rate
  - Fractionation / RBE
  - Age / Gender / Steroid
  - Latency
- Mechanisms
  - Cell Biology
  - Protein Accumulation
  - Molecular Biology
  - Oxidative Stress
  - DNA Damage
  - Genetic Susceptibility

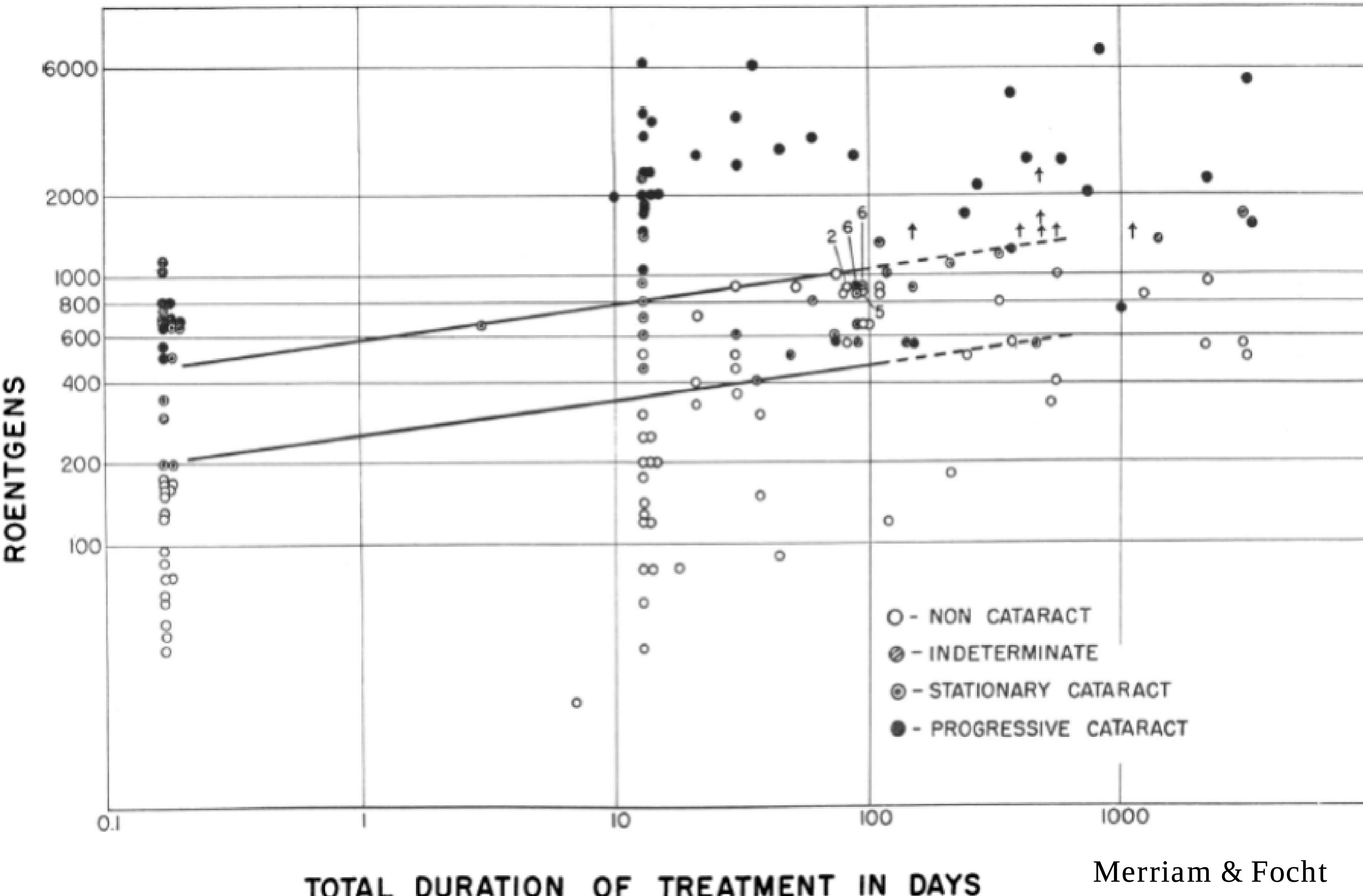
Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

EPIDEMIOLOGY



Dose for Cataract / Non-Cataract Cases vs. Overall Treatment Time



Merriam & Focht
1962

More Recent Reviews of Radiation Cataractogenesis Epidemiological Studies

- Shore & Worgul, 1999.
- Ainsbury et al, 2009.
- Cooper et al, 2009.
- Blakely et al, 2010.
- Shore et al, 2010.
- Blakely, 2011.
- Martin, 2011.
- Bouffler et al, 2012
- ICRP, 2012.
- Hammer et al, 2013
- Little, 2013.
- EPRI, 2014.
- Hamada, 2014.
- Hamada & Fujimichi, 2014.

- General Conclusions:
  - Strong likelihood of an association between exposure to ionizing radiation and initiation or development of various opacifications and/or cataracts.
  - Recognize large uncertainty.
  - A lower threshold or no threshold *may* be an appropriate model for radiation cataractogenesis risk.

Populations Evaluated (>60 publications)

- Atomic Bomb Survivors.
- Chernobyl Liquidators and Cleanup workers.
- Medical Patients.
- Health Care Personnel.
- Flight Personnel and Astronauts
- Other Occupational
- External Exposure
- Internal Exposure
- Single Person Results
- Population Studies and Residentially Exposed

- Large Variation in Studies:
  - Only a few investigate low dose effects.
  - Differ in:
    - Radiation source / type.
    - Exposure condition.
    - Study design / size.
    - Method (if any) of dose estimation.
    - Range of lens doses.
    - Lens detriment endpoint.
    - Method (and possible scoring) of endpoints.
    - Adjustments or assessment of potential other risk factors and/or confounders.

Quality of Epidemiological Studies (EPRI, 2014)

- Quality score according to methodology strengths and weakness
  - Typical approach when evaluating available epidemiologic evidence for outcomes due to exposures (as does the EPA, e.g., Wartenberg et al, 2010).
  - 0 for expected good design.
  - +1 for strengths.
  - -1 for evident shortcomings.
- 9 Tier 1 – most informative.
- 15 Tier 2 – important.
- 34 Tier 3 – unreliable.

Quality Evaluated On:

1. Study Design
2. Dosimetry
3. Age Adjustment
4. Confounding Causes
5. Numerical Risk Assess
6. Exposure-Response
7. Account for Latency
8. Reporting Bias
9. Selection Bias
10. Pathology Method
11. Blinded Path or Scoring
12. Cataract Scoring Method

Odds Ratio Meta-analysis

- Tier 1 and 2 Studies that provided Odds Ratio covered ~4 population groups:
  - Atomic Bomb Survivor Cohorts
    - Some difficulties – lack of standard photographic method, unclear focus of photographs difficult to judge, retro-illumination camera not used for examination of cortical and PSC cataracts.
    - In process of revising the studies (RERF 2014).
  - Chernobyl Liquidators and Clean-up Workers
  - Clinically Exposed Infants
  - Radiation Technologists
    - < 60 mGy questionnaire study with relatively high RR but not statistically significant.

Odds Ratio Meta-analysis

- Recognizing several limitations and questions, the meta-analysis results of these 4 study populations:
  - PSC OR=1.45 at 1 Gy (95%, 1.15-1.85).
  - Cortical OR=1.37 at 1 Gy (95%, 1.20-1.56).
  - Mixed OR=1.75 at 1 Gy (95%, 1.26-2.46).
  - Nuclear OR=1.07 at 1 Gy (95%, 0.5-2.0).
- Likelihood of an association between exposure to ionizing radiation at ~1 Gy and initiation or development of PSC, mixed, and/or cortical cataracts.

Threshold Evaluations

- Only two(2) Tier 1 or Tier 2 study populations evaluated threshold for cataractogenesis: A-Bomb (being re-evaluated), and Chernobyl.
- Considerable uncertainty in these estimates, which depend heavily upon the dose response function used and uncertainties in dose estimates.
- Too few data, not possible to perform meta-analysis.
- Currently not enough available information to make any new specific conclusions with regard to chronic or acute exposure thresholds for cataracts.

Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

POPULATIONS / PROTECTION

Members of the Public – per ICRP

- Equivalent Dose for Lens of Eye Limit of 15 mSv/y.
- Effective Dose Limit of 1 mSv/y.
- ICRP-118 – no new limit for public exposure to lens of the eye, as the Commission judged that the existing limit was adequately protective, and therefore a reduction could impose unnecessary restrictions.
- Highly improbable a member of the public would receive >0.5 Gy in a planned exposure situation, considering application of the effective dose limit of 1 mSv/y, low likelihood of the lens being preferentially exposed for significant periods, and optimization of protection below the equivalent dose limit for lens of the eye.

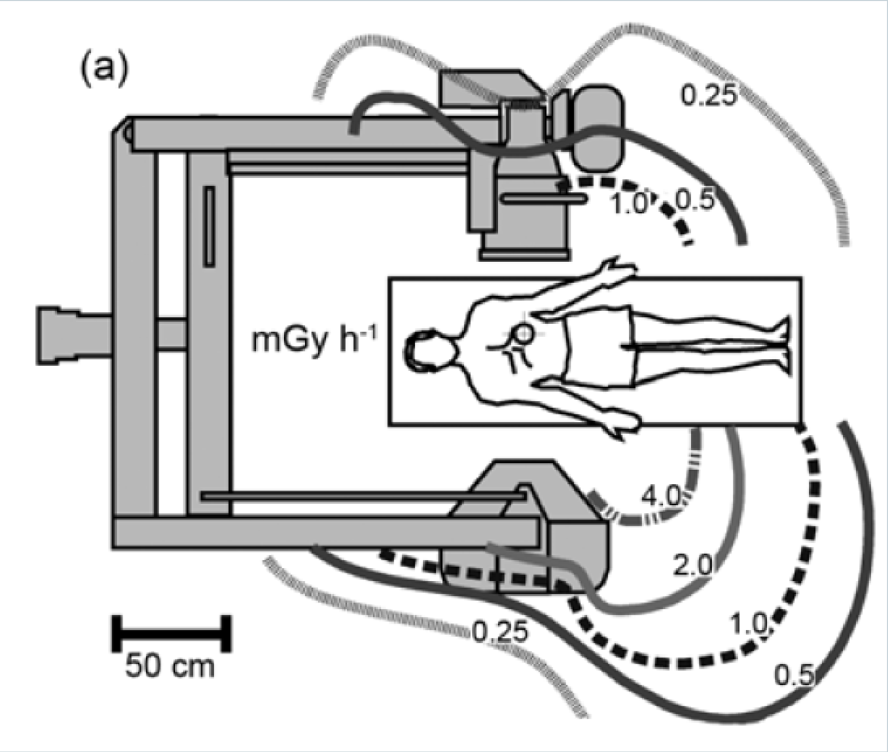
Occupational: Populations / Protection

- Medical
  - Interventional Radiology and Cardiology
  - Radiopharmacy, Radiochemistry, Nuclear Medicine
  - Other workers
  - Patients
- Nuclear Facilities
- Industrial Radiography
- Astronauts / Pilots

- Engineering, Safe Work Practices, Administrative Controls
- PPE
  - Screens, Goggles, Leaded Glasses
  - Face Shields
  - Respirator Face Shields
  - Bubble Suit Masks
- Monitoring Lens Dose

FGI IR/IC Protection Controls (NCRP-168)

- Engineering
  - Equipment
  - Structural Shielding
  - Equipment Shielding
- Safe Work Practices
  - SOPs
  - 10 Commandments/Pearls
- Administrative
  - Training/Credentialing
  - Expectations
- PPE (aprons/collar/glasses, etc.)



NCRP-168

Operator Training / Credentialing

- Equipment design and shielding help…BUT
- Training and Credentialing needs improvement.
- Europe leads in operator training.
- As of 2011, only 27 states enacted legislation regarding radiation education for FGI operators

Shielding Strategies for FGI LDE reduction

Strategy	Reduction Factor
Leaded glasses	3-10
Shielded drape	25
Leaded glasses + drape	140
Ceiling shield	130
Rolling shield	1000

Thornton et al 2010
JVIR

How to Measure LDE?

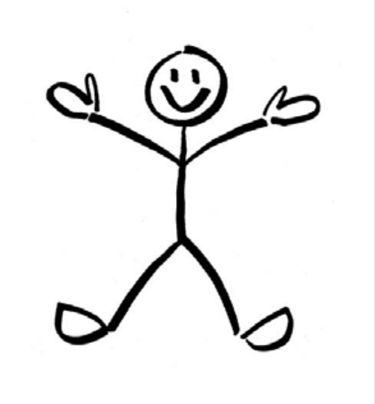
Radiation Field	$H_p(0.07)/H_{lens}$	$H_p(3)/H_{lens}$	$H_p(10)/H_{lens}$
Photons < 30 keV	0.9 – 5	0.6 – 1	0.01 – 0.9
Photons > 30 keV	0.8 – 1.1	1 – 1.2	0.9 – 1.2
Electrons	1-500	~1	<<1 – 1.2
Adequate?	Perhaps for photon radiation	OK for Photons. Necessary for Beta	Not for low E photons or beta.

