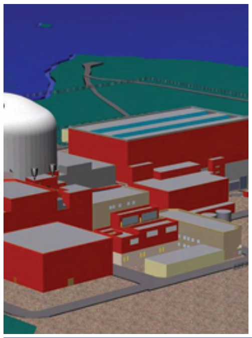
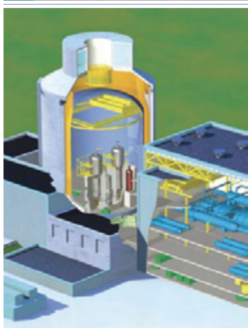


Forty-Fifth
Annual Meeting Program



Future of Nuclear Power Worldwide: Safety, Health and Environment

March 2–3, 2009

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

NCRP 1929 2009

On the cover:

- *top*: Evolutionary power reactor now being built in Finland.
- *center*: Advanced pressurized water reactor now being built in China.
- *bottom:* Advanced boiling water reactor built in Japan.

Introduction

Future of Nuclear Power Worldwide: Safety, Health and Environment

Forty-Fifth Annual Meeting of the National Council on Radiation Protection and Measurements

The role of nuclear power as a major resource in meeting the projected growth of electric power requirements in the United States and worldwide during the 21st century is a subject of great contemporary interest. The goal of the 2009 National Council on Radiation Protection and Measurements (NCRP) Annual Meeting will be to provide a forum for an in-depth discussion of issues related to the safety, health and environmental protection aspects of new nuclear power reactor systems and fuel production and processing strategies. The meeting will be an international conference with participation by representatives of many nations, scientific organizations, nuclear industries, and governmental agencies engaged in the development and regulatory control of advanced reactor systems and fuel concepts.

Topics of major interest in the context of the expected expansion in worldwide use of nuclear power that will be discussed include the following: (1) primary safety, health and environmental issues associated with the growth of nuclear power as an energy resource; (2) infrastructure needs for future nuclear power reactor systems and the associated radiation protection requirements, including nuclear plant operational practices, environmental issues associated with the growth of nuclear fuel-cycle and waste-management issues, and fuel nonproliferation safeguards; (3) key challenges to be addressed for nuclear power in the 21st century, including regulatory practices and controls, expansion of trained human resources and expanded educational capabilities in nuclear power technology, radiation protection requirements, and effective communication of the risks and benefits of nuclear power resources; and (4) perspectives on how to meet the major challenges in projected growth of nuclear power energy sources. The 2009 Annual Meeting will mark the 80th anniversary since the founding of NCRP and its predecessor organizations, and will be the 45th Annual Meeting held by NCRP following the 1964 Congressional Charter under Public Law 88-376 to provide guidance on matters related to radiation protection and measurements.

Future of Nuclear Power Worldwide: Safety, Health and Environment

Monday, March 2, 2009

Opening Session

8:15 am **Welcome**
Thomas S. Tenforde
President
National Council on Radiation Protection and Measurements

Sixth Annual Warren K. Sinclair Keynote Address

8:30 am **The Role of a Strong Regulator in Safe and Secure Nuclear Energy**
Peter B. Lyons
U.S. Nuclear Regulatory Commission

9:30 am **Panel on Safety, Health and the Environment: Implications of Nuclear Power Growth**
Sama Bilbao y Leon, *Moderator*
International Atomic Energy Agency

Panelists:

Challenges to New Nuclear Plant Development
Charles Pardee
Exelon Corporation

Impact of the Renewed Growth in Nuclear Power on State Radiation Control Programs
John P. Winston
Conference of Radiation Control Program Directors, Inc.

Other Side of the Waste Confidence Consideration
Robert M. Bernero
U.S. Nuclear Regulatory Commission (retired)

Next Generation Safeguards for Future Nuclear Power
Michael C. Miller
Los Alamos National Laboratory

10:30 am **Break**

Trends in Worldwide Use of Nuclear Power

Angelina Howard, *Session Chair*
Nuclear Energy Institute

10:45 am **NEA Nuclear Energy Outlook 2008**
Uichiro Yoshimura
OECD Nuclear Energy Agency

11:10 am **U.S. Evolutionary Power Reactor: Certainty in Safety**
Thomas A. Christopher
AREVA

11:35 am **Advanced Reactors and Associated Fuel-Cycle Facilities: Safety and Environmental Impacts**
Robert N. Hill
W. Mark Nutt
James J. Laidler
Argonne National Laboratory

12:00 pm **Lunch**

1:10 pm **Panel on International Perspectives on Future of Nuclear Power**
Joseph C. Perkowski, *Moderator*
Idaho National Laboratory

Panelists:

Expanded Development and Use of Nuclear Energy: Important Way to Solve Environmental Pollution in China
Liu Senlin
China Institute of Atomic Energy
Ziqiang Pan
Chinese Radiation Protection Association

New Nuclear Power Stations in the United Kingdom
David Bennett
Environment Agency, United Kingdom

Program Summary

International Perspectives on Nuclear Fuel Cycle
Alan Hanson
AREVA

Experience Feedback on Radiation Protection in Nuclear Power Generation: Japanese Perspective
Shojiro Matsuura
Japan Nuclear Safety Research Association
Shizuyo Kusumi
Nuclear Safety Commission, Japan

Nuclear Energy in the United States
Alexander Marion
Nuclear Energy Institute

2:40 pm **Break**

Infrastructure Needs for Future Nuclear Power

Patrice M. Bubar, *Session Chair*
U.S. Nuclear Regulatory Commission

3:00 pm **Radiation Protection at U.S. Nuclear Power Plants: Today and Tomorrow**
Michael Blevins
Luminant Power

3:25 pm **World Nuclear Association's Worldwide Overview on Front-End Fuel-Cycle Growth and Health, Safety and Environmental Issues**
Sylvain Saint-Pierre
Steve Kidd
World Nuclear Association

3:50 pm **Reactor Based Management of Used Nuclear Fuel: Assessment of Major Options**
Phillip Finck
Idaho National Laboratory
Robert Hill
Argonne National Laboratory
John Kelly
Sandia National Laboratory
Roald Wigeland
Idaho National Laboratory

4:15 pm **International Safeguards and the Global Expansion of Nuclear Power**
Thomas E. Shea
Pacific Northwest National Laboratory

4:40 pm **Break**

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

5:00 pm **Introduction of the Lecturer**
Robert L. Brent
Alfred I. duPont Institute

Radiation Epidemiology: The Golden Age and Remaining Challenges
John D. Boice, Jr.
Vanderbilt University School of Medicine
International Epidemiology Institute

6:00 pm **Reception in Honor of the Lecturer**

Future of Nuclear Power Worldwide: Safety, Health and Environment

Tuesday, March 3

8:20 am **NCRP Annual Business Meeting**

9:20 am **Break**

Key Challenges to be Addressed for Nuclear Power in the 21st Century

Audeen W. Fentiman, *Session Chair*
Purdue University

9:40 am **Essential Infrastructure: National Nuclear Regulation**
Carl J. Paperiello
U.S. Nuclear Regulatory Commission (retired)

10:05 am **Maintaining a Highly-Qualified Nuclear Industry Workforce**
Carol L. Berrigan
Nuclear Energy Institute

10:30 am **Break**

10:45 am **U.S. Department of Energy Facilities Needed to Advance Nuclear Power**
John F. Ahearne
Sigma Xi

11:10 am **New Nuclear Build and Evolving Radiation Protection Challenges**
Edward Lazo
OECD Nuclear Energy Agency

11:35 am **Communicating with Stakeholders about Nuclear Power Plant Radiation**
Ann Stouffer Bisconti
Bisconti Research

12:20 pm **Lunch**

1:30 pm **Role of the International Radiation Protection Association**
Kenneth R. Kase
Philip Metcalf
International Radiation Protection Association

1:50 pm **Panel on How to Meet the Challenges for Nuclear Power**
Mary E. Clark, *Moderator*
U.S. Environmental Protection Agency

Panelists:

Nuclear Power Expansion: Challenges and Opportunities
Paul W. Lisowski
U.S. Department of Energy

Three Most Important Actions For the Growth of Nuclear Power
Wayne L. Johnson
Pacific Northwest Laboratory

How to Meet the Challenges Reinvigorating the Research and Development Community and Infrastructure
Mark T. Peters
Argonne National Laboratory

Outlook for Nuclear Energy in a Shifting Political Climate
Annie Caputo
House Committee on Energy and Commerce

Low-Level Radioactive Waste Management: Status, Challenges and Solutions
Michael T. Ryan
Michael T. Ryan and Associates, LLC

Challenges and Opportunities of a Global Nuclear Energy Future
Thomas Isaacs
Stanford University
Lawrence Livermore National Laboratory

Program Summary

3:15 pm **Break**

3:35 pm **Rapporteur Summary**
Michael L. Corradini
University of Wisconsin-Madison

4:15 pm **Questions and Comments from the Audience**

4:50 pm **Closing Remarks**
Thomas S. Tenforde
President, NCRP

5:00 pm **Adjourn**

Monday, March 2, 2009

Opening Session

8:15 am

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

8:30 am

Sixth Annual Warren K. Sinclair Keynote Address

The Role of a Strong Regulator in Safe and Secure Nuclear Energy
Peter B. Lyons
U.S. Nuclear Regulatory Commission

A strong independent regulatory authority is not only necessary but valuable for any country that utilizes nuclear energy in its quest for energy diversity and security. Specific areas of elaboration will be: the value of the independent role played by the U.S. Nuclear Regulatory Commission (NRC), NRC's licensing process for new reactors, the current status of new reactor licensing work, some of the current challenges, and what the future may hold.

Commercial nuclear power in the United States began under the oversight of the U.S. Atomic Energy Commission (AEC). At that time, AEC's regulatory programs sought to ensure public health and safety without imposing excessive regulation that would inhibit the growth of the industry. As a result of this difficult balance, in 1974 Congress divided these roles, assigning the regulatory function to NRC. Not only did NRC become the regulator for nuclear power reactors, but also the regulator of all civilian use of radioactive materials, including fuel enrichment facilities, industrial and medical applications, and waste disposal facilities. Today, senior executives of the nuclear power industry understand and appreciate the value that an independent and technically strong regulator brings to assuring the public that nuclear plants are being operated safely and securely. The level of public assurance depends on NRC being a tough regulator—the job of NRC is to ask the tough questions and make the tough calls. The nuclear industry recognizes that any possibility of construction of new nuclear power plants in the United States depends directly on continued public assurance of safe and secure operations of existing power reactors in operation today.

NRC's 10 CFR Part 52 licensing process, which is now being used for the first time, was initially developed almost 20 y ago. The licensing process provides a regulatory framework addressing design certifications, early site permits, and combined licenses. The design certification process allows a reactor vendor to submit a design to NRC for review and certification that is independent of a site. Safety reviews must be based on an essentially complete design. Similarly, the early site permit process allows an applicant to apply for a site permit independent of any particular design. In reviewing an early site permit application, NRC staff address site safety issues, environmental protection issues, and plans for coping with emergencies. A combined license authorizes both construction and conditional operation of a nuclear power reactor. All of these licensing actions allow for public and other stakeholder participation through public meetings and hearings. As of October 2008, NRC had 17 combined license applications under review, representing 26 reactors using five designs.

Many important challenges face NRC and the industry, such as ensuring that applications submitted to NRC for design certifications and licenses for new plants are fully complete and of high quality and implementing modular construction.

Other challenges that will impact both new and operating reactors include: the globalization of the nuclear supply chain, procurement of off-the-shelf commercial grade components for use in safety-related applications, new designs such as security enhancements and digital systems, and maintaining a quality workforce with an appropriate safety culture. Over the past 3 y, NRC alone has hired over 400 engineers and scientists per year to keep up with the attrition of an aging workforce in concert with our expanding workloads. Likewise, industry is hiring engineers and health physicists to support activities ranging from new reactors to site decommissioning and cleanup. The challenge to support educational programs in these areas must be shared by NRC, industry, and academia.

Management of both high- and low-level waste may challenge industry, NRC, and the Agreement States. NRC faces a monumental task in the review of the license application for a potential Yucca Mountain high-level waste repository. Low-level waste issues may also present special challenges, especially since the Barnwell Site closed to out-of-compact wastes earlier this year. A final challenge, specifically relevant to NCRP, is the refinement of understanding and communications associated with low doses of radiation. In a time when scientific information is significantly increasing, it is critical that we carefully and continually evaluate the scientific basis for radiological protection recommendations.

Provided that continued safety is demonstrated by the nations that operate reactors, the future may be promising, as reactor technology can be expected to progress toward new generations of designs with demonstrably greater safety and potentially greater utility, especially for small modular types. Increasing concern for carbon-free electrical power and process heat sources may drive further interests in both new plants and in extending the operation of existing units. The requirement of the Energy Policy Act of 2005 for the U.S. Department of Energy to develop a Next Generation Nuclear Plant is one example of an initiative that will further advance nuclear technologies. Future challenges will include developing the expertise necessary for reviews of these advanced technologies and ongoing challenges such as spent-fuel and waste management.

[*The remarks above are the personal views of Commissioner Lyons, and may not represent the collective view of the Commission.*]

Future of Nuclear Power Worldwide: Safety, Health and Environment

9:30 am

Panel on Safety, Health and the Environment: Implications of Nuclear Power Growth

Sama Bilbao y Leon, *Moderator*
International Atomic Energy Agency

Panelists:

Challenges to New Nuclear Plant Development

Charles Pardee
Exelon Corporation

The recent presidential election brought to light that no matter what the solution is for our future energy needs, the answer involves a more diverse mix of energy resources, one of which is nuclear. Many factors are driving the debate over new nuclear plant development. The challenges to new plant development include operating nuclear plant performance, environmental considerations, public sentiment, used-fuel management, and cost uncertainties. The threshold condition before any other considerations can be given credence is our current industry performance. First and foremost, if nuclear operators fail to maintain high levels of safety and performance, the rest of the challenges will become a moot point. It is imperative that current nuclear plants safely operate at high-capacity factors, maintaining competitive fuel costs, and experience no significant events for new nuclear plant development to remain attractive to the energy mix. Compared to its competition such as coal, gas or petroleum, nuclear power's production costs, fuel costs, and greenhouse gas generation are among the lowest in the electric utility sector. These attributes combine to set the stage for future nuclear plant development.

The increase of carbon dioxide levels in the atmosphere, coupled with concern about their possible climate effect, is now a very significant factor in the comparison of coal and nuclear power for producing electricity. A major selling point for new nuclear plant construction is the fact that it produces less carbon dioxide than even wind energy per kilowatt hour, when calculated as a total life-cycle carbon footprint.