R. Behrens and G. Dietze
Phys Med Bio 55 (2010) 4047-4062
Phys Med Bio 56 (2011) 511

?What if Leaded Glasses are worn?

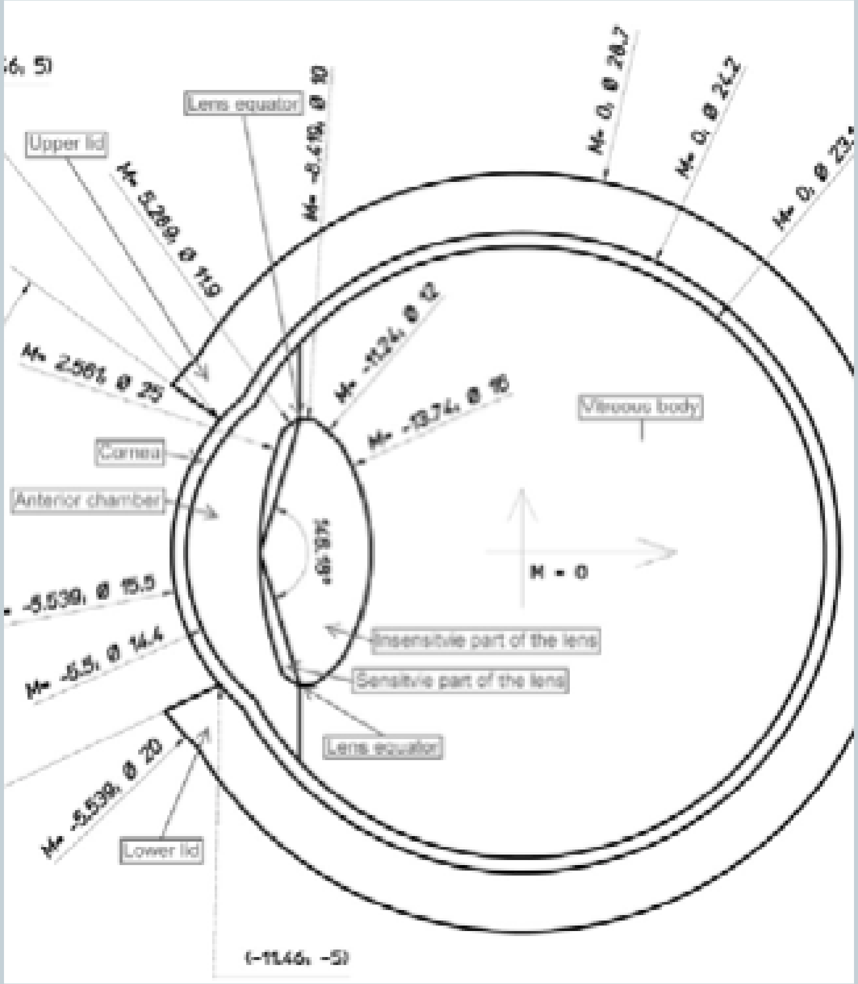
Practical LDE Dosimeter Choices
– Starts with actually wearing them!

- DDE dosimeters (Whole Body) $H_p(10)$:
  - On trunk or waist far from eyes.
  - Underestimate at low photon energies (too thick)
  - Under lead apron if in use.
- SDE dosimeters (Extremity) $H_p(0.07)$:
  - Must be worn facing the beam/scatter
  - Worn near eye (note NCRP-168 factor of ~1 at collar)
  - OK for photons, overestimates for beta (too thin)
- LDE dosimeters (Eye) $H_p(3)$ – exist?:
  - Must be worn facing the beam/scatter
  - Only type OK for photons and beta.

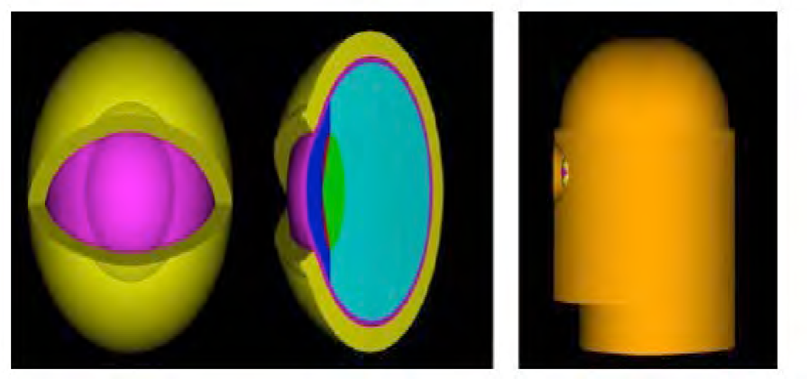


Behrens, Oct. 2012, IAEA

ICRP External Dose Factors for Lens of Eye



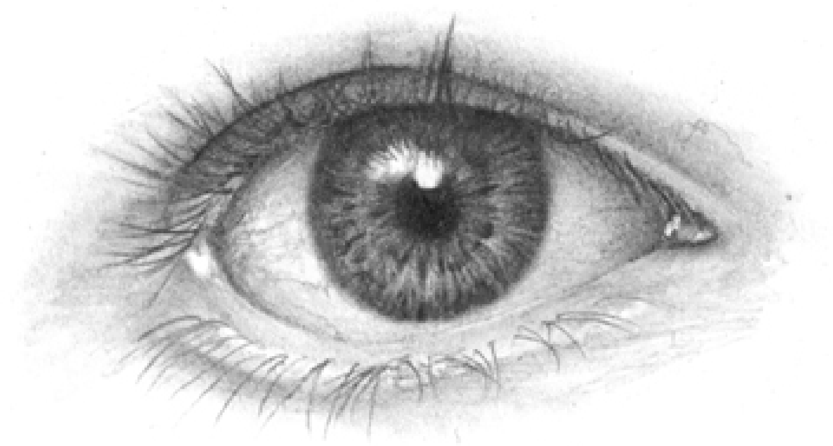
- Stylized eye phantoms.
- New dose conversion coefficients.
- ICRP-116, Appendix F.



Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

DRAFT CONCLUSIONS



SC 1-23 Draft Conclusions

- Should radiation-induced cataracts be characterized as stochastic or deterministic effects?
  - Several authors indicate radiation-induced opacities may be stochastic in nature.
  - Mechanism and link between induction of minor opacities and occurrence of clinically-relevant, visual-impairing cataracts within a relevant timescale is still far from clear.
  - Best epidemiological evidence still indicates a threshold model.
  - Continue to use this model for radiation protection purposes.
  - Not possible to make a specific quantitative estimate of the threshold at this time.

SC 1-23 Draft Conclusions

- What effects do LET, dose rate, acute and/or protracted dose delivery have on cataract induction and progression?
  - Although different studies have looked at many of these factors independently, there is still very little evidence upon which to base an answer to this question.
  - Mechanistic evidence is perhaps stronger in some instance (e.g., differential effect of increased radiation ionization qualities enhancing the induction and progression of opacities).
  - More high-quality epidemiological and mechanistic studies are required. Need for better dosimetry and scoring methods.

SC 1-23 Draft Conclusions

- How should detriment be evaluated for cataracts?
  - Cataracts are not life threatening but may affect individuals' ability to carry out their occupations or other daily tasks.
  - ICRP lowered dose limit for lens could be interpreted as putting lens opacities on equal footing with diseases affecting mortality. Many authors question appropriateness of this.
  - NCRP SC 1-23 encourages NCRP-168 recommendation that until there is sufficient evidence available to accurately reassess current dose-limit values, it is prudent to regard eye exposures in much the same way as whole-body exposures (*i.e., ensure exposures are consistent with ALARA principles*). This includes careful justification and optimization in exposure situations including radiation doses to the lens of the eye.

SC 1-23 Draft Conclusions

- Based on current evidence, should NCRP change the recommended limit for the lens of the eye at this time?
  - Current epidemiology and biology studies indicate an association between exposure to ionizing radiation and initiation or development of PSC, cortical and/or mixed visually-impairing cataracts for various exposure situations, perhaps even at lower doses than previously considered for lens dose limits.
  - However, the data are limited and have large uncertainties.
  - Not yet possible to quantitatively estimate threshold values.
  - At this time there is no sufficient justification to make a change in the current NCRP recommended lens of eye occupational dose limit of 150 mSv/y.

Guidance on Radiation Dose Limits for the Lens of the Eye
Status of NCRP SC 1-23 Commentary

DRAFT RECOMMENDATIONS

SC 1-23 Draft Recommendations

- Urgent need for NCRP comprehensive evaluation of overall effects of radiation on the eye. (Begun, ~3y).
- Wait for outcome of re-evaluation of RERF data and work in progress.
- Need for new, high-quality epidemiology and basic research on mechanisms of action.
- On-going opportunity for dose-sparing optimization and the need for more education and more accurate dose assessment for potentially exposed populations.
  - EURADOS/ORAMED
- Need additional information on children effects.
- Longitudinal studies.

Guidance on Radiation Dose Limits for the Lens of the Eye

Status of NCRP SC 1-23 Commentary

NCRP 51st Annual Meeting:
Changing Regulations and Radiation Guidance:
What Does the Future Hold?
16-17 March 2015
Bethesda, MD

National Council on Radiation Protection & Measurements

LAWRENCE T. DAUER, PHD, CHP

DEPARTMENT OF MEDICAL PHYSICS
DEPARTMENT OF RADIOLOGY
MEMORIAL SLOAN-KETTERING CANCER CENTER

dauerl@mskcc.org

Update of ICRP Publications 109 and 111

Michiaki KAI, Ph.D.
Chair TG93, ICRP Committee 4

NCRP Annual Meeting in 2015

Situation-based approach

- **Existing exposure situations**: when exposures result from sources that already exist when decisions to control them are taken.
  - Characterization of exposure is a prerequisite to their control
- **Planned exposure situations**: when exposures result from the deliberate introduction and operation of sources.
  - Exposures can be anticipated and fully controlled
- **Emergency exposure situations**: when exposures result from the loss of control of a source.
  - These situations require urgent and timely actions in order to mitigate exposures.

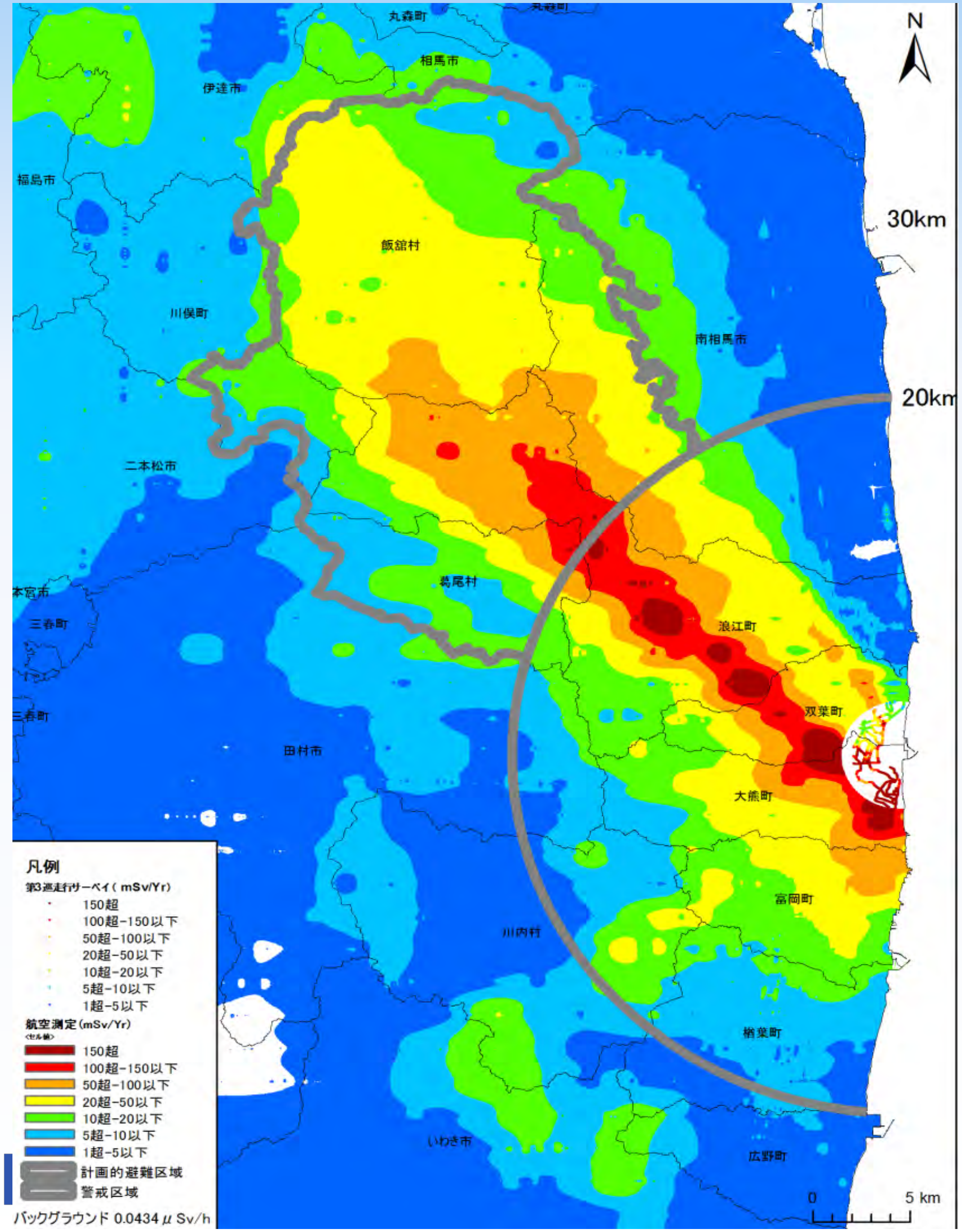
What is at stake ?