However, production of electricity from any form of primary energy has some environmental impact. Nuclear plants are no exception because they have infrastructures that require significant landscape to accommodate heat sinks, water consumption needs and requirements to support transmission line access. They generate thermal, gaseous and liquid discharges that must be managed appropriately to ensure minimal environmental impact and to demonstrate their ability to be positive environmental stewards to local communities.

One of the key influences surrounding nuclear power for generation purposes is public sentiment. Today, nuclear power is benefiting from increased public acceptance of electricity generated from sources that are greenhouse gas compliant, which is helping to create a resurging interest in nuclear power as part of our energy mix.

Current public concerns regarding nuclear power generation are centered on emission-free energy, economic benefits, the environmental footprint, vulnerabilities to terrorism, weapons proliferation, and the perceptions left by the legacy events such as Three Mile Island and Chernobyl. With the complex nature of the physics behind the design, we are often challenged and measured on our ability to communicate to the public that nuclear power is a safe, clean and reliable source of energy for the future.

Used-fuel management has been a utility concern for years and plants are now forced to develop costly temporary onsite storage solutions because of delays encountered with the development of a government-owned central repository (Yucca Mountain). New plant construction and operation will accelerate the necessity for a resolution (both interim and the long term) to the used-fuel storage issue.

A nuclear renaissance is refreshing, but brings with it challenges to an industry that had been somewhat stagnant or dormant for years. Cost uncertainties associated with construction, component availabilities, an aging workforce, attracting new talent, and new regulatory processes are challenges the industry must face to successfully build in the future. The need is there and made more attractive with the incentives offered by the Energy Policy Act of 2005.

The question now is who will be first?

Impact of the Renewed Growth in Nuclear Power on State Radiation Control Programs

John P. Winston
Conference of Radiation Control Program Directors, Inc.

The renewed interest in nuclear power in the United States will impact state radiation control programs in many ways. The time lapsed since the last siting and construction process has left state programs with a generation of employees having no experience in evaluating environmental impact studies associated with the siting and construction of new plants. State programs will be involved in the coordination and attendance of public meetings, hearings, and the dissemination of information. A stack and perimeter environmental monitoring program will need to be designed, implemented and maintained.

In states with existing nuclear power generation, new plants at new locations will require additional personnel and resources to develop and perform both environmental monitoring and emergency response plans. If the plant involves a new design, training will be required for the individuals in an existing nuclear safety and radiation control program.

States with their first plant within or near their state line will be tasked with developing the infrastructure necessary for a new off-site emergency response program. A mechanism of funding or fee collection to support the additional staff and resources associated with implementing the new program will be required.

The projected growth of nuclear power will mean additional opportunities for development and training of state personnel. State radiation control programs will benefit from an expanded emphasis on emergency response capabilities, which also enhances the program's ability to respond to other radiological emergencies. The success of the necessary expansion and training will hinge on the level of financial resources.

Other Side of the Waste Confidence Consideration

Robert M. Bernero
U.S. Nuclear Regulatory Commission (retired)

In the aftermath of the Three Mile Island accident, a lawsuit challenged the right of the U.S. Nuclear Regulatory Commission (NRC) to continue issuing new reactor licenses, or amending existing licenses, given that there was no solution evident for the disposal of the high-level radioactive waste (HLRW) generated by these reactors. Not long after this challenge, Congress enacted the Nuclear Waste Policy Act of 1982; the Act that began the process of site selection and licensing of a HLRW repository that has reached the stage of license application now under review by NRC. An initial policy statement of "waste confidence," was issued by NRC, that is, confidence that the national activity would lead to the establishment of HLRW disposal capability on an acceptable time scale. NRC issued another waste confidence finding about 1990, recognizing the contention about the selection of the Yucca Mountain Site for development. The 1990 statement even considered that the Yucca Mountain Site might be finally rejected, putting the search for another site on a generation-long development of an alternate site. This length of time is considered tolerable because long-term surface storage of HLRW can be safe for at least a 100 y. NRC remains conscious of the need for waste confidence and continues to consider new and amended licenses for reactors.

There is another side of the waste confidence issue, consideration of the disposal of low-level radioactive waste (LLRW). Disposal sites were operating in several places across the United States at the time of the waste confidence challenge. In 1980, Congress enacted the Low-Level Radioactive Waste Policy Act, and in 1985 enacted the Low-Level Radioactive Waste Policy Amendments Act. These Acts established a wholly new system of LLRW sites, to be developed by groups of states, called Compacts. Under the terms of these Acts, each state's governor did make what amounts to a statement of waste confidence to NRC in 1990. In the years after the Acts the Compacts were formed and site work proceeded in varying degrees. Before long the site development process stalled in most Compacts. The Northwest Compact chose the Hanford Washington Site, already operating, for their LLRW and agreed to accept LLRW from the Rocky Mountain Compact. The operating LLRW site in Barnwell, South Carolina continued to accept LLRW from all other states. These operating sites were accepting all classes of LLRW, Classes A, B and C for varying disposal fees. In addition, sites such as the one in Clive, Utah opened to receive Class A waste from any state. The Barnwell Site began to restrict its LLRW receipts and recently closed to all states outside its Compact. Under current restrictions LLRW generators in 36 states are storing Class B and C LLRW for lack of access to an acceptable disposal site.

Only a few of the early generation power reactors have been or are being decommissioned. Those that do not have access to disposal for Class B and C LLRW must continue to store it. Most of these decommissioning projects go to "green field" state, that is, complete removal of the radioactive waste. NRC and the U.S. Environmental Protection Agency have not established a national standard for "clearance," a standard for the low level at which radioactive waste may be disposed of without regard to its level of activity. For many of the reactors decommissioned, concrete rubble that could be technically justified as being within a clearance standard is shipped for disposal to other states at significant cost. Most of the earlier generation power reactors have been granted life extensions, extending their end-of-useful life by at least 20 y. They face substantial difficulties and costs for decommissioning and disposal of LLRW as well as for HLRW. New reactors, even if designed for decommissioning ease, will face this same disabled LLRW disposal system. The other side of waste confidence, for LLRW, should be considered.

Next Generation Safeguards for Future Nuclear Power

Michael C. Miller
Los Alamos National Laboratory

An essential component in the expansion of nuclear energy is full confidence in nonproliferation and safeguards. In addition to expansion of the existing light-water reactor fleet, advanced fuel-cycle concepts are increasingly being developed and deployed. New technologies will be needed to achieve this confidence in a way that enables efficiency as well as efficacy. In this talk I will outline the needed research and technology development to support the nuclear renaissance: including incorporation of safeguards into facility design, advancing instrumentation for tracking and accounting for nuclear material, and fully integrating all available data so that near real-time knowledge of facility operations is possible.

10:30 am **Break**

Trends in Worldwide Use of Nuclear Power

Angelina Howard, *Session Chair*
Nuclear Energy Institute

10:45 am

NEA Nuclear Energy Outlook 2008

Uichiro Yoshimura
OECD Nuclear Energy Agency

This presentation refers to Nuclear Energy Outlook, which is the first of its kind and responds to the renewed interest in nuclear energy by many Organization for Economic Cooperation and Development (OECD) member countries. World energy demand continues to grow unabated and is leading to very serious concerns about security of supply, soaring energy prices, and climate change stemming from fossil-fuel consumption. Nuclear energy is increasingly seen as having a role to play in addressing these concerns.

This Outlook uses the most current data and statistics available and provides projections up to 2050 to consider growth scenarios and potential implications on the future use of nuclear energy. It also offers unique analyses and recommendations on the possible challenges that lie ahead.

Topics covered by the Nuclear Energy Outlook include nuclear power's current status and projected trends; environmental impacts; uranium resources and security of supply, costs, safety and regulation; radioactive waste management and decommissioning; nonproliferation and security; legal frameworks; infrastructure, stakeholder engagement; advanced reactors; and advanced fuel cycles.

11:10 am

U.S. Evolutionary Power Reactor: Certainty in Safety

Thomas A. Christopher
AREVA

The original design goal of the Evolutionary Power Reactor (EPR) was increased to have margins of safety in all aspects of the plant, the use of proven technology, and more efficient operation for higher capacity factors. Based upon the extensive experience of the U.S., German, and French nuclear industries, this evolutionary design is tailored to the safety and environmental issues that we anticipate in the next 60 y. Reactor safety was raised to a new global level in the design of EPR. Not only have we improved the reactor core margins, the design thoroughly addresses the possibility of severe accidents, including airplane crashes. Additionally, the containment shielding and layout allows for access to significant areas of the containment for maintenance at power.

EPR provides a geographical footprint for a 1,600 MWe power plant that is 40 % less than that required today. Also, there is a substantial reduction in thermal discharge to the environment for that power level.

11:35 am

Advanced Reactors and Associated Fuel-Cycle Facilities: Safety and Environmental Impacts

Robert N. Hill
W. Mark Nutt
James J. Laidler
Argonne National Laboratory

Advanced nuclear fuel-cycle technology is being developed worldwide to improve waste management and resource utilization. The safety and environmental impacts of these new technology and fuel-cycle approaches will be contrasted to conventional technology options in this presentation. The evaluation will address three fuel-cycle phases: power reactor operation, fuel recycle, and waste management. This presentation will focus on technology options being investigated in current U.S. nuclear research programs.

Two advanced reactor technologies, the sodium-cooled fast reactor and the very high temperature gas-cooled reactor are being developed. Modern designs emphasize inherent features to prevent accidents. The safety approach and resulting performance for each reactor type will be explained. In addition, the potential impact on environmental assessment for siting and accident response will also be explored.

Both advanced aqueous and electrochemical technologies are being considered for used-fuel processing; the used fuel is separated into product streams and valuable materials are recovered for recycle as new nuclear fuel. Treatment of both existing spent light-water reactor fuel and advanced reactor fuels must be considered. In this presentation, the safety performance and regulatory limits of existing fuel-cycle facilities will be reviewed. The impact of technology options to improve recycle efficiency, restrict emissions, and improve safety will be identified.

A closed fuel cycle implies a vastly different strategy for spent-fuel handling and storage, compared to the current once-through fuel cycle. Furthermore, the spent-fuel processing system can be designed to provide optimized waste management strategies. In this presentation, key technology alternatives will be identified and safety and environmental impacts will be compared.

12:00 pm

Lunch

Abstracts: Monday, March 2

1:10 pm

Panel on International Perspectives on Future of Nuclear Power

Joseph C. Perkowski, *Moderator*
Idaho National Laboratory

Panelists:

Expanded Development and Use of Nuclear Energy: Important Way to Solve Environmental Pollution in China

Liu Senlin
China Institute of Atomic Energy

Ziqiang Pan
Chinese Radiation Protection Association

Coal-fired power is the main source of air pollution and greenhouse gas in China. To solve this issue, it is necessary to adjust the structure of power sources and reduce the percentage using coal-fired power. Developing a nuclear power station is the best way to resolve this issue.

Because of the large amount of discharged sulfur dioxide by the coal-fired chain, it has developed an acid rain zone in southern China including part of Zhe Jiang Province, most of Jiang Xi Province, central and north of Hu Nan Province, west of Guang Xi Province, east of Gui Zhou Province, and west of Chong Qing. The greenhouse gas rate of the coal-fired chain is about 1,300 g CO_2/KWh. The nuclear-power chain emission rate is about 13.7 g CO_2/KWh, 100 times less than for the coal-fired chain.

In the beginning of the 21st century, China has decided to actively develop nuclear power. In 2006, the State Council of China announced a 2020 nuclear power development program. The program states that by the year of 2020, we will achieve 40 GW_e with 18 GW_e more in development. By the end of 2008, we have 9.1 GW_e operating in China and 11.3 GW_e being constructed, with an approved-to-be-built reactor output of 23.9 GW_e. The total amount is 44.3 GW_e. It has exceeded our original 2020 plan. According to the current developing situation, we will achieve 70 GW_e before 2020 and 30 GW_e to-be-built. The estimation of some scholars indicates we may achieve 200 GW_e in China's nuclear power capability by 2030.

New Nuclear Power Stations in the United Kingdom

David Bennett
Environment Agency, United Kingdom

In May 2007 the U.K. government published a policy document, *Meeting the Energy Challenge*. It provided a framework for addressing U.K. future energy needs. As part of this it invited vendors of nuclear power plants to submit requests for Generic Design Assessment (GDA) to the nuclear regulators. Health and Safety Executive and the Environment Agency are the regulators for safety, security and environmental performance of any new nuclear power stations.

In June 2007 the government announced that four designs had met their criteria for being accepted for design assessment. The regulators formally started the assessment process for the four designs in August 2007.

The GDA process allows the nuclear regulators to assess new designs before an application to build and operate at a particular site is made. The early interaction allows regulators a better opportunity to influence vendors' designs. For vendors it provides an opportunity to reduce project risk by obtaining early regulatory approval and reducing overall time scales.

GDA is a structured, multi-step process spread over several years and is being carried out in an open and transparent manner. It is designed to be a rigorous and thorough process by which the regulators are carrying out their role in connection with new nuclear power station designs. The first stage of assessment has been completed. The regulators have concluded that there are no fundamental design aspects or shortfalls at this stage (in terms of safety, security or the environment) that would prevent any of the designs from ultimately being constructed in the United Kingdom.

The GDA process is setting high standards of openness and transparency with the creation of a public involvement process, which allows the public to view detailed design information on the web and comment, and by the decision to publish HSE and the Environment Agency's internal assessment reports. At the end of the GDA process, designs will not be issued with statements of acceptability unless the regulators' assessment criteria are met and appropriate safety, security, environmental and waste management standards can be assured.

There are a number of challenges associated with the GDA process. Much of the vendor documentation for the designs have been developed to meet regulatory systems in other countries. Inevitably these differ from those in the United Kingdom, which means that some of the documentation provided does not provide all the information needed by U.K. regulators. To maximize the benefit from other assessment work and ensure that missing information is provided, U.K. regulators are developing links with overseas regulators and also developing the vendors' understanding of U.K. regulatory needs.

International Perspectives on Nuclear Fuel Cycle

Alan Hanson
AREVA

It appears that the world is at the leading edge of resurgence in nuclear power as a source of electricity. In order to fuel the dozens of new reactors expected to be built, there will need to be new facilities for the mining, conversion, enrichment and fabrication of nuclear fuel. Following fuel irradiation, new facilities will also be needed to store, recycle and dispose of nuclear waste. Efforts are already underway to put in place the needed fuel-cycle facilities, but more will be needed.