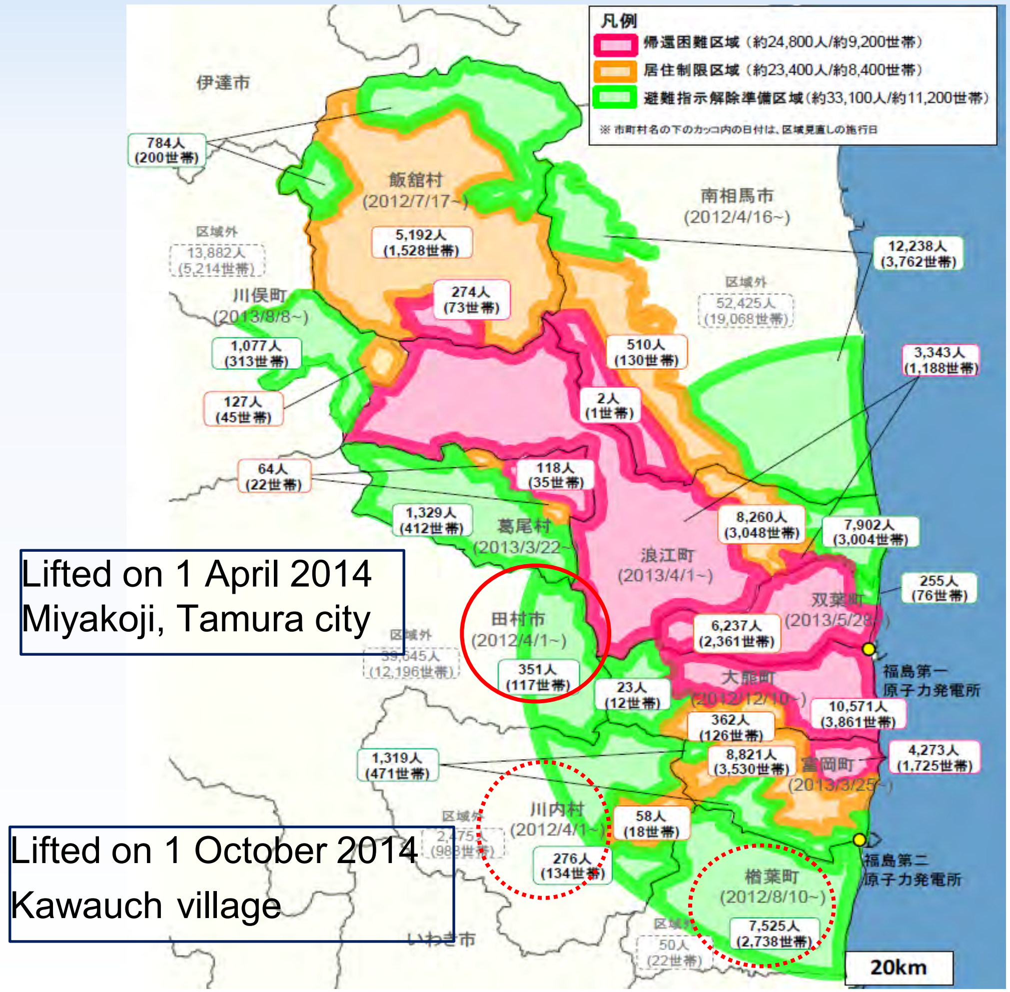
- Previous approach in radiological protection was mainly based on the management of planned exposure situations
- In normal situations, radiation uses are strictly regulated based on the ALARA and limitation principles.
- This has enabled radiological protection to be developed as an acceptable system
- However, post-accident situations like in Fukushima bring about a lot of emerging issues
- Application of previous approach failed to cope with the recovery phase

The gap in the protective principles between the two situations has confused both the regulators and the affected people

Evacuation : Fukushima : 146,000 people

- Exclusion zone : 81,300
  - Area 3 (50mSv<) : 24,800
  - Area 2 (20 - 50mSv): 23,400
  - Area 1 (20mSv>) : 33,100



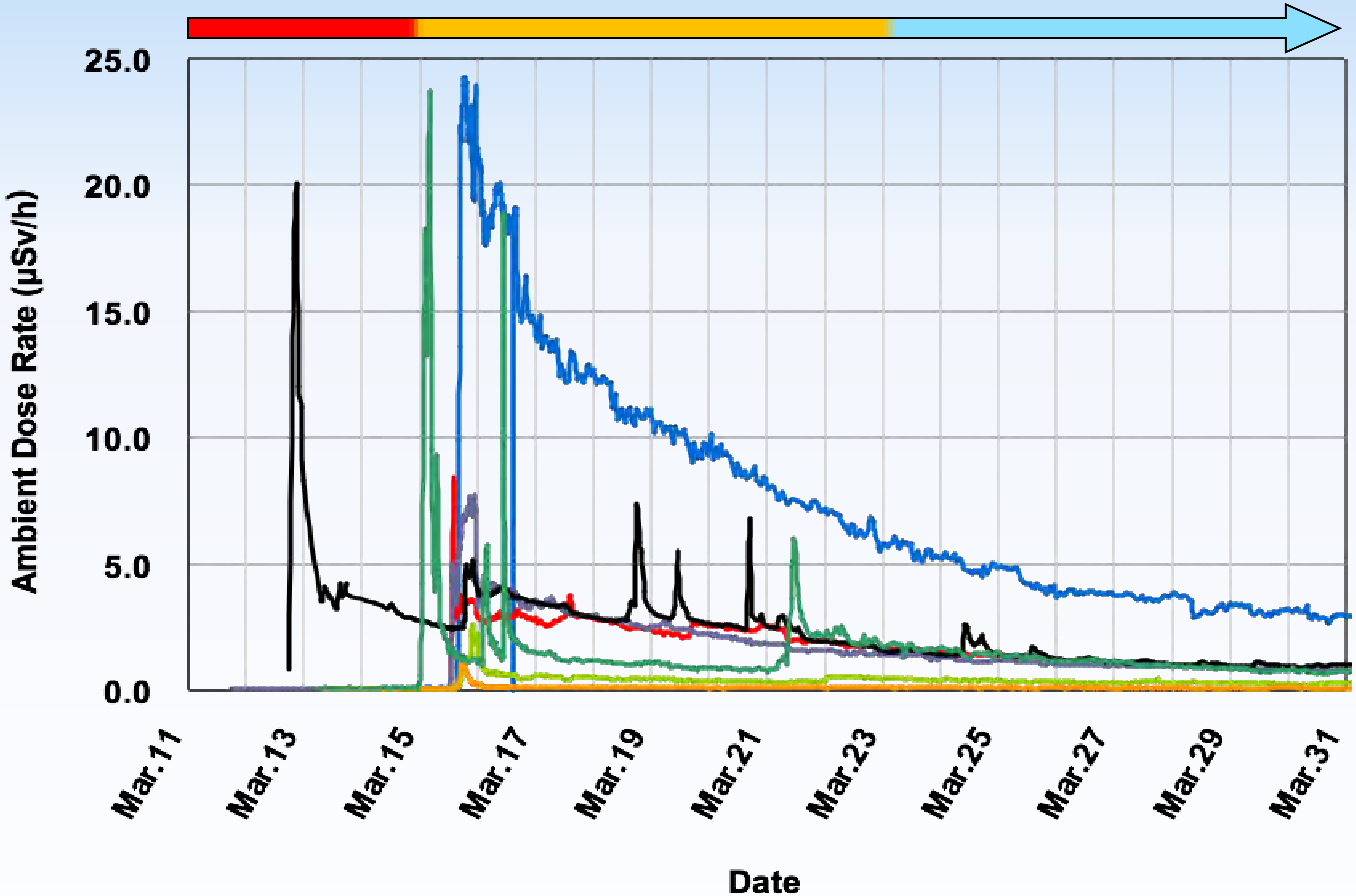


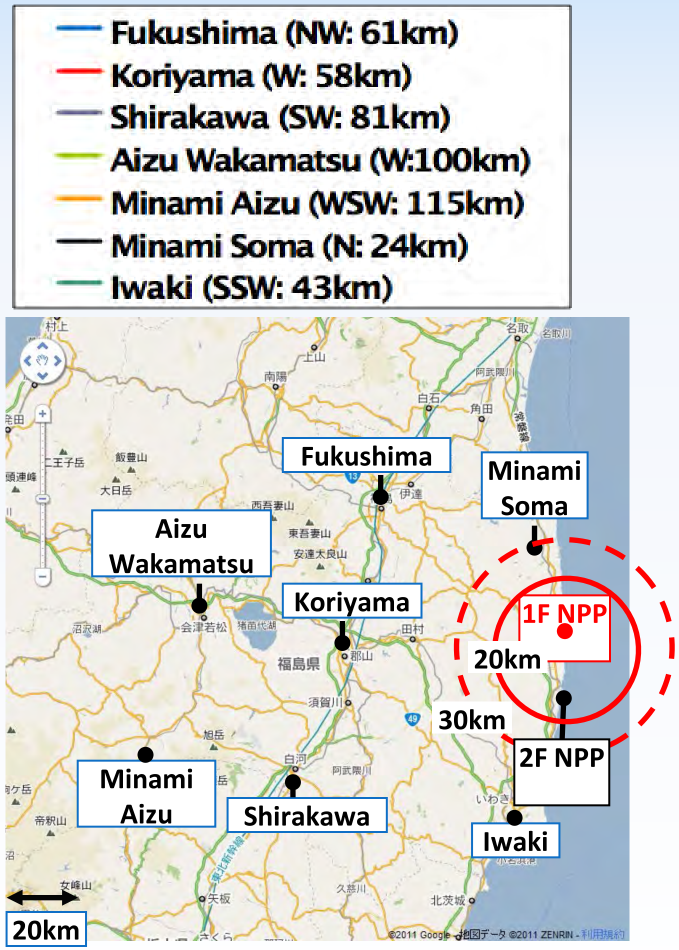
Radiological situation and corresponding protective actions

Precautionary urgent protective actions (evacuation, sheltering)

Urgent protective actions (foodstuff and water restrictions)

Early protective actions (preparation for temporary relocation)





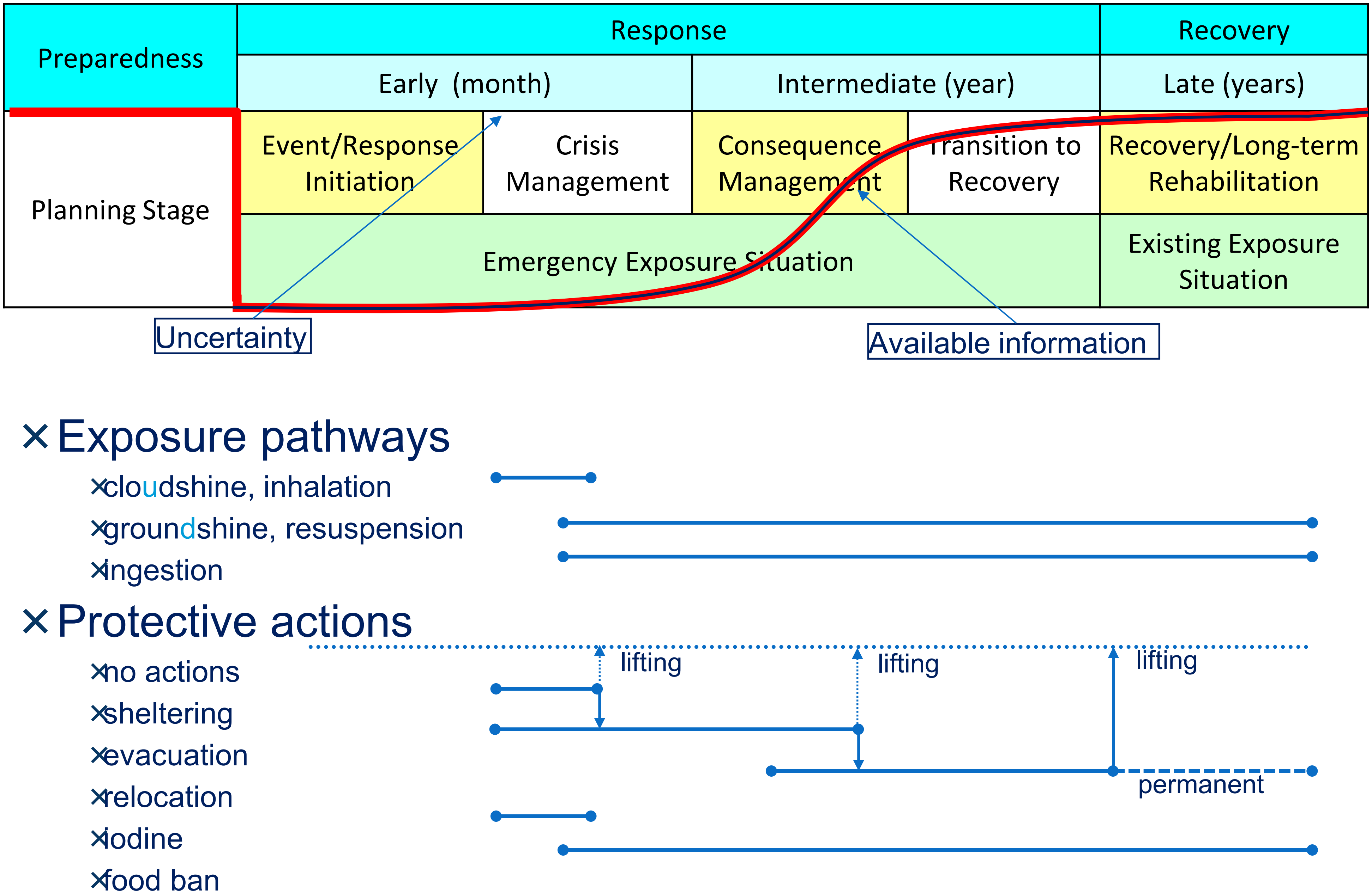
Prolonged releases with multi-unit events