Experience Feedback on Radiation Protection in Nuclear Power Generation: Japanese Perspective

Shojiro Matsuura
Japan Nuclear Safety Research Association

Shizuyo Kusumi
Nuclear Safety Commission, Japan

Nuclear power plants (NPPs) have been constructed continuously in Japan since the1960s and currently 55 commercial NPPs are in operation. Simultaneously, efforts are made to establish fuel-cycle related installations based on the nation's policy on spent-fuel recycling and there exist 12 such installations including one under construction. Furthermore, an experimental sodium-cooled fast reactor (SFR) named "Joyo" and a prototype SFR, "Monjyu" were built, as well as a high temperature gas-cooled engineering test reactor.

Meanwhile, evolutionary advanced light-water reactors (LWRs)—advanced boiling water reactor (ABWR) and advanced pressurized water reactor (APWR)—were developed in the country. In a national project called "LWR Improvement and Standardization Program," the Japanese government assisted the development of the evolutionary reactors through such activities as establishing the development targets, conducting various verification tests for the new or improved systems and components, and evaluating the LWRs. The evolutionary LWRs have been in operation or in preparation for construction already. In April 2008, Japan launched the Next Generation LWR Development Program as a national project for further advancement in LWRs. Furthermore, public and private sectors are actively developing innovative reactors such as SFR and very high temperature reactor (VHTR) which are also selected as Generation IV reactors in the Generation IV International Forum.

In the above mentioned "LWR Improvement and Standardization Program," which began in 1975, "reduction of radiation exposure of NPP workers" was one of the main objectives. Various improvements have been realized in Phase 1 and Phase 2 of the program. Making many fundamental improvements from the design stage of the evolutionary LWRs in Phase 3 (started in 1981), it was shown that yearly NPP workers collective dose can be as low as 0.5 person-Sv in ABWR and APWR.

For operating reactors, including those constructed in the 1960s and 1970s, collective dose data of NPP workers are evaluated. The exposure reduction measures for operating reactors are discussed in terms of reactor water chemistry.

For future advanced reactors, general and specific considerations needed for exposure reduction at the design stage are summarized. Based on the operating experience of Jyoyo, Monju and the High Temperature Test Reactor, general radiation protection characteristics of SFR and VHTR are summarized. Finally, based on the Japanese experience, selected topics and issues relevant to radiation protection of future nuclear power generation are briefly presented.

Nuclear Energy in the United States

Alexander Marion
Nuclear Energy Institute

Today in the United States, 104 nuclear power plants in 36 states generate nearly 20 % of the nation's electricity with a high level of safety and reliability at a low cost. The focus on safety remains first and foremost, with continued excellence and positive trends as measured by industry and regulatory performance indicators related to nuclear, radiation and industrial safety.

In 2007, the plants continued to perform well, turning in new records for output and capacity factors. Production costs continue to be the lowest of any source of electricity.

In March 2000, the U.S. Nuclear Regulatory Commission (NRC) began to approve 20 y renewals of nuclear power plants' 40 y operating licenses. This allows those plants that have compiled detailed applications and undergone rigorous review to operate for a total of 60 y. Since then, NRC has approved license renewals for 49 nuclear reactors. To date, the owners of 99 nuclear units have decided to pursue license renewal, and more are expected to follow suit.

Nuclear energy is the only major source of base-load electricity generation that does not emit criteria air pollutants or greenhouse gases. As discussions of both tighter emissions controls and greenhouse gas reductions continue at the national, state and regional levels, nuclear energy's environmental benefits take on more significance. In 2007 alone, operating nuclear power plants prevented the emission of three million tons of sulfur dioxide and one million ton of nitrous oxide. Nuclear energy is perhaps even more important when considering carbon dioxide emissions, with nuclear plants preventing emission of 693 million metric tons in 2007.

The U.S. nuclear power industry continues to make progress toward the construction of new nuclear power plants in the United States. To date, companies have submitted 17 license applications to NRC for 26 new reactors. The U.S. Department of Energy has received 19 applications for federal loan guarantees, representing 21 new reactors and loan guarantees of 122 billion dollars.

Given the current business environment, a reasoned perspective on the "renaissance" of nuclear power suggests that it will unfold slowly over time. A successful nuclear renaissance will see, at best, four to eight new plants in commercial operation by 2016 or so. The exact number will, of course, depend on many factors—electricity market conditions, capital costs of nuclear and other base-load technologies, commodity costs, environmental compliance costs for fossil-fueled generating capacity, natural gas prices, customer growth, customer usage patterns (which would be heavily influenced by lower economic growth), availability of federal and state support for financing and investment recovery, and more.

If those first plants are completed on schedule, within budget estimates, and without licensing difficulties, a second wave could be under construction as the first wave reaches commercial operation. The confidence gained by completing the first projects on time and within budget estimates will support the decision-making process for the follow-on projects, and provide incentive for companies to invest in the expansion of the U.S. nuclear component manufacturing sector.

2:40 pm **Break**

Infrastructure Needs for Future Nuclear Power

Patrice M. Bubar, *Session Chair*
U.S. Nuclear Regulatory Commission

3:00 pm **Radiation Protection at U.S. Nuclear Power Plants: Today and Tomorrow**
Michael Blevins
Luminant Power

The nuclear power industry work ethic and culture is founded on learning from experience and continuously finding ways to improve performance; especially in regard to radiation safety. Over the past 25 y, this process of continuous improvement has yielded dramatic results in regard to radiation protection of workers, the public, and the environment. In light of the resurgence of nuclear energy in the United States, the nuclear power industry is developing strategies to achieve step change improvements to performance and address emerging challenges in the area of radiation protection.

In the area of occupational radiation safety, every plant has a well-developed program for maintaining radiation exposures as low as reasonably achievable (ALARA) that involves all levels of plant workers, radiation protection staff, site management, and company senior management and executives. Work to be performed in a radiologically-significant area is planned, staged and carried out in a manner that will ensure a high degree of radiation and industrial safety and minimize radiation exposures. Following completion of the work, post-job reviews are conducted with the workers to identify lessons learned and plan further improvements for the next time the work is scheduled.

The dose reduction results that have been achieved through this process of continuous improvement have been dramatic. In the past 25 y, the average annual collective dose per reactor was reduced from 7.74 to 1.06 mSv, a sevenfold decrease. At the same time, average annual measurable dose per worker was reduced from 6.6 to 1.4 mSv, more than a fourfold decrease. In the area of industrial safety, the results have been equally dramatic, with a threefold decrease achieved in the industrial safety accident incidence rate over the 10 y period from 1997 to 2006, from 0.38 per 200,000 worker-hours to 0.12. For perspective, the incidence rate for office workers in 2006 (1.7 per 200,000 worker hours) was more than 10 times that for nuclear power plant workers.

Similar results have been achieved and sustained in regard to minimizing public dose from radiological effluents from nuclear power plants. Conservatively estimated doses are a small fraction of regulatory radiation dose limits and are well below regulatory criteria that define ALARA. In addition, nuclear power plants have established programs for ecological stewardship that are reflective of the fundamental compatibility of nuclear power as an energy source with the goals of conservation and protection of the environment.

In consideration of the extended operating period of the current fleet of nuclear power plants and in anticipation of building and operating new plants, the nuclear power industry has formed a working group of utility company executives and nuclear power plant radiation protection program managers to develop industry strategies to prepare for the future and address emerging challenges in radiation protection. The name given to the effort is “RP 2020,” to characterize a planning time frame through the year 2020 that will encompass the period in which the first wave of new nuclear power plants are expected to commence operation.

The working group concluded that simply improving the existing programs and processes would ultimately fall short of what is needed to address emerging challenges, so the mission of RP 2020 has been aimed at “reshaping” radiological protection at nuclear power plants.

The initial focus of RP 2020 (in 2008 to 2009) is on developing and implementing strategies in the area of occupational radiation safety. Examples of strategies that are being pursued include the following:

- reform radiation protection regulations to become more focused on results, rather than process;

- significantly reduce radiation fields that are accessed by workers in the plant;
- improve technologies utilization to facilitate remote monitoring and worker self-protection;
- redefine the roles, skills and qualifications for radiation protection staff;
- improve worker and public access to radiation protection information; and
- standardize radiation protection practices.

In 2009 to 2010, the nuclear power industry will focus on the development of strategies that address public radiation safety and protection of the environment.

3:25 pm

World Nuclear Association's Worldwide Overview on Front-End Fuel-Cycle Growth and Health, Safety and Environmental Issues

Sylvain Saint-Pierre
Steve Kidd
World Nuclear Association

This presentation first presents the World Nuclear Association (WNA) worldwide nuclear industry overview on the anticipated growth of the front-end fuel cycle from uranium mining to conversion and enrichment, and on the related key health, safety and environmental (HSE) issues. This presentation subsequently puts an emphasis on uranium mining in new producing countries with insufficiently developed regulatory regimes that pose greater HSE concerns. It introduces and describes the new WNA policy on uranium mining: sustaining global best practices in uranium mining and processing, principles for managing radiation, HSE, which is an outgrowth of an International Atomic Energy Agency cooperation project that closely involved industry and governmental experts in uranium mining from around the world.

Given the expected expansion of nuclear power over the coming decades, world uranium production must grow quickly in order to meet increasing demand. Production in the existing major uranium producing countries, such as Canada and Australia, will be expanded, but the most significant increases are likely to come from Kazakhstan. *In situ* leaching (a recovery technique led by the Kazakh operations and used elsewhere) is expected to represent a greater share of uranium production. That said, conventional mining (open-pit and underground mines) is expected to remain dominant. Uranium production is also likely to start in some new countries, mainly in Africa. Conversion facilities will be expanded to cope with rising demand, with complete replacement of the present plant in France (AREVA). The most significant feature in enrichment will be the gradual replacement of the older gas diffusion facilities in France (AREVA) and the United States (Usec) by heavy investment in gas centrifuge facilities. Elsewhere, both Urenco and the Russians will likely expand their existing centrifuge capacities. General Electric has invested in the SILEX laser enrichment technology and will try to commercialize it within the next 5 y.

Concerning HSE issues, no key issues are foreseen in connection to the global expansion of conversion and enrichment. In fact, the upgrades of existing and new plants are expected to deliver greater HSE performance. Beyond this, one of the most notable improvements no doubt arises from the change of enrichment technology from older hugely energy hungry gas diffusion enrichment plants to low energy consumption centrifugation enrichment plants. Concerning uranium mining, current HSE performance is expected to continue improving in current uranium producing countries which benefit from well-established regulatory regimes. Real HSE challenges point rather at new uranium producing countries with insufficiently developed regulatory regimes. Recognizing that managing radiation, health and safety, waste, and the environment is paramount, the worldwide community of uranium mining and processing recently issued the above stated new WNA policy on uranium mining which reflects the global industry commitment by setting out common, internationally-shared principles in these fields that are applicable to sites throughout the world. This new policy serves as a key worldwide reference to establish suitable policies and infrastructures at the world, region and national levels.

3:50 pm

Reactor Based Management of Used Nuclear Fuel: Assessment of Major Options

Phillip Finck
Idaho National Laboratory
Robert Hill
Argonne National Laboratory
John Kelly
Sandia National Laboratory
Roald Wigeland
Idaho National Laboratory

In recent years and throughout the world, concerns about global warming and energy security have prompted a reassessment of the benefits of the nuclear option, with significant plans to deploy new reactors. Simultaneously, pathways for disposing of used nuclear fuel have not yet been deployed. Partitioning of used fuel and transmutation of certain fission products and actinides has been assessed to provide a more sustainable approach to used-fuel management.

We have assessed conventional management schemes, such as the use of mixed-oxide fuel in light-water reactors, and advanced schemes, such as the transmutation of minor actinides in fast reactors. More advanced schemes, such as the use of deep-burn options in advanced thermal reactors have also been assessed.

These options are being compared on several key criteria, including better utilization of repository space, reduction of radiotoxicity, potential consequences on the public, investment and deployment strategies, and long-term energy sustainability issues, including concerns about proliferation of nuclear materials.

This comparison indicates that several technologies, or combination of technologies in advanced systems offer potential for improving all measures simultaneously. Nevertheless, few of these technologies have reached sufficient technical maturity to be deployed today; furthermore, recent progresses in basic sciences and advanced modeling and simulation offer the opportunity to develop novel approaches that will leapfrog current technologies and provide significant improvements for the key criteria described earlier.

This presentation will review these comparisons and propose pathways for a systematic development of the technologies.

The data suggesting this conclusion will be presented.

4:15 pm **International Safeguards and the Global Expansion of Nuclear Power**

Thomas E. Shea
Pacific Northwest National Laboratory

Nuclear power is in the minds of many national energy planners today, so many that the Director General of the International Atomic Energy Agency, Mohammed El Baradei, has lost count. For the nuclear renaissance to reach to the far corners of the world, new reactors and new deployment arrangements will help to realize these ambitions. This presentation will address the interest, the means through which that interest might be realized, and the challenges that expansion poses. It will focus on how to manage the proliferation risks, how international safeguards might address the verification requirements, and in particular, how assurances of supply of critical goods and services (especially addressing fuel supply and spent-fuel disposition) may reinforce international efforts to prevent proliferation and nuclear terrorism.

4:40 pm **Break**

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

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

Robert L. Brent
Alfred I. duPont Institute

Radiation Epidemiology: The Golden Age and Remaining Challenges

John D. Boice, Jr.
Vanderbilt University, School of Medicine, International Epidemiology Institute

Although the history of radiation epidemiology spans nearly 100 y, it was not until about the mid-1950s that radiation doses were estimated and organ-specific risks quantified in cohort studies. The major studies during the golden age of radiation epidemiology include the atomic-bomb survivors, radium dial painters, underground miners, ankylosing spondylitis patients, cervical cancer patients, children x rayed prenatally, children irradiated for benign conditions, women with tuberculosis fluoroscopically monitored, women with mastitis, patients given Thorotrast®, and patients treated with radiation for a variety of malignant and nonmalignant conditions. These studies remain the foundation of our understanding organ-specific radiation risks and are considered by the various national and international committees when making recommendations for radiation protection of workers and the public. During the past 50 y, there was a shift in emphasis from the study of genetic or heritable effects to somatic effects in the individuals exposed—since no study had found convincing evidence for genetic effects in man. Radiogenic cancers were identified at lower and lower doses providing support for the linearnonthreshold model used in radiation protection. The increased radiation exposure to the world's populations has also reinforced the need for knowledgeable scientists to provide balanced evaluations of risks so that benefits are not unduly curtailed. The world continues to need nuclear power for electricity; and medical imaging (computed tomography and positron emission tomography scans) has catapulted medical radiation to the number one contributor to population exposures, surpassing natural background. Below are five studies that exemplify the golden age issues and future opportunities for radiation epidemiology.

1. Breast cancer was increased after repeated chest x-ray fluoroscopies to monitor lung collapse treatments of young women with tuberculosis. Fractionated, though high dose rate, exposures resulted in similar breast cancer risks as acute exposures and the dose response was linear. Lung cancer and leukemia and heart disease, however, were not increased.
2. Cervical cancer patients were at a much lower risk of leukemia than atomic-bomb survivors, indicating that cellular killing predominates over cell transformation when high radiotherapeutic doses are delivered to small volumes of tissue. Cancers of other organs, such as the rectum and bone, appear increased only after enormous radiotherapy exposures. Some organs, such as the stomach and pancreas, receive low dose scatter and provide evidence for and against radiation effects at nontherapeutic dose levels.
3. An association between prenatal x-ray exposures and childhood cancers has been repeatedly found in case-control studies. Despite the absence of individual dose reconstructions, these studies are put forward as demonstrating low dose radiation effects. Such claims, however, are not entirely well-founded. No cohort study has revealed an increase in childhood cancer following *in utero* exposure. The remarkable similarity (in case-control studies) in all the relative risk estimates for all the different childhood cancers (all ~1.5) suggests a bias, as does the unlikelihood that embryonic tumors such as Wilms would be induced following a pelvimetry x ray given just a week or so before birth. *En passant*, studies of populations living near nuclear installations in the United States and other countries have not confirmed a causal association between radiation exposures and childhood leukemia—any possible exposures are likely small.
4. Studies of underground miners around the world have clearly demonstrated that radon is a lung carcinogen; the linearity of the dose response in all cohort studies is noteworthy as is the absence of elevations in other cancers. Studies of indoor radon support an association at low doses, but risk estimates for protection purposes remain focused on the robust underground miner data at low radon concentrations.
5. Finally, radionuclide intakes by workers exposed in the 1950s and 1960s are being incorporated into epidemiologic studies following comprehensive dose reconstructions such as among Pratt and Whitney Rocketdyne® workers exposed primarily to uranium compounds. Organ-specific dose from internal radiation accrues over time and is the proper metric for risk analyses, and not effective dose (a radiation protection quantity).

So what are the challenges remaining for epidemiology? While we know that radiation causes cancer, there are a surprising large number of cancers for which an association with radiation is not convincing. These include cancers of the cervix, uterus, testes, prostate, pancreas and kidney, and blood disorders such as chronic lymphocytic leukemia, Hodgkin and non-Hodgkin lymphoma, and multiple myeloma. The ameliorating effect of lowering the rate of exposure over time needs to be convincingly demonstrated for specific cancers. Lumping all cancers together for inferences may be useful for radiation protection but is of questionable biological validity; thus more pooled analyses of specific organs should be encouraged. Finally, more knowledge is needed on the effects of intakes of radionuclides and on possible noncancer effects.

6:00 pm **Reception in Honor of the Lecturer**

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Tuesday, March 3

8:20 am **NCRP Annual Business Meeting**

9:20 am **Break**

Key Challenges to be Addressed for Nuclear Power in the 21st Century

Audeen W. Fentiman, *Session Chair*
Purdue University

9:40 am **Essential Infrastructure: National Nuclear Regulation**
Carl J. Paperiello
U.S. Nuclear Regulatory Commission (retired)

In order for nuclear power to expand to many countries that do not currently have it, it will be essential for these countries to have laws, regulations, guidance and organizations that can license or permit nuclear power plants and support nuclear facilities, ensure compliance by inspection, and enforce nuclear regulations. These are necessary both because the viability of nuclear power worldwide depends on an extremely high level of safety, and compliance with a number of international treaties is required before nations will supply the material, hardware and software to build and operate nuclear power plants. While infrastructure support can be obtained from the International Atomic Energy Agency (IAEA) and other countries, an essential core must exist in the country seeking to establish domestic nuclear power generation. Further, while some reliance can be placed on the safety reviews of standard reactor designs by the nuclear regulators in supplier nations, the certification of fuel design, the quality of instruments, and the matching of the reactor to a proposed site in the importing nation will require site-specific reviews. National arrangements are also needed for emergency preparedness, environmental protection, transportation and the storage of fuel, and transportation and disposal of radioactive waste. Furthermore, even if foreign contractors and consultants are engaged to perform much of the technical work for the regulatory body that has to be performed by the importing nation, that nation must have a core cadre of technically knowledgeable regulators and an organization to provide management and oversight of the contractors and consultants. These technical skills encompass a broad range of engineering disciplines, not just nuclear engineering, earth sciences, environmental sciences, radiation protection, physical security and material control, and accountability to identify a few. IAEA has a number of programs to support the development of national nuclear regulatory infrastructures. These programs address: nuclear safety standards, nuclear installation safety, radiation safety, the safety of radioactive waste management, decommissioning, safety and security of radioactive sources, incident response and emergency preparedness, and training and education relative to these areas. Consistency in national nuclear regulations and requirements, the deployment of standardized nuclear power plant designs, and standardized supporting material infrastructure can promote the safe and secure worldwide growth in nuclear power.

10:05 am

Maintaining a Highly-Qualified Nuclear Industry Workforce

Carol L. Berrigan
Nuclear Energy Institute

Despite nuclear power's vital role in the U.S. economy, the nuclear utility industry faces the same staffing challenges as the rest of the utility workforce and the American workforce at large. Aging demographics play a role in human resource concerns. However, the commonalities of the fields that are hiring reveal that the labor market is tightening. Companies must prepare for increased competition for qualified and experienced workers and craftspeople.

Overall, the nuclear industry is responding to this challenge. The 2007 Nuclear Energy Institute Workforce Survey indicates that industry efforts are translating into an increasing number of young employees at nuclear vendors and within the nuclear utilities in the engineering and operations fields. There is an increased focus across the industry on developing maintenance staff, radiation protection technicians, and other specialized personnel as new educational programs and partnerships are developed.

With expanded staffing requirements to support new nuclear plants, growing competition from other sectors, and increasing attrition rates of current employees due to retirement and other attrition, the nuclear industry must continue to expand its aggressive efforts to maintain its highly-qualified staff today and develop its future workforce.

The nuclear industry has responded to workforce trends. It has engaged organized labor, government, educational institutions, and nonprofit organizations. These collaborations have had many positive results from development of national demand projections for technicians, power plant operators, and engineers to increasing awareness of nuclear careers among teachers, students and workforce development professionals.

Recruitment efforts across the industry have been enhanced, increasing the number of new hires in several disciplines and targeting untapped labor pools like veterans and minorities. Industry-based curricula and new educational programs have been created and deployed to develop local talent pools. Policy makers have also been engaged at the national, regional and local levels to increase career awareness and allow the industry to leverage its workforce development investments with the public sector funds. In addition, industry has begun a systematic engagement with the public workforce and education systems to ensure that the energy and construction sectors are viewed as a priority in state-based workforce development and education programs.

In addressing the workforce issue, the nuclear power industry is pursuing these key goals:

- systematically assess industry staffing requirements;
- develop and promote programs to increase the quality and quantity of the available workforce;
- develop and deploy programs, tools and techniques to retain and recruit employees; and
- develop and deploy programs to provide additional resources to educate and train employees.

Across industry, government and nonprofits, nuclear industry activities are succeeding and continue to evolve. The examples and good practices outlined in this presentation demonstrate how collaboration helps to align investments, build career awareness and image, and lay the foundation to recruit and train workers within the nuclear field and across the broader energy industry.

10:30 am **Break**

10:45 am **U.S. Department of Energy Facilities Needed to Advance Nuclear Power**
John F. Ahearne
Sigma Xi

Based on several reviews of existing U.S. Department of Energy (DOE) facilities, many high-priority facilities require moderate to significant investment before they can provide the capabilities needed by the DOE Office of Nuclear Energy. The studies show the importance of emphasizing international collaboration, especially with respect to longer-term, high-cost research and development goals, such as in developing recycling and fast-reactor capabilities. A depressing story was revealed of decayed or decaying facilities that in most cases are not suited for their intended uses without significant and often expensive refurbishments. However, even if aggressive new power plants and advanced programs do not proceed, the United States needs a robust set of nuclear research facilities. International collaborations should be increased, especially in the current climate of stringent budgets.

Some research and development programs would be the same whether there are no new builds, a few builds, or many builds. Research and development is needed:

- to keep current plants running well and avoid any surprises, including aging phenomena;
- to encourage a new cadre of engineers and scientists to become involved in nuclear energy;
- on waste management; and
- to maintain the United States as a major participant in international nuclear power discussions.

11:10 am

New Nuclear Build and Evolving Radiation Protection Challenges

Edward Lazo
OECD Nuclear Energy Agency

Radiological protection has continued to evolve in order to meet emerging challenges and will continue to do so. This presentation will discuss the scientific and social challenges that will or may be faced by the radiological protection community in the coming 10 to 20 y, and will discuss how these challenges may affect what is expected to be a renewed interest in building and operating nuclear power plants for electricity generation.

11:35 am

Communicating with Stakeholders about Nuclear Power Plant Radiation

Ann Stouffer Bisconti
Bisconti Research

A national public opinion survey taken on September 18–21, 2008 for the Nuclear Energy Institute added new insights about perceptions of radiation and radiation from nuclear power plants, as well as effective strategies for communicating with stakeholders. Bisconti Research conducted the survey with the GfK Group, based on telephone interviews with a nationally representative sample of 1,000 U.S. adults, margin of error of plus or minus three percentage points.

Perceptions of Radiation

The survey found that misperceptions about radiation persist and have changed little over the past 18 y. Most Americans understand that we receive radiation from nature, but almost half of them still believe that radiation from nuclear power plants is more harmful than the same amount of radiation from the sun. Almost half also believe that any amount of radiation is harmful. One-third of Americans do not know that radiation is easily detected and measured.

Perceptions of Radiation from Nuclear Power Plants

The survey repeated a question from 1991 about which of six activities would expose a person to the most radiation, including “living next to a nuclear power plant for a year.” The largest number chose chest x ray (38 %). Those ranking the nuclear power plant first dropped from 58 to 30 % (a 28 percentage-point drop). Also, 41 % said it is likely that people living next to a nuclear power plant are exposed to harmful levels of radiation, compared with 58 % in 2001. These improvements may be due to increased public support for nuclear energy resulting from growing awareness of the need for nuclear energy and its benefits. As of September 2008, 74 % favored the use of nuclear energy. Need trumps fear.

Messages about Radiation from Nuclear Power Plants

The survey tested messages about radiation from nuclear power plants in three ways: emotional appeal, rational appeal, and analogies to put the amount of radiation in perspective. Best points communicate how radiation is controlled and about the many beneficial uses of nuclear technologies. Talking about beneficial uses makes the nuclear technologies more familiar and communicates the ability to control radiation. As in past research, analogies are more effective with men than with women. The messages altogether had a 10-point impact on attitudes. Credibility of the spokesperson may be essential to gain more extensive shifts away from ingrained beliefs about nuclear power plant radiation.

12:20 pm **Lunch**

1:30 pm **Role of the International Radiation Protection Association**

Kenneth R. Kase
Philip Metcalf
International Radiation Protection Association

Global concerns over energy supply and climate change have given rise to a noticeable increase in uranium prospecting, mining and extraction in a number of countries. Many countries are contemplating the introduction of nuclear energy and the changing world economy is spreading the use of advanced nuclear and radiation-related technologies to many parts of the world. International concerns over nuclear proliferation have given rise to global initiatives on nuclear energy and operation of nuclear fuel-cycle facilities. The emerging global nuclear safety regime, with binding international conventions continues to promote and encourage high standards of radiation safety worldwide. All these developments call for increasing capacity and capabilities in radiation protection expertise. These developments have and continue to present both challenges and opportunities to the International Radiation Protection Association (IRPA).

An association of 48 radiation protection societies representing 61 countries with an individual membership of approximately 17,000, IRPA is engaged in fostering the development of competent radiation protection programs in developing countries and mentoring the formation of new radiation protection societies. IRPA also fosters the exchange of scientific and technical information and provides a venue for interaction and communication among radiation protection professionals through its International Congresses on Radiation Protection, most recently in Buenos Aires in October 2008. Future congresses are planned for Glasgow in 2012 and Cape Town in 2016. Midway between these congresses, IRPA sponsors and assists member societies in holding regional congresses. In 2010, congresses will be held in Tokyo in May, Helsinki in June, Nairobi in September, and Medellin in October.

IRPA also promotes the scientific and professional recognition of the radiation protection expert. One significant step forward in this area has been the success of a petition by IRPA to the International Labor Organization to recognize and include radiation protection in the listing of recognized occupations. Linked to this initiative IRPA adopted a definition of the "radiation protection expert" and has proposed its inclusion in the revision of the International Atomic Energy Agency (IAEA) Basic Safety Standards that is currently underway. Related to this activity IRPA continues to engage with regional and international initiatives to harmonize approaches to qualifications and recognition by combinations of training, experience, examination and evaluation by peers. Continuing education and professional enhancement programs are a significant part of each IRPA congress. Close collaboration with the IAEA generally results in IAEA training events being scheduled in conjunction with IRPA congresses.

A number of other activities are designed to enhance the effectiveness of radiation protection practitioners in the implementation of nuclear technologies. Recognizing the ethical dimensions of the role played by radiation protection practitioners in the health and safety of persons working with radiation and of the public living near nuclear installations and facilities using radioactive materials or radiation generating devices, the IRPA Code of Ethics was developed and has been adopted or used by many associate societies. IRPA has embarked on the development of guidelines for the conduct of stakeholder engagement to address the importance of engaging stakeholders (people or organizations interested or affected by activities involving occupational or public exposure to radiation) and discussing radiation effects and risks as part of a decision-making process. IRPA recently began work on an initiative proposed by the French Society for Radiation Protection designed to maintain and improve current levels of radiation protection and transfer this culture to the new generation of radiation protection professionals. This is a multi-year project to develop guidance for maintaining and improving the radiation protection culture as part of an overall safety culture. The guidance would include standards for teaching, offer the basic tools needed, establish qualifications for radiation protection experts, and assist in forming radiation protection societies. These IRPA projects are discussed and refined through the Associate Society Forum discussions that are held at each IRPA international and regional congress.