Key issues in update of Publication 109

- Timeline of situations and protective measures in emergency management
- Justification of protective measures (more good than harm with taking into account non-radiological consequences)
- Optimisation of protection strategies in emergency
  - The ICRP concept of optimising whole protection strategies (i.e. response through to recovery/rehabilitation) is **useful for planning** purposes but very **difficult to implement** in practice.
  - There is a need for more **specific guidance** on how to carry out optimisation following an accident.
  - Reference levels and intervention levels
- Lifting protective measures
- **Criteria for the transition from emergency to existing exposure situations**

- **Environmental monitoring and health surveillance**
- **Foodstuff and contaminated waste management**
- **Radiation protection of responders**

Timeline of situations and protective measures in emergency management



Implementing protection strategies

- Triggers that can be expressed in terms of any observable circumstances or directly **measurable quantities.**

Once the protection strategy has been optimised, **triggers** for initiating the different parts of an emergency response plan for the early phase should be developed.

- Predefined reference levels may need to be quickly revised to fit the prevailing circumstances with taking into account the actual dose distributions.

- The decision to **terminate** individual protective measures will need to reflect the prevailing circumstances of the emergency exposure situation. The decisions to terminate protective measures should have due regard for the appropriate **reference level**.

Criteria for the transition from emergency to existing exposure situations

- A **good characterization** of the radiological situation of the **environment, foodstuffs, goods and people**
- Actions have reduced exposure to levels where habitation can be allowed living on an ongoing basis
- Individuals have returned from evacuation and temporary relocation or they are in an area that was never left
- An organization of public authorities (national and local) adapted to the situation
- The setting up of **the conditions and means for the involvement of local authorities and professionals and the local population** in decisions and actions for the rehabilitation of living conditions in the affected areas
- Decision on the level of exposure above which people are not allowed to stay (forbidden zone)

Responders

- The radiological protection system of workers for planned exposure situation is **not always feasible** for emergencies and post-accident situations
- A specific management with a graded approach based on optimization principle is needed

- **Categories** of working conditions:
- All the people involved are not workers (e.g. firemen, elected representatives, citizens)
- Early phase:
  - Emergency responders
    - On-site: Special teams (prepared and trained, informed consent)
    - Off-site: Firemen, rescues, et al. Protective actions to protect the public
- Intermediate phase:
    - On-site: Emergency workers
    - Off-site: Responders, eg. clean-up workers
- Recovery phase:
  - Recovery responders
    - Return of workers to normal activities after an intervention

Key issues in update of Publication 111

- Living in contaminated areas is an **existing exposure situation**
- The protection strategy should **do more good than harm**
- Implementation of protection strategy
  - Protection actions implemented by authorities
  - **Self-help protection and radiation protection culture**
- Reference levels
- **Non-radiological aspects and human dimension**
- **Engaging local stakeholders**
- **Environmental monitoring and health surveillance**
- **Foodstuff management**
- **Radiation protection of recovery workers**

Implementation of protection strategy

- **Protection strategy for actual situations**
  - This chapter will describe additional recommendations to be learned from the Fukushima experience and other international organizations
  - Need clear explanations on situation-based approach for post-accident situation including optimization and reference levels
  - Protection strategies should be based on integrated complex rehabilitation programs.

- **Self-help protection and radiation protection culture**

- **Reference levels**
  - This chapter will describe additional explanations to be stressed in the protection of post-accident situation as an existing exposure situation.
  - Consider log-normal distribution of doses as a driver

The optimisation process in Publication 111

On going evaluation of the exposure situation to identify **where, when and how people are exposed**

Use of a reference level to prioritize the protection of individuals **with the highest exposure** and in parallel to reduce all exposures ALARA

Implementation of the protective actions by **national and local authorities** and by the **affected inhabitants** = self-help protection

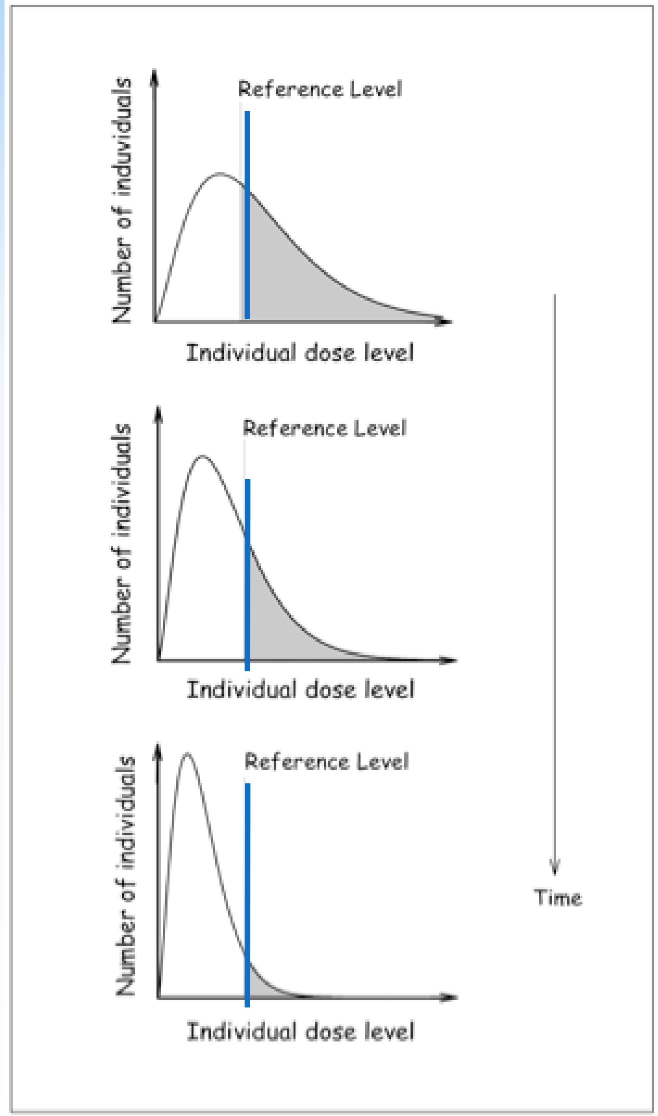


Fig. Evolution of the distribution of individual doses with time as a result of the optimization process

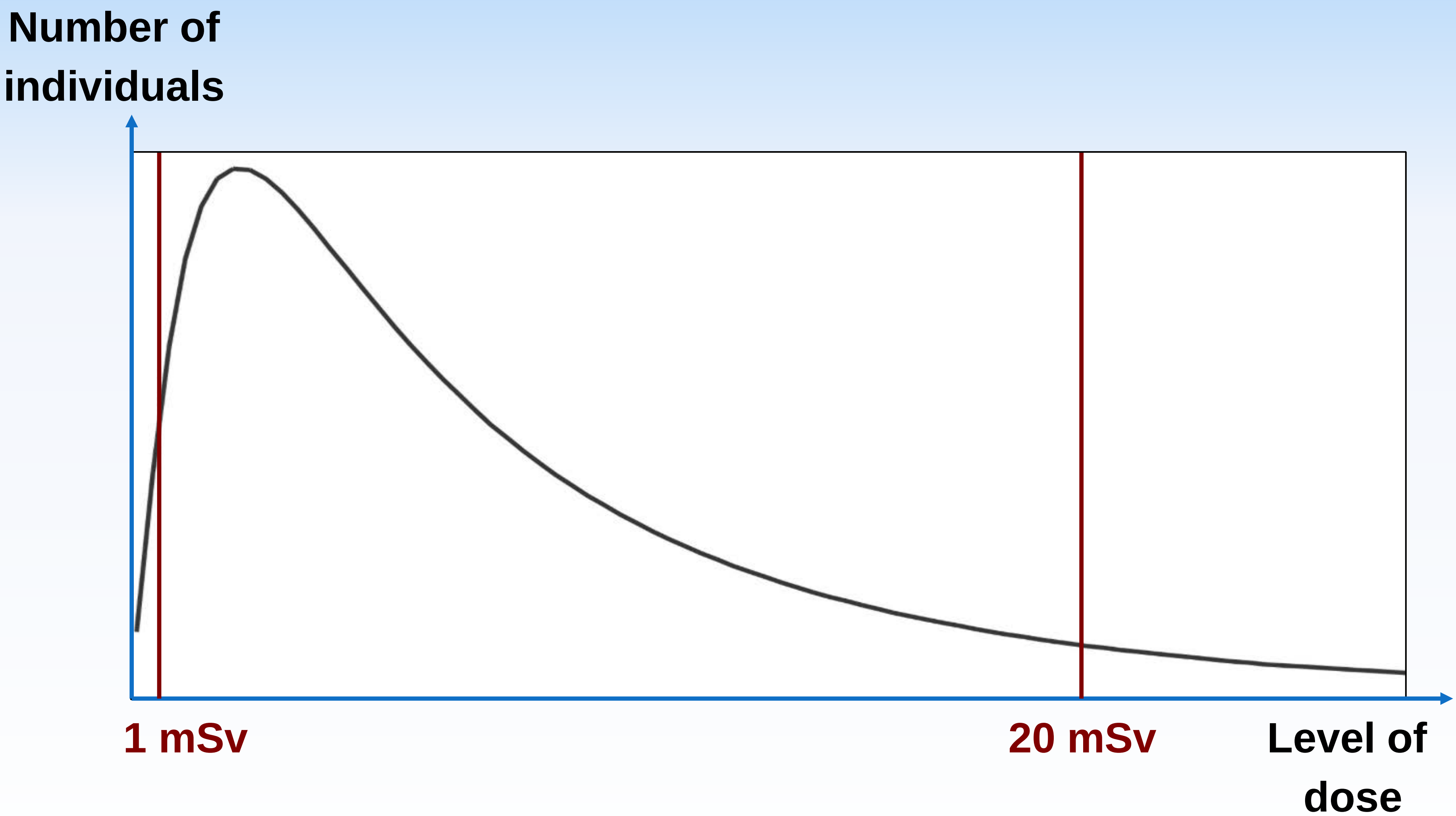
Practical approach using time-variable reference levels

The use of reference levels in an existing situation is illustrated in Fig. 3.1 of Publication 111, which shows the evolution of the distribution of individual doses with time as a result of the implementation of protection strategies.