1:50 pm

Panel on How to Meet the Challenges for Nuclear Power

Mary E. Clark, *Moderator*
U.S. Environmental Protection Agency

Panelists:

Nuclear Power Expansion: Challenges and Opportunities

Paul W. Lisowski
U.S. Department of Energy

Increases in demand for energy and growing concerns about climate change have started a substantial worldwide expansion of nuclear electric power. Nations with mature nuclear installations are working to maintain the existing high standards of safety and reliability and to address the challenges of maximizing plant lifetime and managing used nuclear fuel. Increased use of nuclear energy for unconventional applications such as desalinization and production of hydrocarbon liquid fuel from coal without concomitant carbon emissions are under consideration. Those efforts require increased infrastructure investment and, in some cases, research and development to successfully move ahead. Geologic repositories must be made available for used fuel and for the residual high-level radioactive waste from recycling. Nations moving towards initial nuclear power deployment must develop the intellectual, regulatory and technical foundations before construction and operation. For international security reasons, the expansion of nuclear power to new nations must avoid the need for indigenous enrichment or reprocessing facilities. For that reason essential elements of the expansion need to include reliable fresh fuel supply and used-fuel recovery together with enhanced material accountability and safeguards. In light of this, the United States launched the highly successful Global Nuclear Energy Partnership. The Partnership has developed a statement of principles to accomplish the above goals and has put in place a management framework used by 25 nations working to achieve safe, secure nuclear power expansion.

Future of Nuclear Power Worldwide: Safety, Health and Environment

Within the United States, the Advanced Fuel Cycle Initiative is successfully developing fuel-recycling technologies that increase utilization of reactor fuel, diversify our fuel supply, simplify management of used nuclear fuel, and reduce the long-lived waste radiotoxicity. Successfully completing the research and development necessary to initiate recycling in those areas will be vital to sustaining the U.S. long-term use of nuclear energy.

Three Most Important Actions for the Growth of Nuclear Power

Wayne L. Johnson
Pacific Northwest National Laboratory

There is broad and increasing recognition that nuclear energy must play a role domestically and internationally in meeting energy needs in the 21st century. Nuclear energy's growing acceptance is most often attributed to the fact that it is a base-load source of electricity which has virtually no carbon emissions and can help reverse the adverse impacts of global warming; however, it is also due to the greatly improved operational performance of reactors worldwide.

Despite the favorable conditions for the growth of nuclear energy, there is little agreement on the specifics of fuels, reactor types, fuel cycles, and waste disposal practices. Furthermore, the support for nuclear energy is fragile and could be hampered or derailed by even a minor accident, terrorist threat (real or hoax), cost or schedule overruns, or a number of other events. While it is absolutely necessary to do all we possibly can to prevent these events, or limit their direct impact, some negative events will invariably occur. Most major nuclear projects take up to 20 y from initial planning through design, licensing, construction and start up. What are the three most important actions which could be taken by government or industry in the next 4 y to provide a predictable and stable base for the global growth of nuclear power? Clearly there are a number of important actions to consider, including the timely licensing of future plants, capital cost reductions and the financing of new and advanced reactors, closing the fuel cycle with either light-water or fast reactors, the opening of a repository for radioactive waste disposal, prevention of nuclear proliferation, and of course, continued safe operation. National decisions will be important, but international institutions such as the International Atomic Energy Agency can also play an important role. This will identify a range of important actions for consideration, and then focus on the top three actions that are necessary, explain why, and elaborate on the impact each action will have.

How to Meet the Challenges Reinvigorating the Research and Development Community and Infrastructure

Mark T. Peters
Argonne National Laboratory

The world energy demand is increasing at a rapid pace. In order to satisfy the demand and protect the environment for future generations, future energy sources must evolve from the current dominance of fossil fuels to a more balanced, sustainable approach to energy production. The future approach must be based on abundant, clean and economical energy sources. Therefore, because of the growing worldwide demand for energy and need to minimize greenhouse gas emissions, there is a vital and urgent need to establish safe, clean and secure energy sources for the future. Nuclear energy is already a reliable, abundant and carbon-free source of electricity for the United States and the world. In addition to future electricity production, nuclear energy could be a critical resource for "fueling" the transportation sector (*e.g.*, process heat for hydrogen and synthetic fuel production, electricity for plug-in hybrid and electric vehicles) and for desalinated water. Nuclear energy must experience significant growth to achieve the goals of our future energy system. To allow the necessary growth, many challenges must be met, including a concentrated effort to rebuild the necessary nuclear enterprise, including a broad-based research and development (R&D) effort.

To reduce cost, ensure sustainability, and improve efficiency, safety and security, investments in a sustained nuclear science and technology R&D program are needed. Such a program must effectively support and integrate both basic and applied research and use, to the extent possible, modeling and simulation capabilities to address both near-term, evolutionary activities (*e.g.*, life extensions of the current fleet) and long-term solutions (*e.g.*, advanced reactors and fuel-cycle facilities). Industry will pursue evolutionary R&D to further improve efficiencies along each step of the current fuel cycle. It is incumbent upon the government to implement long-term R&D programs for developing transformational technologies and options for advanced nuclear fuel cycles. Including regulators in the research and evaluation of results will facilitate the development of licensing and regulation of future nuclear facilities and technologies.

Finally, training the next generation of engineers and scientists must be an integral part of a robust nuclear program. To satisfy the need, government and industry must both play important roles to stimulate workforce development by providing an environment that is exciting and thriving. Industrial and federal government commitment will be required to reinvigorate university and national laboratory programs. In addition, R&D infrastructure must include modern capabilities, such as irradiation systems for testing new fuels and structural materials; chemical separations and characterization capabilities; and physics facilities for radiation transport, thermo-hydraulics, cross-sections, and criticality science. These and other capabilities require modern facilities, as our current R&D infrastructure has atrophied and is becoming obsolete. Modeling and simulation technologies have made tremendous advances since the design of existing facilities. The design of the next-generation facilities must incorporate state-of-the-art testing and diagnostics tools and be guided by the data requirements for advancing the realism and accuracy of high-performance simulation tools and approaches.

Outlook for Nuclear Energy in a Shifting Political Climate

Annie Caputo
House Committee on Energy and Commerce

Driven by several positive factors, U.S. utilities have shown strong interest in building new nuclear plants for the first time in 30 y. These positive factors include passage of incentives in the Energy Policy Act of 2005, the increasing likelihood that the federal government may pass legislation limiting the emission of greenhouse gases, and the growing demand for electricity. While several of these positive factors remain, there are also many challenges including waste management, regulatory stability, and project financing. The new presidential administration, the economic crisis, and changing Congressional attitudes toward nuclear power will have a significant impact on the development of new plants. This presentation will attempt to give a snapshot of how new nuclear construction may fare in this shifting political climate.

Low-Level Radioactive Waste Management: Status, Challenges and Solutions

Michael T. Ryan
Michael T. Ryan and Associates, LLC

The historical foundations and future challenges for commercial low-level radioactive waste (LLRW) management in the United States will be presented. LLRW has been managed at government facilities since the beginning of the nuclear age and in the commercial sector since the early 1960s. Over the intervening years many technical, management and regulatory changes have occurred. Significant progress has been made in waste form, waste packaging, and in recognizing radionuclides important to performance of disposal technologies and disposal facilities. This presentation will examine approaches that can be used under existing regulations and risk-informed approaches to improve and clarify guidance used to develop and evaluate disposal facilities during the licensing process, operational phase, and ultimately during the closure of LLRW facilities. The management of LLRW has been successfully achieved in the commercial sector in the Unites States. Additional successes can be achieved by taking advantage of past operating experiences as well as continuing improvements in LLRW treatment, packaging and disposal technologies. Combining these successes and process improvements with risk-informed decision making can perhaps improve the management of these wastes while at the same time making the regulatory process more transparent for practitioners, stakeholders, and the public.

Challenges and Opportunities of a Global Nuclear Energy Future

Thomas Isaacs
Stanford University
Lawrence Livermore National Laboratory

Global warming, energy security, energy adequacy, and environmental protection are among the factors causing renewed attention to new nuclear power. Whether or not there will be what qualifies as a “nuclear renaissance” in the coming 20 y or so, it is quite likely that there will be a return to the construction of nuclear power plants. In some cases these programs will result in a growth of nuclear power within nations that already have operating plants. In other cases, it is likely that countries that currently do not have nuclear power plants or have very few will begin a program, resulting in the spread of facilities and expertise.

One of the concerns that arises, particularly with the envisioned spread of nuclear power is the potential impact on nuclear security. Will the potential for more opportunities for nuclear power raise more opportunities for nuclear proliferation, “latent” proliferation, regional instability, or acts of nuclear terrorism?

Much attention is being paid recently to the possible formulation of initiatives to provide assured fuel supplies to countries starting or adding to their nuclear capabilities. The principal rationale is to provide sufficient assurances that countries will have access to the fuel they need to run these plants for the 40 to 60 y they will be in operation. It is hoped that they will then be willing and able to forgo the development of indigenous enrichment capabilities needed to supply reactor fuel, since enrichment plants can bring nations to the doorstep of a nuclear weapons capability.

Though many have discussed in passing the need to also consider the "back end" of the nuclear fuel cycle, spent fuel, waste management, interim storage, reprocessing, and ultimate disposal, it has received much less attention to date. Yet this is likely to be the element of the fuel cycle with which most nations, and new nuclear nations in particular, will need and appreciate the most assistance.

Is it possible that by addressing all challenges associated with the entire fuel cycle together and throughout time, we stand a better chance of simultaneously meeting energy security, national security, nonproliferation, and waste management objectives than if we address these as separate issues?

3:15 pm **Break**

3:35 pm **Rapporteur Summary**
Michael L. Corradini
University of Wisconsin-Madison

4:15 pm **Questions and Comments from the Audience**

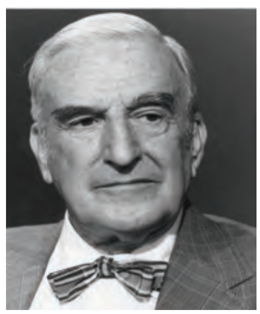
4:50 pm **Closing Remarks**
Thomas S. Tenforde
President, National Council on Radiation Protection and Measurements

5:00 pm **Adjourn**

Mission Statement

The National Council on Radiation Protection and Measurements (NCRP) seeks to formulate and widely disseminate information, guidance and recommendations on radiation protection and measurements which represent the consensus of leading scientific experts. The Council monitors areas in which the development and publication of NCRP materials can make an important contribution to the public interest.

The Council's mission also encompasses the responsibility to facilitate and stimulate cooperation among organizations concerned with the scientific and related aspects of radiation protection and measurements.



Lauriston S. Taylor
1929–1977

Warren K. Sinclair
1977–1991

Charles B. Meinhold
1991–2002

Thomas S. Tenforde
2002–

Recognized worldwide as an authority on radiation health protection for 80 years.

Program Committee

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Marvin S. Fertel	Carl J. Paperiello
Alan S. Hanson	Mark T. Peters
Ryoko Kusumi	Sylvain Saint-Pierre

Registration

Monday, March 2, 2009	7:00 am – 5:00 pm
Tuesday, March 3, 2009	7:00 am – 1:00 pm

(no registration fee)

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

2010 Annual Meeting

Communication of Radiation Benefits and Risks in Decision Making

March 8-9, 2010
Bethesda, Maryland

NCRP Publications

(http://NCRPpublications.org)

Future of Nuclear Power Worldwide: Safety, Health and Environment

Publication	Title	Price
Report No. 158	Uncertainties in the Measurement and Dosimetry of External Radiation	$ 145.00
Report No. 154	Cesium-137 in the Environment: Radioecology and Approaches to Assessment and Management	100.00
Report No. 138	Management of Terrorist Events Involving Radioactive Material	50.00
Report No. 127	Operational Radiation Safety Program	30.00
Report No. 120	Dose Control at Nuclear Power Plants	30.00
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Report No. 114	Managing Radiation Protection Records	30.00
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Commentary No. 19	Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism	30.00
Commentary No. 10	Advising the Public About Radiation Emergencies	20.00

Excerpts from reviews and correspondence related to NCRP reports:

"As an environmental health physicist, I found this report [NCRP Report No. 154] to be a very valuable compendium of essential technical and practical facts regarding the characteristics of ^{137}Cs in the environment."

M.L. Miller [published in Health Physics **93** (2007) 596]

"The report [NCRP Report No. 138] is directed particularly to expert groups and public authorities who will be responsible for coping with actual, potential and rumored releases of radiation."

"With commendable foresight, the NCRP initiated the committee some years ago with support from the U.S. Department of Energy, and its work was concluded prior to the terrorist attacks of September 11, 2001."

N. Wald [published in Radiation Research **158** (2002) 812-813]

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

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, 2008.

Contracts

- Centers for Disease Control and Prevention
- Defense Threat Reduction Agency
- U.S. Department of Homeland Security
- U.S. Department of Veterans Affairs
- U.S. Navy

Grants

- National Aeronautics and Space Administration
- National Cancer Institute
- U.S. Department of Energy

Contributors

- American Academy of Health Physics
- American Academy of Oral and Maxillofacial Radiology
- American Association of Physicists in Medicine
- American College of Medical Physics
- American College of Radiology Foundation
- American Industrial Hygiene Association
- American Nuclear Society
- American Osteopathic College of Radiology
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U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

The Role of a Strong Regulator in Safe and Secure Nuclear Energy

Dr. Peter B. Lyons
Commissioner
U.S. Nuclear Regulatory Commission

Warren K. Sinclair Keynote Address
2009 NCRP Annual Meeting
Bethesda, Maryland
March 2, 2009

NRC's Legislative Mandate

- **Atomic Energy Act (1954) as amended**
  - "Assure the adequate protection of public health and safety and the promotion of the common defense and security."
- **National Environmental Policy Act (1969) as amended**
  - "…to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Oversight