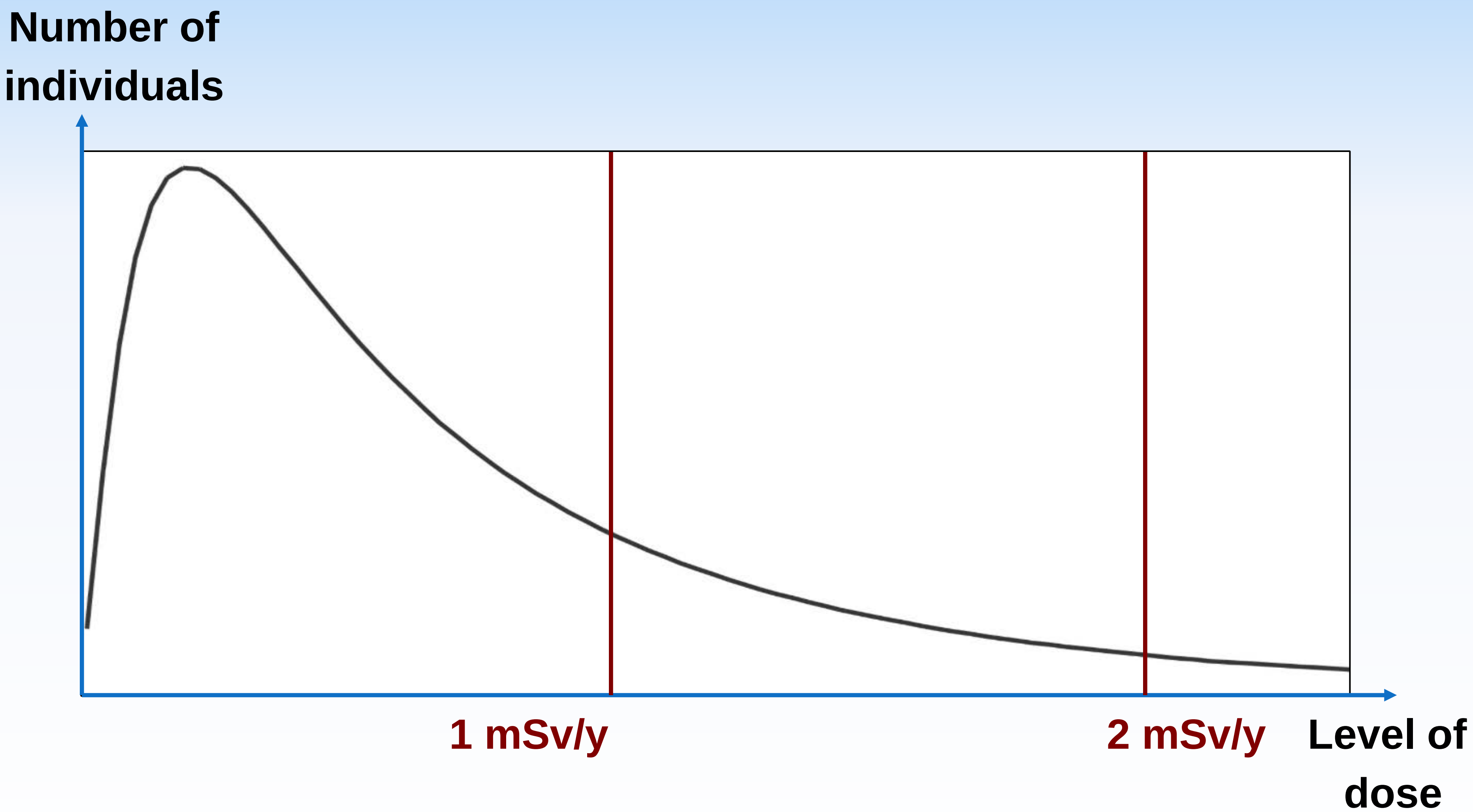
- Misunderstanding of 1 mSv/y could be avoided by setting a realistic time-variable RL
- Recommending to set the RL in the lower part of the 1 to 20 mSv/y band, i.e. below 10mSv/y

Remark: The long-term objective for existing exposure situations is 'to reduce exposures to levels that are close or similar to situations considered as normal' (ICRP, 2007, Para. 288)

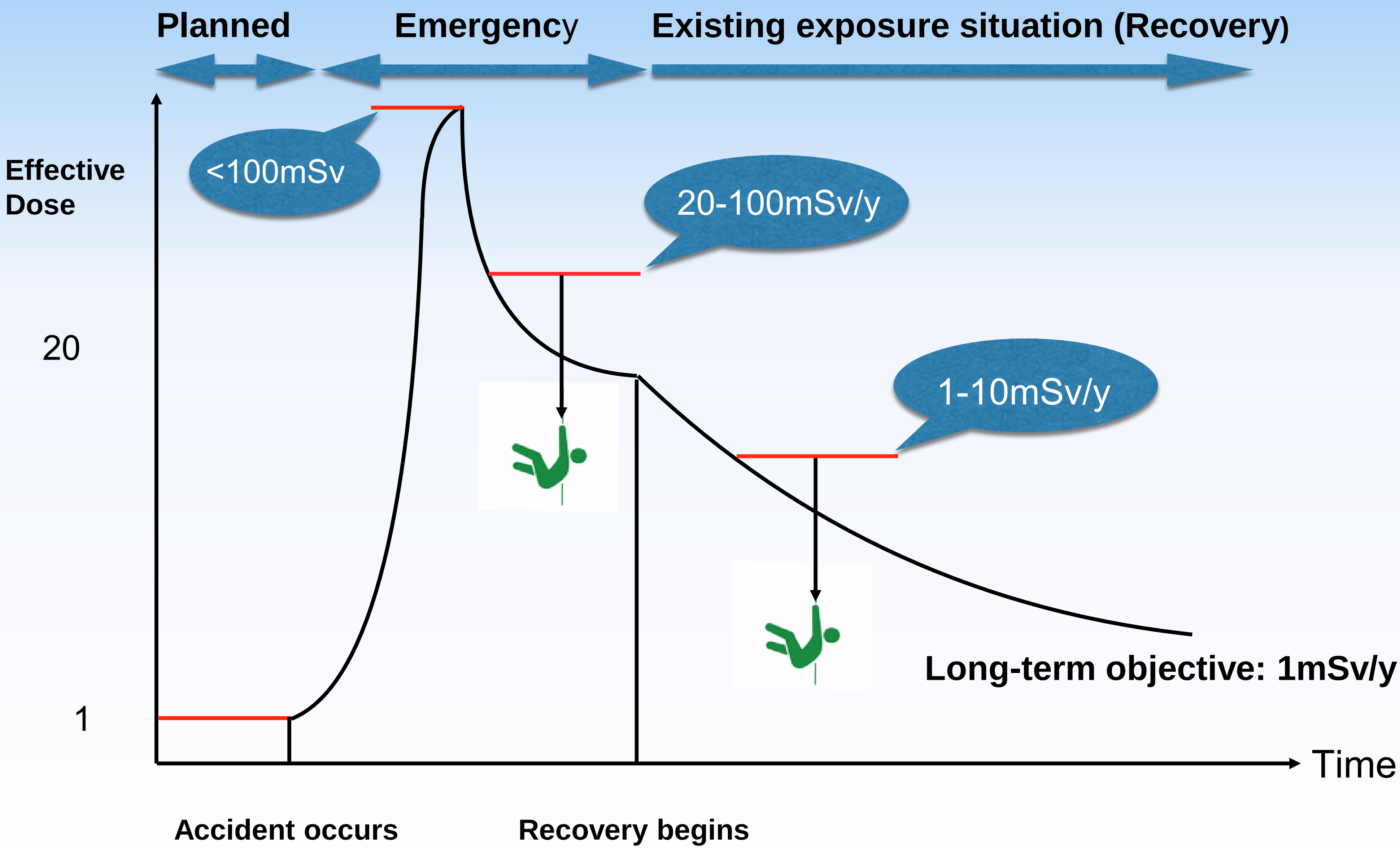
Total individual dose distribution resulting from the emergency



Annual individual dose distribution in the recovery phase after a few years



Reference Levels in exposure situations



Practical Radiological Protection Culture

- A possible definition:

the knowledge, skills and resources
enabling citizens to make choices and behave wisely
in situations involving potential or actual exposure
to ionizing radiation

- The access of people to **individual measurements** with suitable devices is **critical** to ensure the development of this culture

The Suetsugi community experience

Participation to the 7th ICRP dialogue seminar in Iwaki – November 2013

Some general lessons from the ICRP Dialogue meetings

- The human consequences of the accident are massive and will be lasting
- Local communities must be engaged in developing improvement projects and in assessing progress
- Expertise and support must be at the service of local citizens
- Individual monitoring (internal and external) and self-measurement of land and foodstuff are essential, and require outside support
- Radiation protection culture is at least as important as remediation to improve safety and a feeling of security
- Success depends on the combined action of authorities and self-help actions implemented by the affected population

The stakeholder engagement process in summary

Co-Expertise

↓

Radiological Protection Culture

↓

Self Help Protection

- Citizens are informed and supported by experts,
- they progressively engage themselves to understand their situation,
- and finally take effective actions to improve their living conditions

Conclusions

- The concepts and approach in ICRP Publications 109 and 111 should be kept
- The situation-based approach introduced by ICRP (2007) to implement radiological protection should be disseminated
- The fundamental principle for implementation of protective strategy should be optimization with time-variable reference levels.
- **Engaging local** stakeholders in the management of the radiological situation is essential to rehabilitate their **living conditions** and restore their **dignity**
- The ICRP Task Group will deal with key issues raised such as the protection of responders, selection of the criteria for foodstuff management and transition criteria from emergency to existing exposure situation.

www.icrp.org

Using ICRP 60+ Dosimetry

for Radiological Emergencies

Sara DeCair, US EPA

March 2015

Topics to Cover

- The question at hand
- Protective Action Guides: 1992 approach
- How various programs are using ICRP 60+
- Considerations for using age groups
- Protective Action Guides: 2015 approach

The question at hand

- Newly revised Protective Action Guide (PAG) Manual recommends using ICRP 60 series dosimetry
- Programs vary in how they are calculating doses to age groups, genders
- Should we identify best practices for users of the PAGs?

Implications for Protective Actions

- Updating to ICRP 60 series – how to use age-specific dose conversions
- For a four-day or one-year projection, age can make a big difference
- Setting vs. implementing PAG recommendations
  - Protective actions apply to whole communities
  - Conservatism built in
  - Don't avoid less dose than intended

Basis for PAG Levels

Appendix B: Risks to Health from Radiation Doses

…

The thyroid is an exception

…

…

This difference is not considered large enough, given the uncertainties of exposure estimation for implementing protective actions, to warrant establishing age-dependent PAGs.

…

Basis for PAG Levels

Appendix C: Early Phase PAGs

Special risk groups include fetuses, and persons who are not readily mobile. …

However, due to the difficulty of rapidly evacuating only pregnant women in a population, and the assumed higher-than-average risk associated with their evacuation, it is not considered appropriate to establish separate PAGs for pregnant women.

We note that the PAG is chosen sufficiently low to satisfy Federal guidance for limiting exposure of the fetus in pregnant workers.

…

Basis for PAG Levels

Appendix E: Intermediate Phase PAGs

… over a period of one year the total dose that should be avoided to justify the cost of relocation would be about 5 to 80 rem.…

Further, no data are available on differing risks of relocation for different population groups. In the absence of such data, we have assumed that these risks will be similar to those from evacuation.

Fetuses are a special group at greater risk of health effects from radiation dose than is the general population, but not at significantly greater risk from relocation itself…

… practicable to reduce these risks by establishing a high priority for efforts other than relocation to reduce the dose in cases where pregnant women reside near the boundary of the restricted zone.

ICRP 63: Principles for Intervention for Protection of the Public in a Radiological Emergency

Page 3's last sentences: "The derived levels should be calculated as far as possible using realistic rather than excessively conservative parameters and assumptions in the models. Otherwise the protective action will avert less dose than was intended."

ICRP 63: Principles for Intervention for Protection of the Public in a Radiological Emergency

Item 27 on page 6, "Justification of an intervention should begin by considering the average avertable individual dose for the whole of the exposed population to which the intervention would be applied (e.g. sheltering, evacuation, relocation). In some cases the avertable collective dose can be used when the exposed population is not easily identified (e.g. food restrictions, decontamination). If implementation of the protective action is not justified, consideration should be given to whether there are subgroups of the population whose characteristics differ significantly from the average and for whom the protective action might be justified (e.g. by greater doses to be incurred, or lesser costs)."

ICRP 63: Principles for Intervention for Protection of the Public in a Radiological Emergency

Item 66 on page 14, "In justifying and optimising the intervention not only should the exposed population be considered as a whole, but several particular groups for whom costs and benefits will differ require separate consideration. These include pregnant women and small children, hospitalised or other institutionalised individuals.

Separate optimisation is needed for workers engaged in shutting down vital industries or farmers taking care of livestock. Social and psychological costs should be considered when different population groups are treated differently."

ICRP 109

(g) It is essential that all aspects of the plan are consulted with relevant stakeholders, otherwise it will be more difficult to implement them during the response. To the extent possible, the overall protection strategy and its constituent individual protective measures should be worked through and agreed with all those potentially exposed or affected. Such an engagement will assist the emergency plans in being focused on the protection of those at greatest risk in the initial phases, and also on the progression to populations resuming 'normal' lifestyles.

(h) In the event of an emergency exposure situation, it is likely that exposure rates will vary in space and time, and that the doses received by individuals will vary, both as a result of the variations in exposure rates and as a result of differences in their physiological characteristics and behaviours. These population groups should be characterised by representative persons, as described in the Commission's advice on the representative person. In accordance with the Commission's advice on the representative person, it is important that the dose estimates reflect those likely to be received by the groups at greatest risk, but that they are not grossly pessimistic.