Uranium Mining

Uranium Conversion

Uranium Enrichment

Power Reactors

Transportation

Storage

Waste Disposal

Medical/Industrial

New Reactors

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

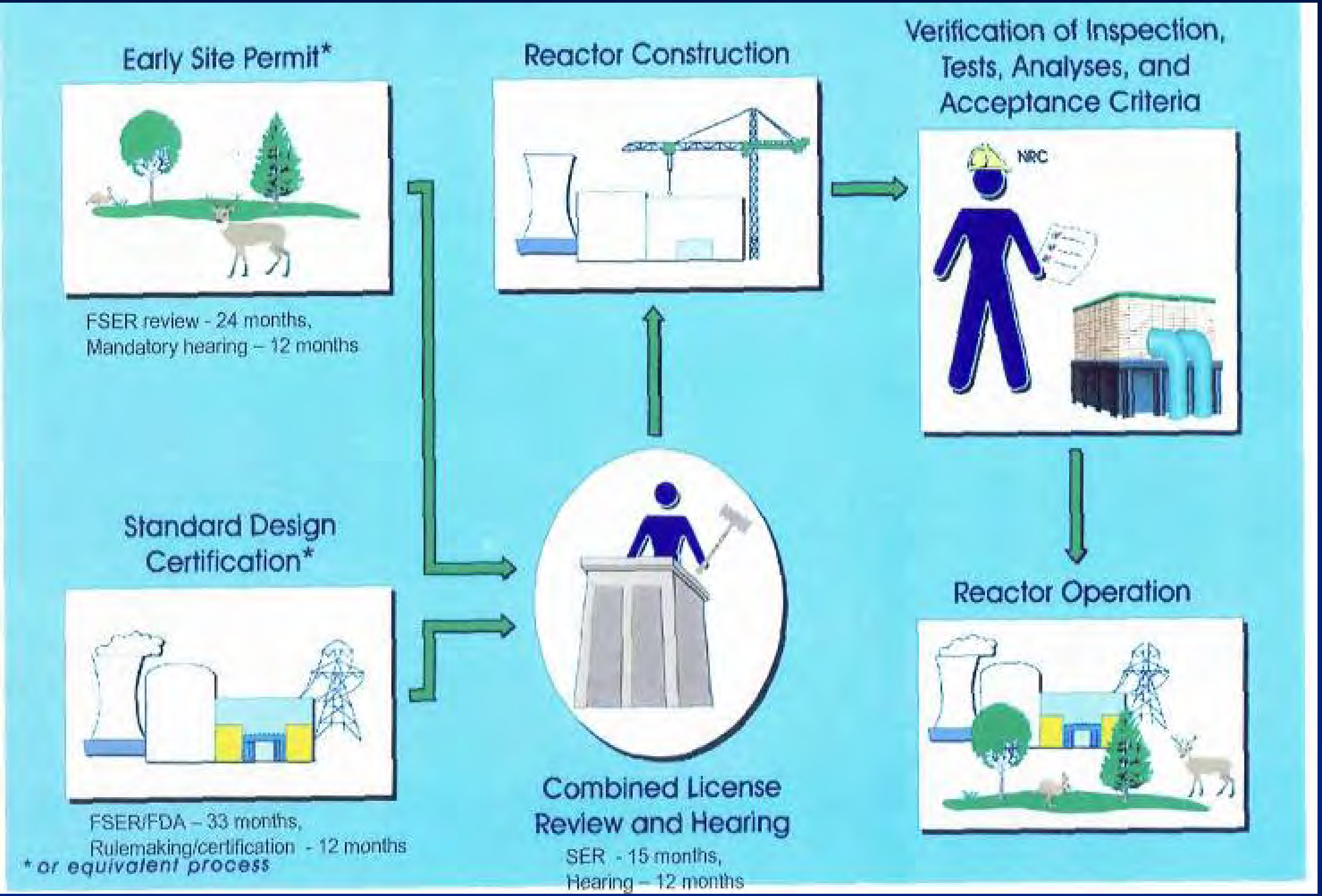
Open Communications

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

The Role of NRC in any Nuclear Renaissance Derives From The NRC Values

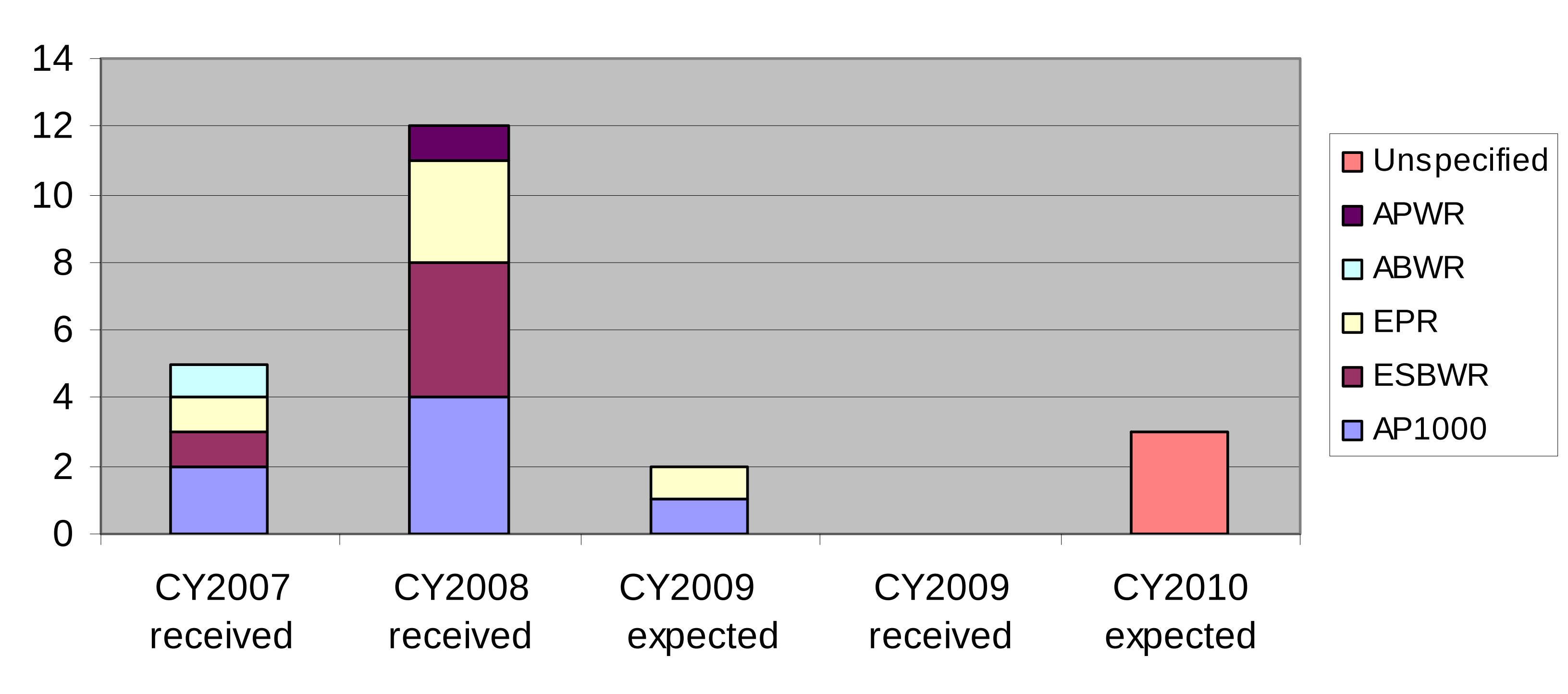
The safe use of radioactive materials and nuclear fuels for beneficial civilian purposes is enabled by the agency's adherence to the principles of good regulation—independence, openness, efficiency, clarity, and reliability. In addition, regulatory actions are effective, realistic, and timely.

10 CFR Part 52 Licensing Process



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

COL Applications Expected & Received



Valid as of January 2, 2009

Construction Inspection

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Design-Centered Reviews

- NRC staff's parallel review of multiple standardized COL applications
- Dependent on extent of industry standardization of COL applications
- Principle:

One Issue

One Review

One Position

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Modular Construction


Off-gas Equipment Module


Piping Unit in T-G Pedestal Module


CUW Heat Exchanger Module

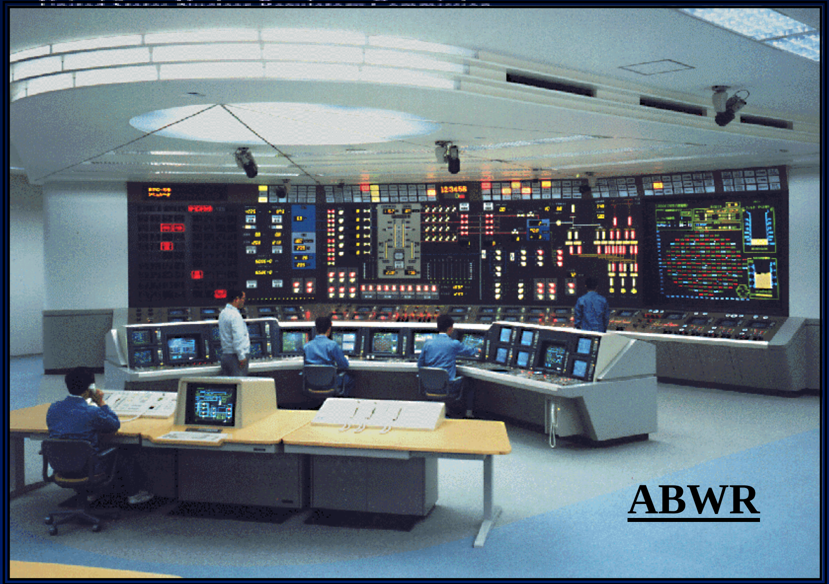

MSV/CV Module


Condensate Demineralizer Module


CUW Reheat Exchanger Module

U.S.NRC

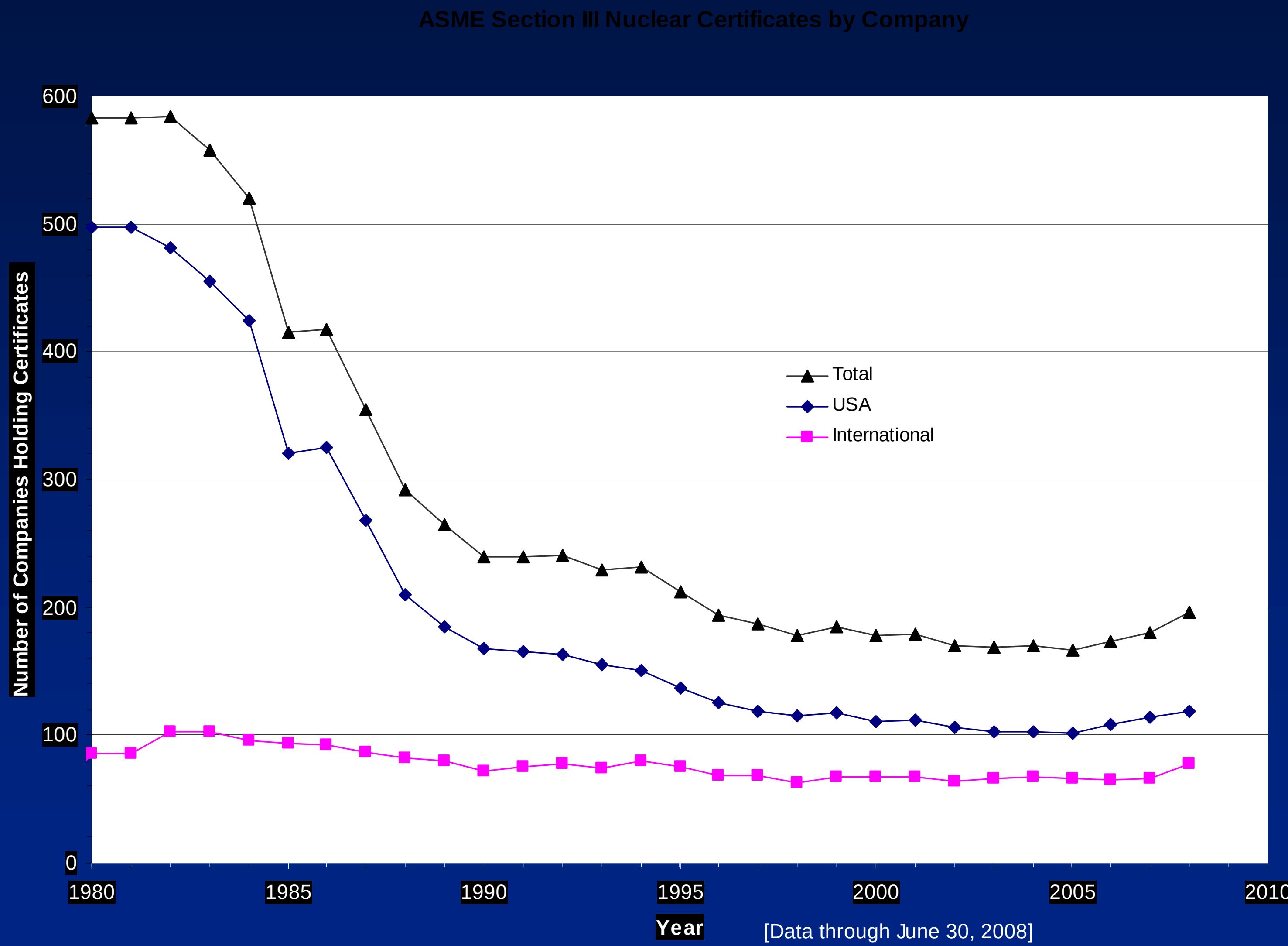
Digital Technology



Global Environment

- Global marketplace a reality – ABWR, EPR, AP1000, APWR
- International partnerships of regulators
  - Multi-National Design Evaluation Program (MDEP)
  - International Nuclear Regulators Association (INRA)
- Need for research:
  - International Test Facilities
  - Provide sound technical bases for decisions
- Lack of United States manufacturing base
- International industrial focus on safety
  - World Association of Nuclear Operators (WANO)

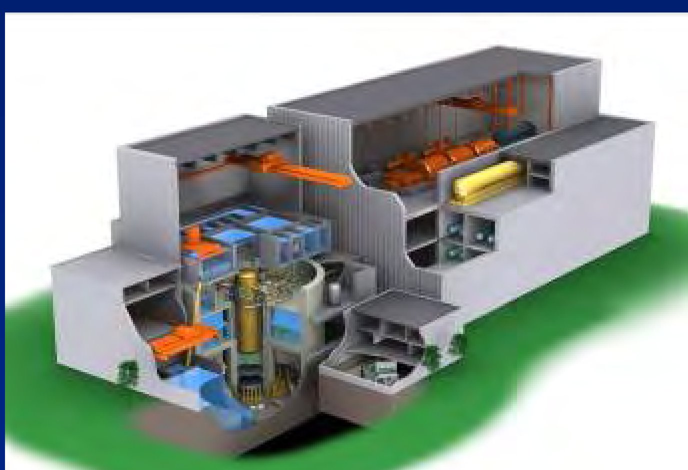
ASME Nuclear Certificate Holders



Safety and Security

Emergency Planning

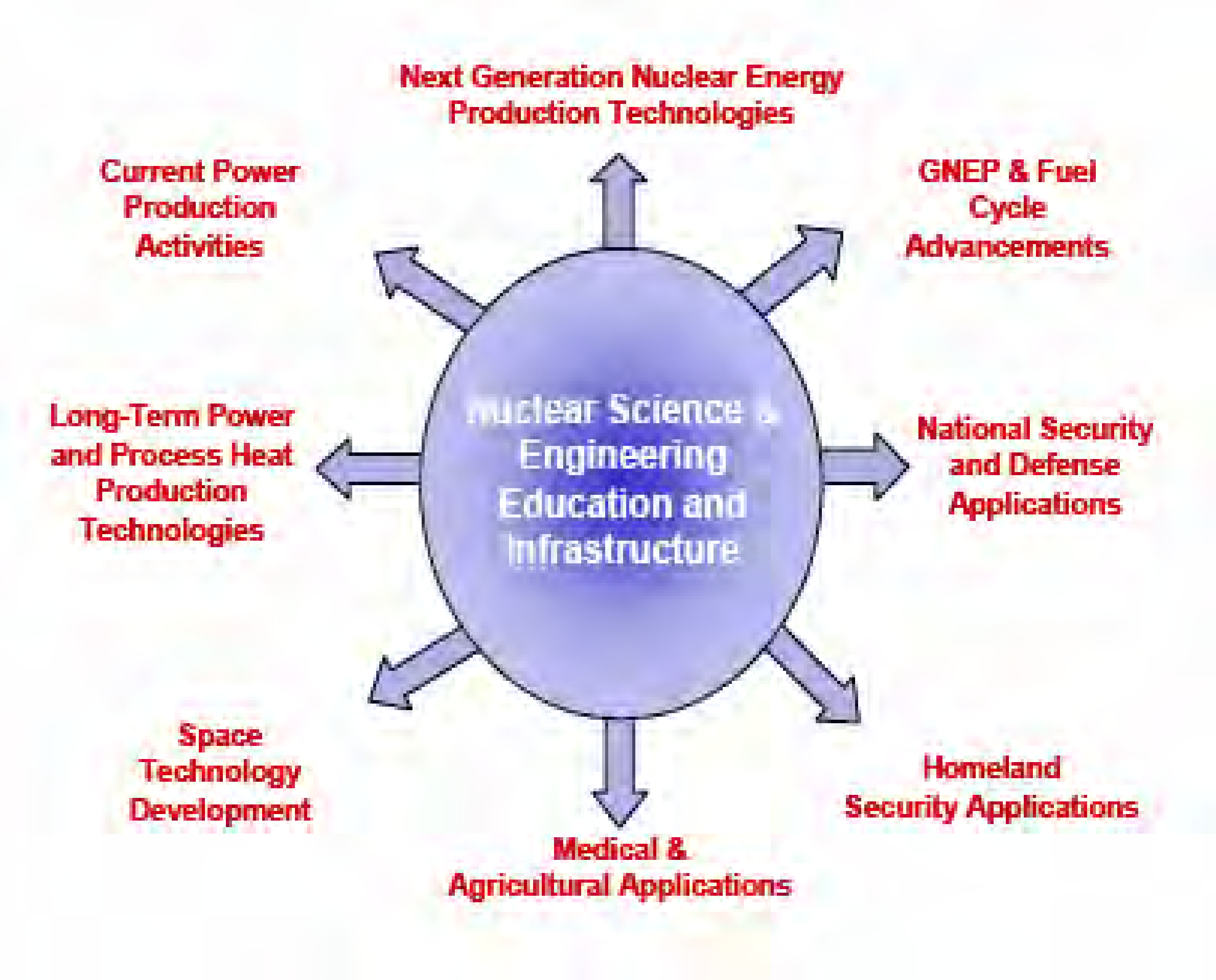
Security Features



Improved Passive Designs

Trained Guard Force

Nuclear Workforce Drivers



From: Nuclear's Human Element, ANS, 2006

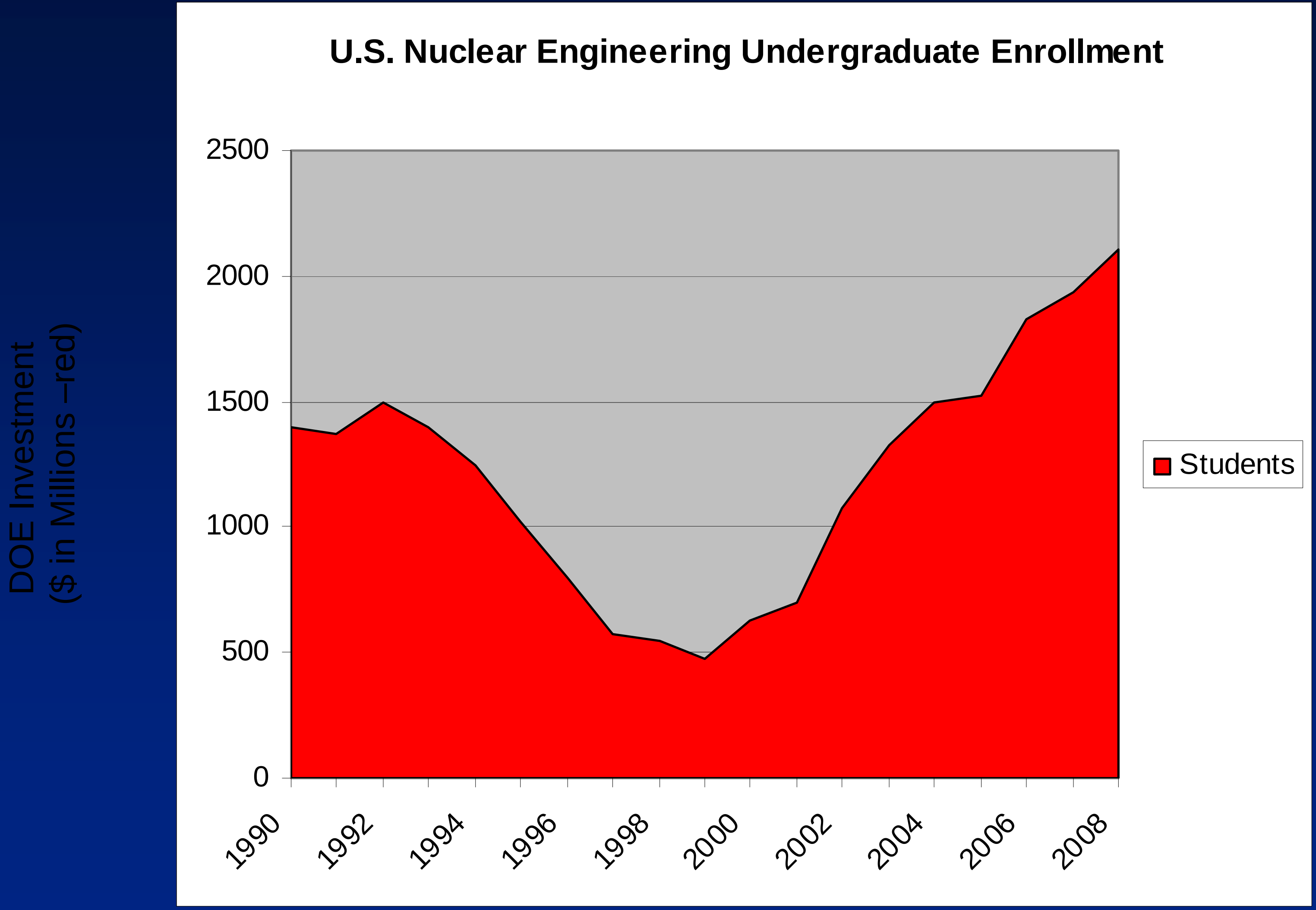
NRC Hiring Trends

Goal – increase net staff by 200 per year

Accomplishments

Fiscal Year	2006	2007	2008
Hired	371	441	521
Attrition	211	222	208
Net Gain	160	219	313

College Enrollment Trends



Source: DOE Survey, J. Gutteridge (2008)

U.S.NRC
United States Nuclear Regulatory Commission

Davis-Besse Reactor Head

NRC Inspectors

The Linear No-Threshold Model

HYPOTHESIS? **FACT?**

PRUDENT? **CONSERVATIVE?**

Implications

- **STEWARDSHIP OF PUBLIC FUNDS**
- **COLLECTIVE DOSE**
- **FEAR OF RADIATION**

NCRP: Research Needs[4]

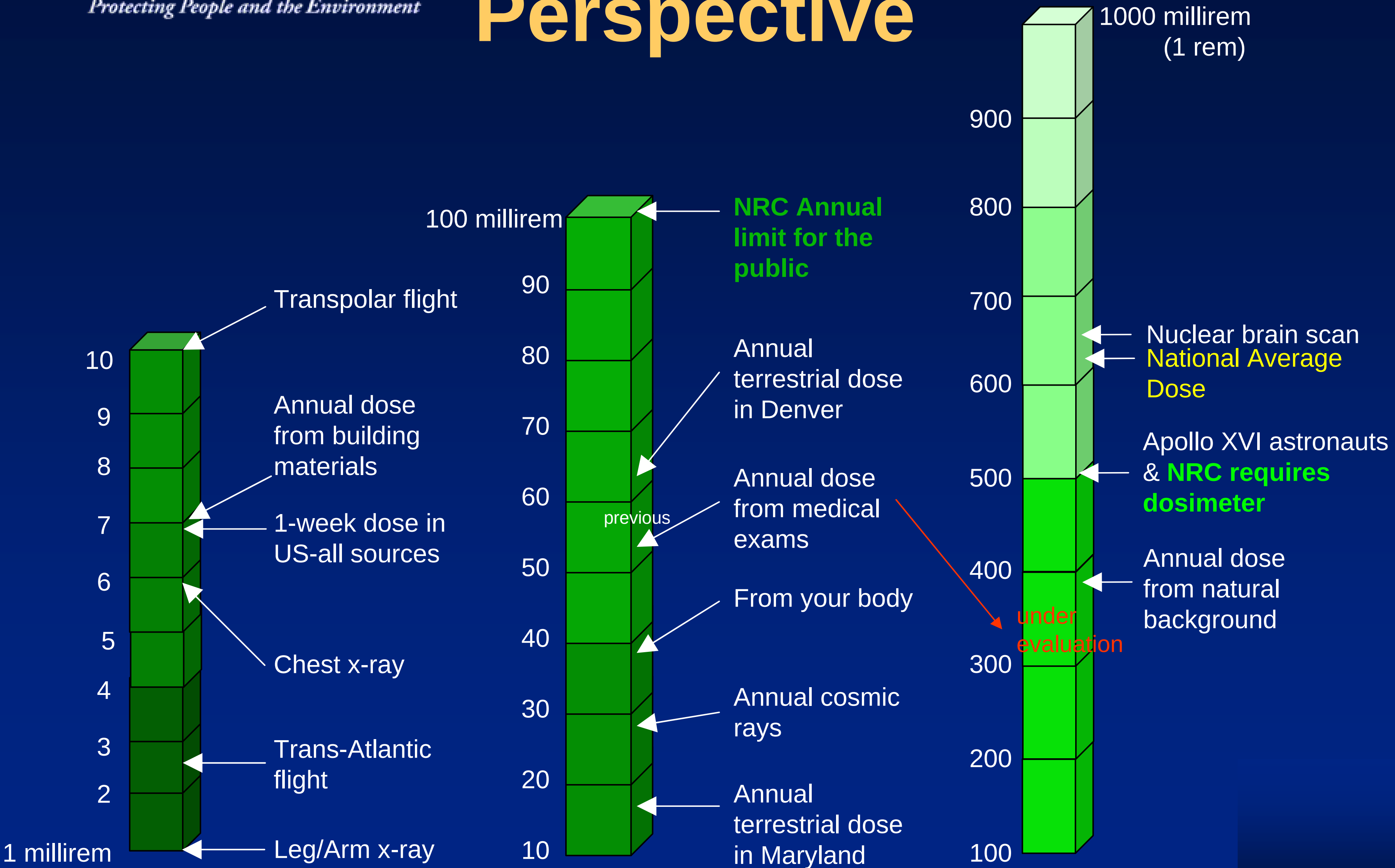
- "Research urgently needed to define more precisely the shape of the dose-response curve ...of low doses of low-LET radiation"

- "Elucidation of the mechanisms of [cellular and molecular mechanisms] is needed to strengthen the scientific basis for risk assessment."

- "Conclusions [on LNT] ... limited by dearth of quantitative information on dose-response relationships in the low-dose domain."

[4]NCRP Report 136, June 2001

Radiation Doses in Perspective



(Walt Schwink/June 2001/perspective.ppt)

Nuclear Renaissance ?

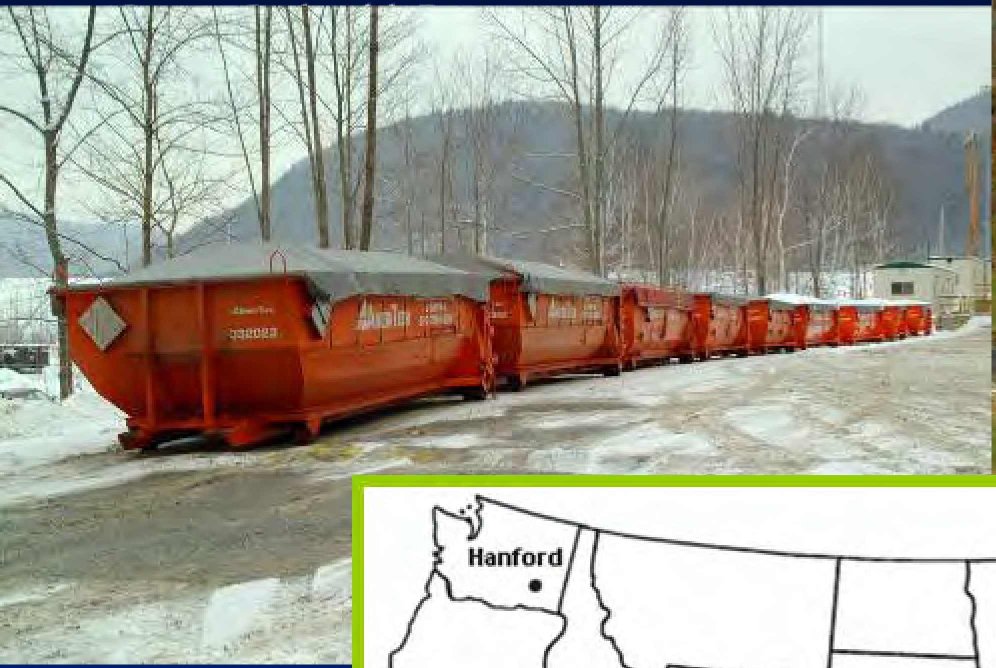
Favorable Outlook for Increased Safe and Secure Utilization of Nuclear Energy……

Depends on a foundation of….