(i) The Commission's band of reference levels is expressed in terms of effective dose. For many emergency plans, this is an appropriate quantity in which to express the reference level. However, there are situations for which effective dose is not an appropriate quantity to express reference levels. This is the case when the type or scale of an emergency may result in doses in excess of 100 mSv effective dose (where the assumption of linearity may no longer hold), when parts of the response need to focus on individuals at risk of incurring severe deterministic injury, and when the resulting exposures are very strongly dominated by irradiation of a single organ for which very specific protective measures are optimum (e.g. releases dominated by radioiodine). For these situations, the Commission advises that consideration should be given to specifying (or providing supplementary) reference levels in terms of organ dose.

What do other countries do?

- An informal poll at NEA’s Working Party on Nuclear Emergency Matters
  - ✓ Most use reference person for shelter, evacuate and relocation
  - ✓ Most use age groups or most sensitive subpopulations for KI

Approaches from Federal Agencies

- NRC
  - Regulatory
  - RASCAL
- DOE
  - Compliance
  - FRMAC
- EPA
  - Federal Guidance Reports

NRC Regulatory Program

10 CFR Part 20 Standards for Protection Against Radiation

- ✓ Advance Notice of Proposed Rulemaking seeking input
- ✓ May use age- and gender-weighted public reference person

10 CFR Part 50 ALARA for Nuclear Power Effluents

- ✓ Appendix I
- ✓ Four age groups since 1976
- ✓ May go to six age groups

RASCAL Comparison

Maximum Dose Values (rem) - Close-In

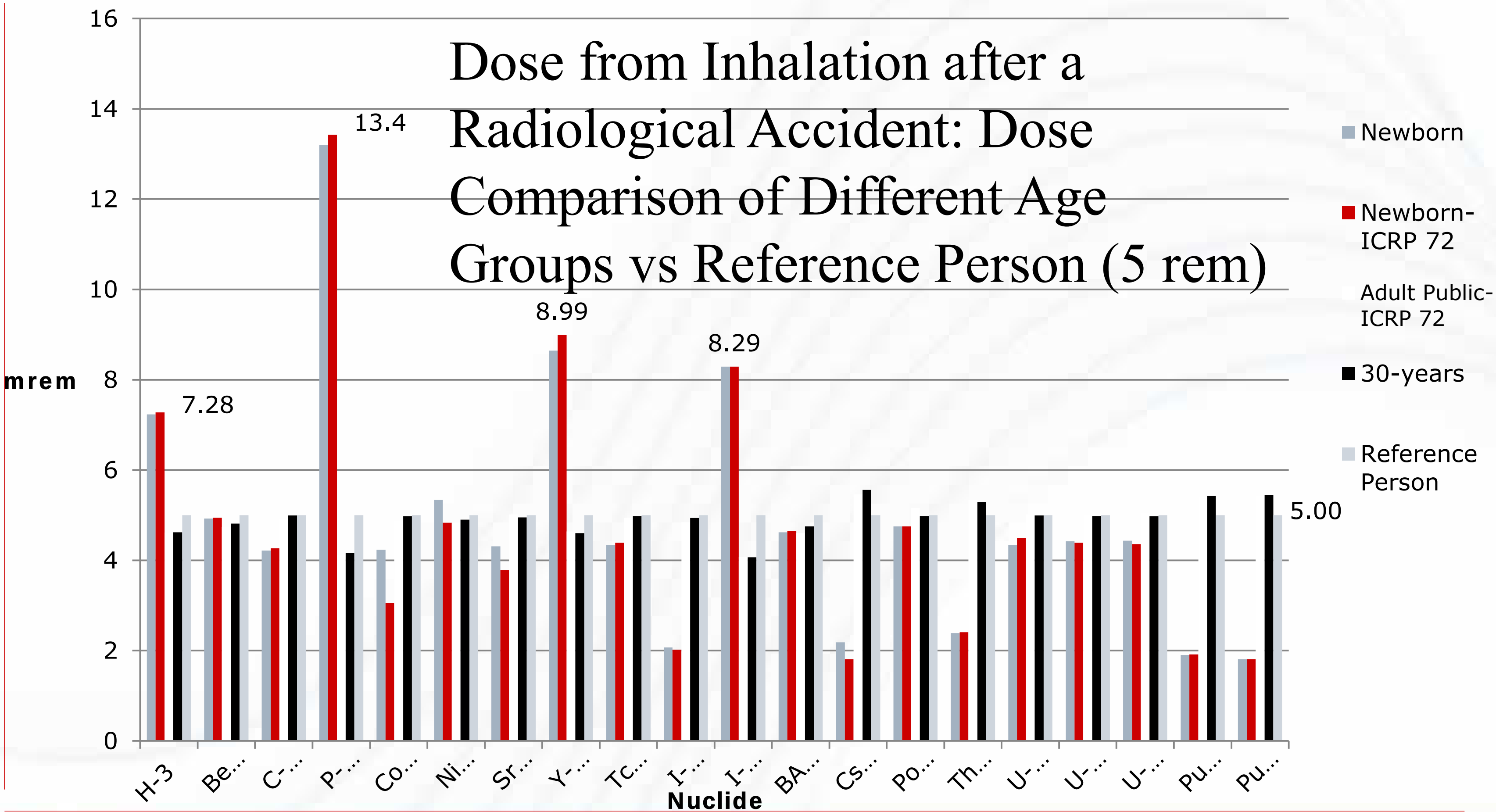
Dist from release miles (kilometers)	0.5 (0.8)	1. (1.61)	1.5 (2.41)	2. (3.22)	3. (4.83)	5. (8.05)	7. (11.27)	10. (16.09)
Total EDE	1.5E+01	5.2E+00	3.0E+00	2.4E+00	1.9E+00	1.3E+00	9.8E-01	6.5E-01
Thyroid CDE	1.1E+02	3.8E+01	2.2E+01	1.7E+01	1.4E+01	9.7E+00	7.1E+00	4.7E+00
Child Thyroid CDE	2.1E+02	7.2E+01	4.1E+01	3.2E+01	2.6E+01	1.8E+01	1.3E+01	8.8E+00
Inhalation CEDE	1.2E+01	4.1E+00	2.3E+00	1.9E+00	1.5E+00	1.0E+00	7.7E-01	5.2E-01
Cloudshine	1.3E-01	5.0E-02	3.4E-02	3.0E-02	2.3E-02	1.6E-02	1.2E-02	7.6E-03
4-day Groundshine	3.2E+00	1.1E+00	6.1E-01	4.8E-01	3.8E-01	2.7E-01	2.0E-01	1.3E-01
Inter Phase 1st Yr	3.0E+01	1.0E+01	5.9E+00	4.7E+00	3.7E+00	2.7E+00	2.0E+00	1.3E+00
Inter Phase 2nd Yr	1.6E+01	5.3E+00	3.0E+00	2.4E+00	1.9E+00	1.4E+00	1.0E+00	6.8E-01

- Inhalation dose factors used: ICRP 60/72
- *** indicates values less than 1 mrem
- To view all values - use Detailed Results | Numeric Table
- Total EDE = Inhalation CEDE + Cloudshine + 4-Day Groundshine

DOE Compliance Program

- Publication of 10 CFR 835 (2007) adopted ICRP 60 dose methodologies for DOE occupational worker protection.
- DOE Order 458.1 (2011) applies ICPR 60 methodologies for public protection and DOE Standard DOE-STD-1196-2011 provides dose factors.
- Not exceed a total effective dose (TED) of 100 mrem/yr all sources and pathways (excluding background, medical and occupational) using reference person (DOE-STD-1196)

Comparing Age Groups using DOE Method



Conclusions from DOE

- For emergency response, age specific dose coefficients may have merit for some radionuclides depending on specific situations.
- Doses to younger age groups will be higher and use of age specific doses may cause relocation/evacuation of populations with varied cost/risk/benefits.
- Age specific doses should not be straight substitute for population average currently used.
- Need to consider possible separate PAGs for special groups or new cost-benefit evaluations.

Federal Guidance Reports

FGR 12	FGR 15
Deterministic and Monte Carlo	Only Monte Carlo except for electron dose to skin
Cross Sections from 1970s	ENDF/B-VI.8
Simulations do not include coherent scatter for photons	Simulations includes coherent scatter
Stylized Adult Phantom only	0 , 1, 5, 10, 15 y.o. and Adult (Male and Female) stylized phantoms
ICRP Publication 60 tissue weighting factors	ICRP Publication 103 tissue weighting factors

PAG Manual refers to FRMAC Methods

- Readers are referred to FRMAC Assessment Manuals for calculations using up-to-date dosimetry.
  - ✓ Lookup tables of DCFs and DRLs not in PAG Manual
  - ✓ FRMAC Manuals updated more frequently
- However, no decision on age group(s) has been made there: FRMAC defers to policy in PAG Manual

FRMAC Method Assumptions Now

- Adult receptor, whole body dose
- Receptor is outside 24/7 with no shielding
- Plume is in contact with the ground
- Airborne noble gases are not deposited
- Deposition is immediate
- Deposition is dry particulates of 1-micron AMAD
- Maximum lung clearance class
- Daughters in equilibrium if $t_{1/2}$< ultimate parent

FRMAC Comparison NPP doses (rem)

Age Group	Early Phase: 4-Pathway, 0-96 hour	Early Phase: 2-Pathway, 12-108 hour	1st Year: 2-Pathway, 12-8772 hour	2nd year: 2-Pathway, 8760-17520 hour	50 Year: 2-Pathway, 12-4.38E5 hour
Adult	1.00	1.00	**2.00**	**0.50**	**5.00**
15 y	1.08	1.00	2.00	0.50	5.00
10 y	**1.15**	1.00	2.00	0.50	5.00
5 y	1.02	1.00	2.00	0.50	5.00
1 y	1.11	**1.01**	2.00	0.50	5.00
3 Month	NC	NC	2.00	0.50	5.00
% Difference	15.09%	0.57%	0.00%	0.00%	0.00%

Considerations from FRMAC

- PAGs are already very conservative.
- Default radiological assessment assumptions are very conservative (e.g., outside and unshielded 24/7/365)
- Decision makers must weight risks and disruptions of overly conservative public protection actions (evacuation, relocation) against the risk of radiation exposure.
- Evacuation and sheltering decisions need to be made quickly.
- If most sensitive age group is 1 year old, does it make sense to base protective actions on 1 year old for a retirement community in Florida?
- Over complicating the assessment calculations may delay protective action decisions.

Considerations from FRMAC

- FRMAC can perform public protection calculations to identify the most sensitive age group and organ.
  - ✓ Must we perform the calculation for each age group (6) and each organ (23), and, eventually each gender?
  - ✓ ICRP 60 dosimetry model: 138 calculations must be run to identify the most restrictive age group and organ if only one gender is considered
  - ✓ ICRP 103 dosimetry model: 184 calculations must be run to identify the most restrictive age group and organ if both genders for adult and 15 year old are considered
- Risk from radiation exposure varies with gender, age and exposed organ
- Different tissues have different weighting factors
- Do we need separate PAGs for each gender, age group and organ in order to identify most sensitive receptor?

Considerations from FRMAC

- In addition to dose coefficients, other assessment inputs (e.g., breathing rate) have to be modified to tailor the calculation for specific age groups and genders.
- A software tool such as Turbo FRMAC can be programmed to run all these calculations relatively quickly but radiological assessments will become more cumbersome and will take longer.

Example: KI Guidance from FDA

Threshold Thyroid Radioactive Exposures and Recommended Doses of KI for Different Risk Groups

	Predicted Thyroid exposure(cGy)	KI dose (mg)	# of 130 mg tablets	# of 65 mg tablets
Adults over 40 yrs	≥500			
Adults over 18 through 40 yrs	≥10	130	1	2
Pregnant or lactating women				
Adolescent over 12 through 18 yrs*		65	1/2	1
Children over 3 through 12 yrs	≥ 5			
Over 1 month through 3 yrs		32	1/4	1/2
Birth through 1 month		16	1/8	1/4

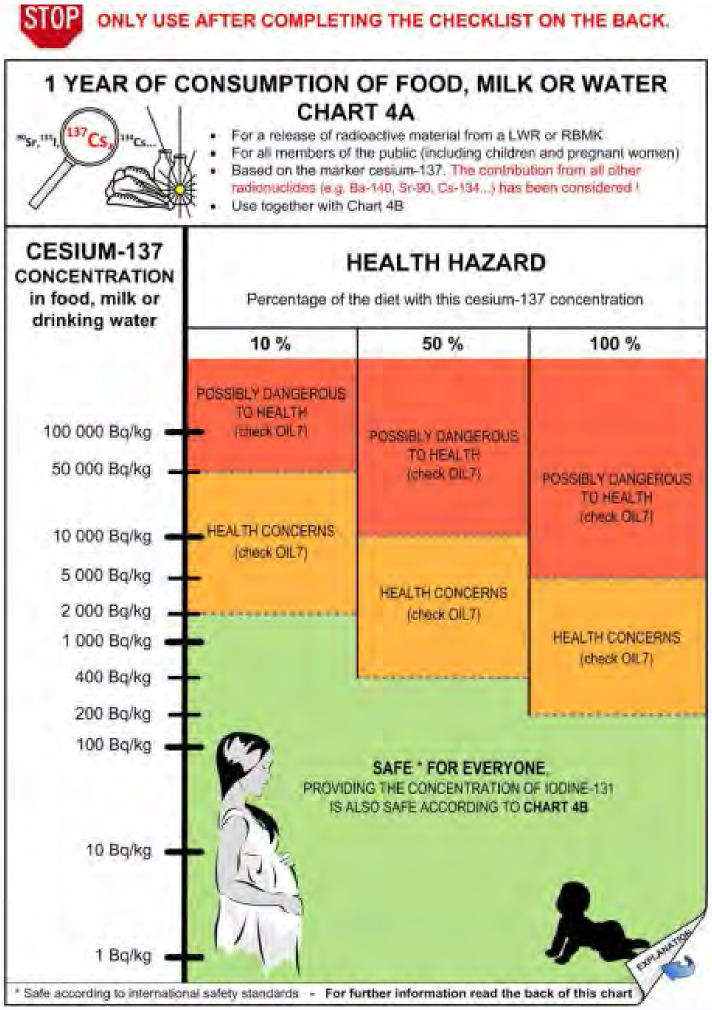
EPA

KI Simplified Approach

- An option in the PAG Manual is to provide KI to the whole community if doses of 5 rem are projected to the one year old thyroid. It is a conservative way to cover the most sensitive and ensure that communicating the protective action to the affected community is as simple as possible.
  - ✓ Not all communities use KI, however, and since it has limiting implementation challenges, it is a supplemental protective action to evacuation.

Drinking Water and Foods

- In 2013, EPA asked for input on whether an emergency PAG for water should be considered, and if so, what value
- The Agency is crafting a drinking water PAG proposal that considers sensitive subpopulations and offers age-specific guidance



FDA Food PAG Methodology

- Dose Coefficients
  - ✓ ICRP 56 (1989) for principal radionuclides
  - ✓ NRPB Publ. GS7 (1987) for expanded list
  - ✓ Six age groups: 3 month old, 1 year old, 5 y.o., 10 y.o., 15 y.o., adult
- Dietary Intake
  - ✓ EPA (1984)/USDA (1977-78)
  - ✓ Ten age groups
  - ✓ Includes tap water for drinking

FDA Derived Intervention Level

- The concentration of radioactivity in food which, if consumed continuously over a year (or the relevant timeframe), could lead to an individual receiving a dose equal to the PAG.
- Accounts for the most limiting PAG and the most limiting age group.

Relocation

- For relocation in the intermediate phase, some implementation concerns are similar to those for early phase evacuation:
  - ✓ The protective action, relocation, is best taken by entire households or neighborhoods, not subgroups based on age. Children and families need to stay together, especially in a stressful situation that takes them out of their daily routine. Relocation may require families to be out of their homes for months to years and for schools and businesses to close until decontamination and cleanup can be accomplished.

Conclusion

- Some PAGs lend themselves to age specificity (KI, Food, Water) while Evacuation, Shelter and Relocation should use simple, conservative projections to inform actions for the whole community
- How is Reference Person defined:
  - ✓ Currently, adult male with conservative assumptions about breathing rate, plume makeup and behavior, building shielding and occupancy factors

2015 Final PAG Manual

- Radiological dose assessors need clear direction on how to perform radiological assessments for public protective action recommendations.
  - ✓ We may allude to future reassessment with ICRP 103 recommendations, a new Reference Person and maybe even new PAGs to go along with them
  - ✓ And we're always interested in your input and questions!

The National Alliance for Radiation Readiness: Leveraging Partnerships to Increase Preparedness

Jim Blumenstock
Chief Program Officer, Health Security
Association of State and Territorial Health Officials

Agenda

- NARR Overview
- Fukushima After Action Report
- Laboratory Prioritization
- EMS Focus Group
- Radiation Control and Preparedness Program Partnerships
- Traveler Screening Guidance
- Neupogen Concept of Operations

National Alliance *for* Radiation Readiness

astho™

NARR Overview

National Alliance for Radiation Readiness (NARR)

- A coalition of organizations committed to improving the nation's ability to prepare, respond, and recover from radiological emergencies at the local, state, and national levels
  - 17 Member Agencies
  - 10 Federal Partners
  - Administered by the ASTHO through a cooperative agreement with the CDC , National Center for Environmental Health, Radiation Studies Branch

National Alliance *for* Radiation Readiness

astho™

NARR Member Agencies

- American Association of Poison Control Centers (AAPCC)
- American Hospital Association (AHA)
- American Public Health Association (APHA)
- Association of Public Health Laboratories (APHL)
- Association of State and Territorial Health Officials (ASTHO)
- Conference of Radiation Control Program Directors (CRCPD)
- Council of State and Territorial Epidemiologists (CSTE)

NARR Member Agencies (cont.)

- Council of State and Territorial Epidemiologists (CSTE)
- Health Physics Society (HPS)
- International Association of Emergency Managers (IAEM)
- National Association of County and City Health Officials (NACCHO)
- National Association of State EMS Officials (NASEMSO)
- National Disaster Life Support Foundation (NDSLF)
- National Emergency Management Association (NEMA)
- National Public Health Information Coalition (NPHIC)
- Radiation Injury Treatment Network (RITN)
- Society for Disaster Medicine and Public Health

National Alliance *for* Radiation Readiness

astho™

Federal Partner Agencies

- Centers for Disease Control and Prevention (CDC)
- Office of the Assistant Secretary for Preparedness and Response/US Department of Health and Human Services (ASPR/HHS)
- US Department of Homeland Security (DHS)
- Environmental Protection Agency (EPA)
- US Department of Energy (DOE)
- US Department of Agriculture (USDA)
- Food and Drug Administration (FDA)
- US Nuclear Regulatory Commission (NRC)
- Federal Emergency Management Agency (FEMA)

National Alliance *for* Radiation Readiness

astho™

NARR Purpose

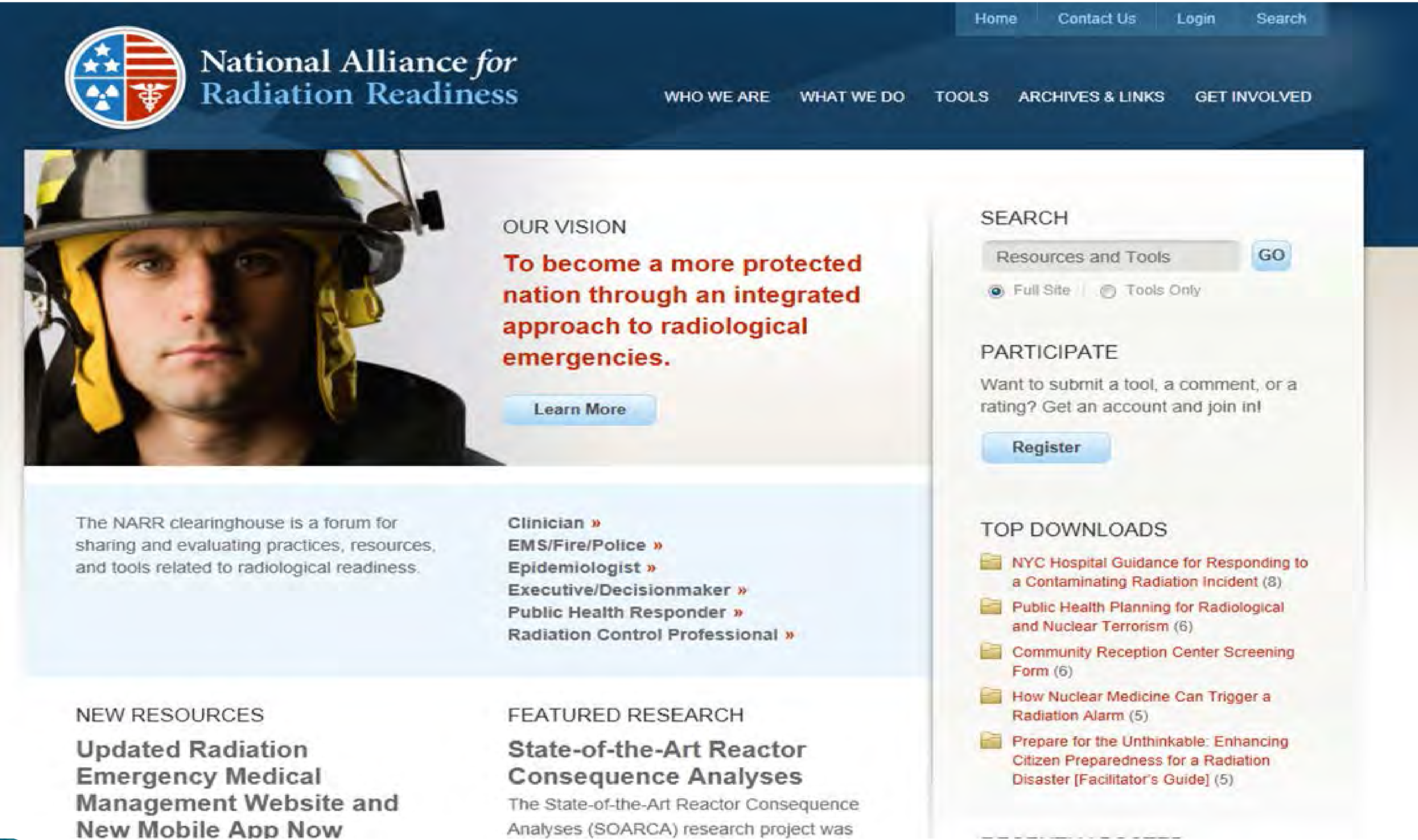
- To serve as the collective "voice of health" in radiological preparedness through the:
- To build radiological emergency preparedness, response and recovery capacity and capabilities

National Alliance *for* Radiation Readiness

astho™

NARR Clearinghouse

- www.radiationready.org
- Forum for sharing resources, tools, and best practices related to radiation planning, response, recovery


Home
Contact Us
Login
Search
National Alliance for Radiation Readiness
WHO WE ARE
WHAT WE DO
TOOLS
ARCHIVES & LINKS
GET INVOLVED
OUR VISION
To become a more protected nation through an integrated approach to radiological emergencies.
Learn More
SEARCH
Resources and Tools
GO
Full Site
Tools Only
PARTICIPATE
Want to submit a tool, a comment, or a rating? Get an account and join in!
Register
The NARR clearinghouse is a forum for sharing and evaluating practices, resources, and tools related to radiological readiness.
Clinician »
EMS/Fire/Police »
Epidemiologist »
Executive/Decisionmaker »
Public Health Responder »
Radiation Control Professional »
TOP DOWNLOADS
NYC Hospital Guidance for Responding to a Contaminating Radiation Incident (8)
Public Health Planning for Radiological and Nuclear Terrorism (6)
Community Reception Center Screening Form (6)
How Nuclear Medicine Can Trigger a Radiation Alarm (5)
Prepare for the Unthinkable: Enhancing Citizen Preparedness for a Radiation Disaster [Facilitator's Guide] (5)
NEW RESOURCES
Updated Radiation Emergency Medical Management Website and New Mobile App Now
FEATURED RESEARCH
State-of-the-Art Reactor Consequence Analyses
The State-of-the-Art Reactor Consequence Analyses (SOARCA) research project was

NARR Clearinghouse Tools

National Alliance *for* Radiation Readiness

Tools

Submit A Tool »

SORT BY: NEWEST TO OLDEST OLDEST TO NEWEST ALPHABETICALLY HIGHEST RATED

2007 Congressional Hearing on Laboratory Readiness

Submitted by: akambui
Date Submitted: 30 January 2012
Source: Association of Public Health Laboratories
Rating:

About this Tool

Held in 2007, this hearing before the Subcommittee on Investigations and Oversight, of the House Committee on Science and Technology, 110th Congress, entitled "Radiological Response: Assessing Environmental and Clinical Laboratory Capabilities", presented environmental and laboratory concerns that are still relevant. The Subcommittee hearing reviewed steps to address the critical laboratory needs related to radiological response;... more »

Tags: Content Type, Executives/Decisionmakers, Federal, Government, Jurisdiction, Legislation, Planners and Responders

SEARCH

Resources and Tools GO

Full Site | Tools Only

PARTICIPATE

Want to submit a tool, a comment, or a rating? Get an account and join in!

Register

TOP DOWNLOADS

- NYC Hospital Guidance for Responding to a Contaminating Radiation Incident (8)
- Public Health Planning for Radiological and Nuclear Terrorism (6)
- Community Reception Center Screening Form (6)
- How Nuclear Medicine Can Trigger a Radiation Alarm (5)
- Prepare for the Unthinkable: Enhancing Citizen Preparedness for a Radiation Disaster [Facilitator's Guide] (5)

Interactive Webinars

- Poison Control Center Collaborations with Public Health– February 2012
- Communicating with the Public in a Radiation Disaster
- NYS Clinical Data Management System: Use for Medical Countermeasure Response and Population Management
- Radiological Emergency Preparedness and Hostile Action Based Exercises: Federal, State, and Local Perspectives

National Alliance *for* Radiation Readiness

astho™

National Alliance *for* Radiation Readiness

Fukushima After Action Report

Fukushima After Action Report

- Review of the US public health and medical response to domestic concerns arising from the 2010 incident at the Japanese Fukushima Daiichi nuclear power plant
- AAR identifies:
  - Key strengths
  - Shortcomings
  - Lessons learned
  - Opportunities for improvement

Key Recommendations

- Need for stronger, more visible federal leadership
  - NRF and NIMS
  - Lead agency designation,
  - Improved data sharing
- More proactive, timely public information and education
- Leverage public and private resources for a more robust "whole of community" response
  - Situational awareness
- Invest in the public health enterprise
  - Bolster capacity of the nation's LRN for rapid and accurate detection of radiological contaminants

National Alliance *for* Radiation Readiness

astho™

Laboratory Prioritization

Laboratory Prioritization I

- Development of the Laboratory Taskforce
  - Volunteers from NARR members and federal partner agencies:
    - CDC, Radiation Studies Branch
    - CDC, Health Studies Branch
    - CDC, Inorganic and Radiation Analytical Toxicology Branch
    - EPA
    - APHL
    - ASTHO

Laboratory Prioritization II

- Overview of some considerations that decision makers may include in the prioritization of laboratory samples following a radiological event including:
  - Sample load projections (clinical, food & agricultural, environmental)
  - Sample management and handling
  - Triage and Screening
  - Quality assurance
  - Data sharing

EMS Focus Group

EMS Focus Group

- Research has shown that there is a decreased willingness by responders to serve during a radiological/nuclear emergency partially due to:
  - concerns about personal and family safety in responding to a radiological/nuclear emergency.
- 2014 NARR sponsored a focus group of EMS providers to gather information to better understand
  - Key attributes of effective training
  - Barrier preventing knowledge transfer
  - Responder reluctance to accept key messages in existing training materials

National Alliance *for* Radiation Readiness

astho™

EMS Focus Group Results I

- Radiological threats are low priority on jurisdictional hazard and threat analyses
- EMS jurisdiction preparedness and ability to respond to patients contaminated with radiation varies by jurisdiction and geographic location
- Current EMS guidance for response to a RDD is not consistent with existing HAZMAT training

National Alliance *for* Radiation Readiness

astho™

EMS Focus Group Results II

- Hands on training, motivational awareness of the threat that radiological emergencies present, and integration of the response disciplines were the most important attributes of effective EMS training for radiological emergencies
- EMS training for radiological emergencies is highly perisable

EMS Focus Group Conclusions

- Multi-disciplinary work group should be established to create a consensus based set of protocols, training, and exercise materials for EMS response to a radiological emergency
- Training for radiological emergencies should be integrated into the existing curriculum and training requirements

Radiation Control and Preparedness Program Partnerships

Partnership Strategies for State Radiation Control and Preparedness Programs

- ASTHO interviewed several state radiation control and public health preparedness staff regarding:
  - Incorporation of radiation and/or nuclear preparedness activities into public health preparedness programs
  - the structure of each program and how they overlap
  - collaboration between radiation/nuclear staff and public health staff

Partnership Strategies for State Radiation Control and Preparedness Programs

- Partnership Development
  - Use actual events (Fukushima disaster)
  - Standing agenda items
    - Subject Matter Expert meetings that include public health preparedness, radiation control, public information, and others
- Inclusion of Radiation-Specific Planning within the Public Health Capabilities

Capability Number	Capability Name	Capability Definition	Radiation-Specific Opportunity for Engagement
1	Community Preparedness	Ability of communities to prepare for, withstand, and recover --in both the short and long terms -- from a public health incident.	Provide subject matter expertise in regards to: - Identifying populations with health vulnerabilities caused or exacerbated by radiological exposure - Jurisdictional risk assessment
2	Community Recovery	Ability to collaborate with community partners to plan and advocate for the rebuilding of public health at least a level of functioning comparable to pre-incident levels.	Provide subject matter expertise on how to conduct follow-up monitoring of people, pets, and environment following a radiological incident. Provide guidance on and coordinate the disposal of contaminated tools, clothing, equipment, and other materiel.

Partnership Strategies for State Radiation Control and Preparedness Programs

- Examples of previously joint funded programs
  - Community Reception Center Annex Development
  - Radiation/Nuclear Annex Development
  - REAC/TS Training
  - Radiation Response Volunteer Corps
  - Preventative Radiation Nuclear Detection Program

Traveler Screening Guidance

Passenger Screening Tabletop Exercise

- Purpose
  - Identify key activities associated with passenger screening at an airport following an radiological exposure in another country
  - Validate and identify opportunities for improvement in the passenger screening protocols developed following the Fukushima Daiichi incident of 2011.
- Goal
  - Enhance preparedness of federal, state, and local responders responsible for coordinating and conducting passenger screening at US airports following a radiological release

National Alliance for Radiation Readiness

astho™

Exercise Objectives

- Understand and/or identify state and local response requirements
- Clarify response roles and communication channels
- How the Epidemiological Assessment form can inform next steps
- Identify key topics for public information releases
- Identify information to distribute to passengers and those potentially exposed at the airport

National Alliance *for* Radiation Readiness

astho™

Strengths

- Partnership- numerous response agencies that worked well together
- Knowledge- clear understanding of the issues surrounding radiation emergencies
- Open Dialogue- existed between federal, state, and local responding agencies

National Alliance *for* Radiation Readiness

astho

Areas for Improvement

- Bioassays- need to develop clear guidance for how bioassays would be triggered, who would collect them, where would they be sent, and how would the results be communicated
- Screening Guidance- Fukushima protocols are not generalizable to any radiation response incident. Need to develop more detailed guidance
- Communication/Public Information Materials- Need to develop templates and fact sheets

NARR Work Groups

- Formation of 4 work groups
  - Communications
  - Screening and Epidemiological Assessment
  - Bioassay Guidance
  - Emergency Management Role

- Participants included NARR members, DPHP, State epidemiologists, Laboratory personnel, and Public information officers

Guidance for Traveler Screening at Ports of Entry Following an International Radiological Incident

- An introduction to screening travelers arriving at U.S. ports of entry who may be contaminated with radioactive material following an international radiological incident.
- It is intended to be used by state, local, and tribal public health professionals who are responsible for initiating the traveler screening response.
- Divided into sections that "walk" the planner/responder through the traveler screening process beginning with consent and registration and ending with the development of a long term registry.
- Specific key communication messages for affected traveler are presented throughout the document in each response section.

National Alliance *for* Radiation Readiness

astho™

Guidance for Traveler Screening at Ports of Entry Following an International Radiological Incident

- The purpose is to provide state and local planners with guidance on how to:
  - Screen, decontaminate, and provide medical follow-up and long-term health follow-up for travelers, staff at POEs, and others with contamination
  - Communicate information and risk effectively with travelers, who need:
    - Urgent medical referral;
    - Decontamination;
    - Reassurance that they are not contaminated
  - Collect and use exposure and epidemiologic data to provide situational awareness and to determine post-incident public health impacts of the radiologic incident.

Current Status of Traveler Screening Guidance

- The Guidance is out for final NARR review and is expected to enter CDC Clearance by April 2015.

Neupogen Concept of Operations

Neupogen

- Neupogen is normally used during radiation cancer treatments
- Neupogen can be used following an IND detonation to “boost” the immune system of those exposed.
  - Neupogen must be given quickly to save lives
  - Neupogen must be given in conjunction with other life saving and supportive care
- Federal agencies are developing a medical utilization guidance for this new use for neupogen

Neupogen Public Health CONOPS

- The NARR has convened a workgroup to develop the public health CONOPs to assist health departments in operationalizing the distribution of Neupogen
  - EMS
  - Public Health
  - Radiation Control Professionals
  - Cancer Treatment professionals
  - Emergency Management

Current Status of CONOPs

- We are currently hosting a series of small group key informant meetings to develop the framework for the CONOPS
- This framework will be presented to the larger workgroup in the Spring/Summer
- The final CONOPS will be developed by December 31, 2015

Changing Regulations and Radiation Guidance: What Does the Future Hold?

Summary of Meeting

Donald A. Cool

Program Committee Chair

Theme

- To everything …. there is a season …
  - Time to consider:
    - Where we are
    - Why we are there
    - Where we want to go
  - Diversity of Topics
  - Diversity of Speakers

Sinclair Keynote Address

Influence of NCRP on Radiation Protection in the United States: Guidance and Regulation

– From the beginning, NCRP has held a key role in the United States with many stakeholders and users
– The basic principles of radiation protection have served us well
– CC-1 updated recommendations will include a number of areas not previously covered

Session 1: Basic Standards

Evolution of the Radiation Protection System and Its Implementation

- Relationships between organizations is complex
- Stakeholder concerns and involvement are becoming much more important to, and integral in radiation protection
- Prevailing circumstances are key to understanding viewpoints and protection
- Optimization with appropriate limitation of dose

Session 1: Basic Standards

Federal Directions in Radiation Regulations: Making the "Old" New Again

- U.S. faces a number of "stressors" and changing expectations
- Needs for clarity, effectiveness, flexibility, and reasonableness
- Need to look forward, anticipate, coordinate, and improve consistency

Session 2: Source Security

Enhanced Radioactive Material Source Security

- “Security” is not new, but much has changed
- Malevolent use now a major concern
- Legislative requirements, and translation of orders into regulation
- A lot of work has been done, but more is still needed

Session 2: Source Security

End of Life Decisions for Sealed Radioactive Sources

- There are lots of sources, and many opportunities for control
- NSTS sources represent ~4% of all sealed sources licensed in the US
- Considerations needed for expanding coverage to more sources, limiting storage time, waste disposal solutions, and opportunities for reuse and recycle
- Potential solutions in States, CRCPD

Session 3: Waste Disposal

Factors Important to an Effective Long-Term Management Strategies for Depleted Uranium Disposal

– DU as a chemical toxic hazard
– LLW defined by what it is not, and has widely varying characteristics, mostly decayed in 300y
– Considerations ongoing at NRC and DOE
– Communications must be accurate, timely, consider the audience, and contribute to the dialogue

Session 3:
Waste Disposal

Alternative Waste Strategies and Implications

- Characterization of DOE-managed wastes
- Physical characteristics and volumes influence how waste may be managed, including size and heat load
- Multiple Options being considered for wastes, including very deep borehole
- Implementation of a phased, adaptive, and consent-based strategy for DOE managed waste

Session 4: Medical

Revision of Suggested State Regulations

- Process includes identification of need, developing requirements within complex structure of State and Federal requirements with many stakeholders
- Capturing medical events in diagnostic
- Evaluating trends and movement towards reference levels
- Wide range of types of equipment, uses, with corresponding issues of standards, qualifications and oversight

Session 4: Medical

NCRP Guidance for Lens of the Eye

- Significant changes in understanding of thresholds for effects, and international recommendations
- Additional information needed to understand effects, not enough info to make new conclusions
- Many occupational populations of possible interest
- Need for additional evaluation and research
- Opportunities for dose sparing optimization, education, and accurate dose assessment

Taylor Lecture

Dosimetry of Internal Emitters: Contributions of Radiation Protection Bodies and Radiological Events

- The calculation of dose from internal emitters has evolved from simple geometries to ever more complex representations of the body
- Events have helped to drive priorities

Tenforde Topical Lecture

Ethics and Radiation Protection

- The system of protection has a firm foundation in ethical tenets across all the cultures of the world
- Uncertainties and Prudence
- Justice, Fairness/Equity, Dignity,
- Reasonableness and Tolerableness → Act Wisely
- As we clarify our reasons for principles and recommendations, we also help to clarify how we communicate and relate

Session 5: Emergency Preparedness

Update of ICRP Publications 109 and 111

- Events lead to emergent issues
- The gap in the protective principles between the Emergency and Existing situations has confused both the regulators and the affected people
- Decisions need to reflect the prevailing circumstances
- Involvement of local authorities, professionals and the local population in decisions and actions
- Self-help protection and RP culture supported by information

Session 5: Emergency Preparedness

Updated Dosimetry in the New Protective Action Guides Manual

- There are a number of issues in setting new PAG levels, including age groups, communities, and effective implementation
- Its not just radiological impacts that have to be considered
- Many issues remain in developing the revision

Session 5: Emergency Preparedness

National Alliance for Radiation Readiness: Leveraging Partnerships to Increase Preparedness

- A coalition committed to improving the nation's ability to prepare, respond, and recover from radiological emergencies at the local, state, and national levels
- Voice of Health
- Wide range of activities and work: Fukushima After Action, Laboratory prioritization, Program partnerships, EMS, traveler screening, Neupogen

Conclusions

- Get the foundations right
- Communicate clearly and openly
- Find the right mix of stability and renewal, coherence and uniqueness

❖ Personal
❖ Protective
❖ Practical

Conclusions