United States Nuclear Regulatory Commission
Protecting People and the Environment

High Level Waste

Low Level Waste



Keys to the Future

Exelon® Nuclear

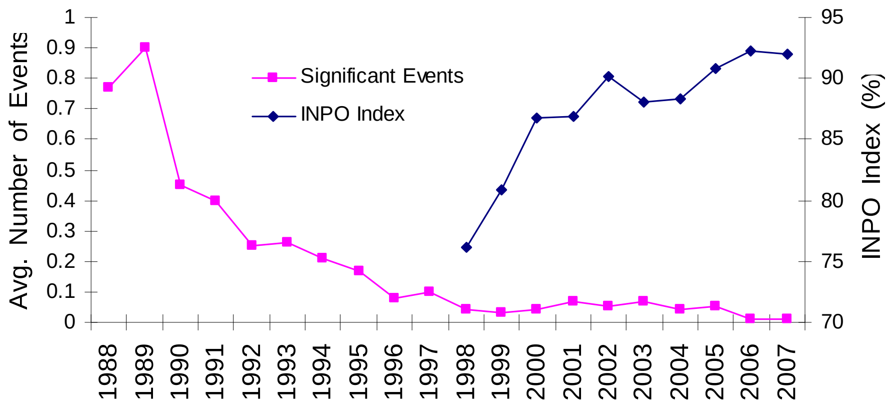
Challenges to New Nuclear Plant Development

Charles Pardee
President and Chief Nuclear Officer
Exelon Corporation

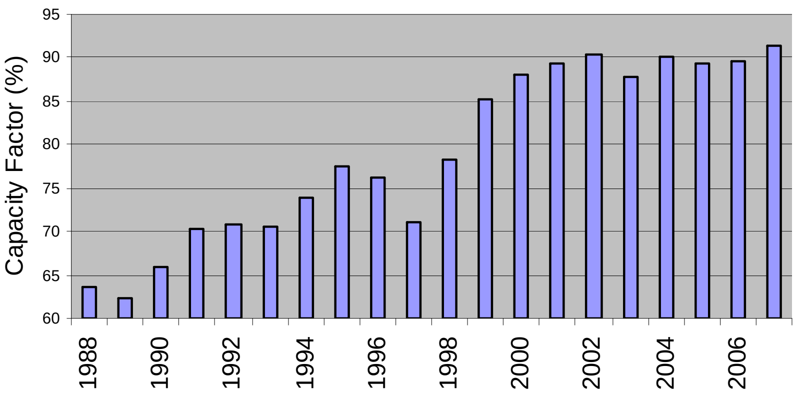
Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation

Safety



Capacity Factor



Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit

Key Enablers to New Nuclear Plant Development

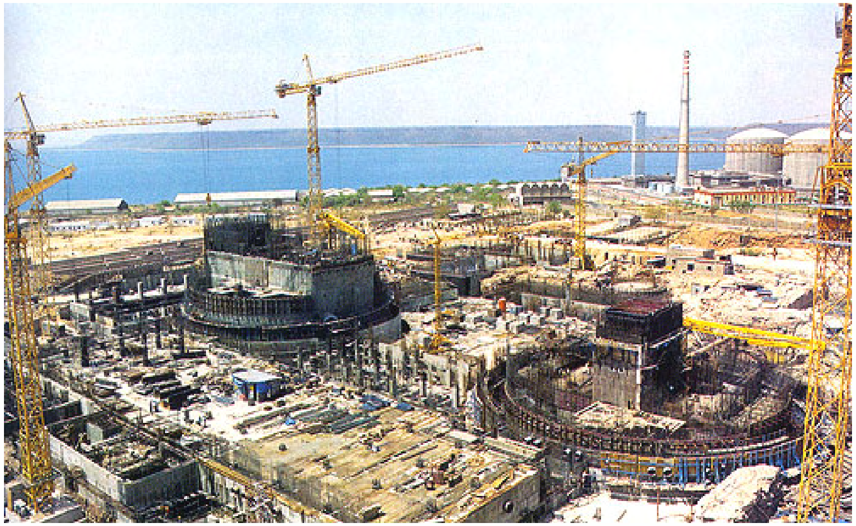
- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit
- Public Desire for Less Threatening Energy Source (energy independence)

Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit
- Public Desire for Less Threatening Energy Source (energy independence)
- Local Community Support

Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit
- Public Desire for Less Threatening Energy Source (energy independence)
- Local Community Support
- Availability of Capital



Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit
- Public Desire for Less Threatening Energy Source (energy independence)
- Local Community Support
- Availability of Capital
- Predictable Cost Structures

Exelon Nuclear

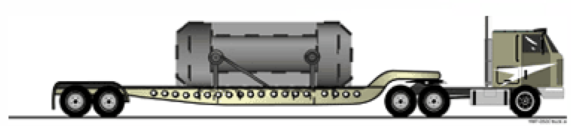
Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit
- Public Desire for Less Threatening Energy Source (energy independence)
- Local Community Support
- Availability of Capital
- Predictable Cost Structures
- Stable Regulations

UNITED STATES NUCLEAR REGULATORY COMMISSION

Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit
- Public Desire for Less Threatening Energy Source (energy independence)
- Local Community Support
- Availability of Capital
- Predictable Cost Structures
- Stable Regulations
- Spent Fuel Management Solutions



Key Enablers to New Nuclear Plant Development

- Confidence in Continued Safe Operation
- Public Opinion Regarding Environmental Benefit
- Public Desire for Less Threatening Energy Source (energy independence)
- Local Community Support
- Availability of Capital
- Predictable Cost Structures
- Stable Regulations
- Spent Fuel Management Solutions
- Manufacturing and Educational Support

The Impact of the Renewed Growth in Nuclear Power on State Radiation Control Programs

Conference of Radiation Control Program Directors

John P. Winston
Chairperson

National Council on Radiation Protection
March 2, 2009

Impact on State Programs

Impact on State Programs

Impact on State Programs

- Personnel
- Experience
- Commitment
- Opportunity

Impact on State Programs

- Current "Nuclear Free" States

  Must develop an infrastructure

  Personnel

  Funding & Fee Collection

Impact on State Programs

- Personnel Requirements
  - Nuclear engineers
  - Emergency response team
  - Environmental monitoring team

Impact on State Programs

- Experience and Training

  A new generation of personnel with no experience in evaluating environmental impact studies

Impact on State Programs

- Commitment of Resources

  Coordination and attendance of public meetings and hearings

  Dissemination of public information

Impact on State Programs

- Training

  New technology and design

Impact on State Programs

- Opportunities
  - ✓ Expanded emphasis on emergency response capabilities
  - ✓ Improved ability to respond to other radiological emergencies

Capability hinges on level of financial resources

SAFETY, HEALTH AND THE ENVIRONMENT: IMPLICATIONS OF NUCLEAR POWER GROWTH

THE OTHER SIDE OF THE WASTE CONFIDENCE CONSIDERATION

Robert M. Bernero

Need For Waste Disposal

- The growth of nuclear power requires confidence in waste disposal: Safe, predictable and cost-effective
- Disposal systems for: HLW, GTCC waste, Class A,B and C waste and mixed waste

Basis for Waste Confidence

- HLW Legislation: Nuclear Waste Policy Act of 1982 (site-selection process) and Nuclear Waste Policy Amendments Act of 1987 (focus on development of the first site)
- LLW Legislation: LLRWP Act of 1980 and LLRWPA Act of 1985
  - All LLRW by states in compacts
  - Each Governor gave Waste Confidence report to NRC in 1990

HLW EXPERIENCE

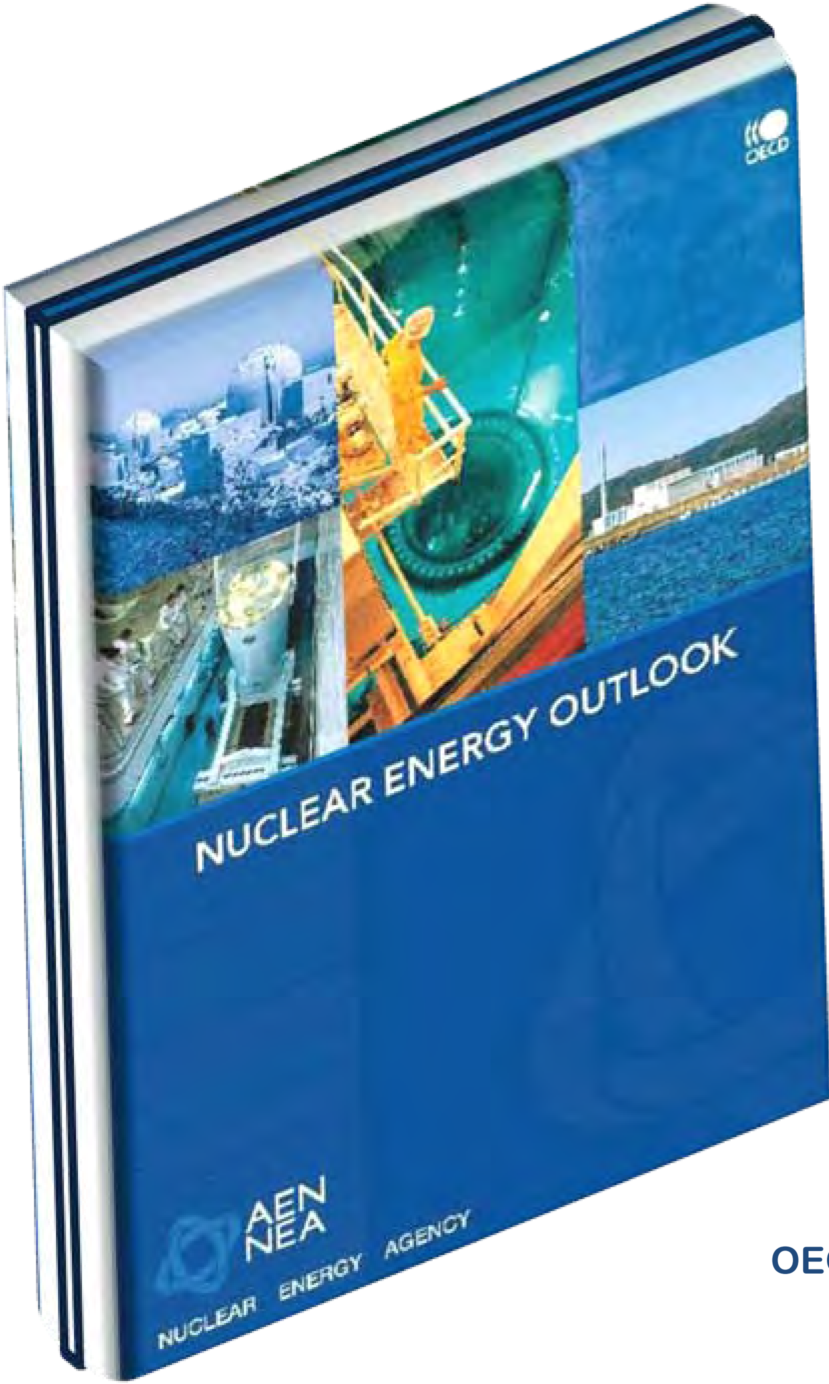
- Yucca Mt. under review but hotly contested
  - Completion of review challenged
  - HLW cost continues to escalate
  - Most reactors have expanded wet and dry storage

LLW EXPERIENCE

- State Compact System broke down
  - Northwest (Hanford, WA) successful
  - Southeast (Barnwell, SC) received most until recently
  - Newer LLW sites (*e.g.*, Clive, UT)
  - Many are processing and storing LLW
  - Only a few decommissioning, impact veiled

IMPLICATION FOR NUCLEAR POWER GROWTH

- HLW: Legislative basis for waste confidence appears to be failing. Lack of HLW disposal is a growing program and cost barrier
- LLW: Legislative basis for waste confidence appears to be failing. Lack of complete LLW disposal is a growing program and cost barrier



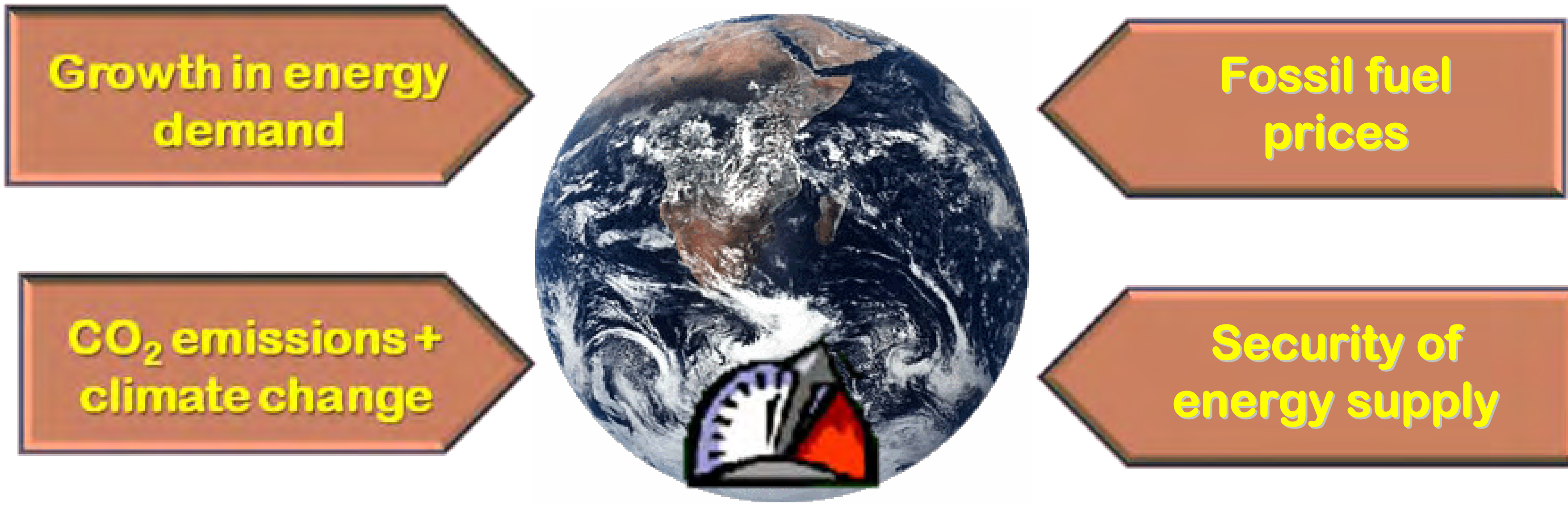
Nuclear Energy Outlook

Uichiro Yoshimura
Deputy Director
OECD Nuclear Energy Agency

A lasting tribute to NEA's 50 years

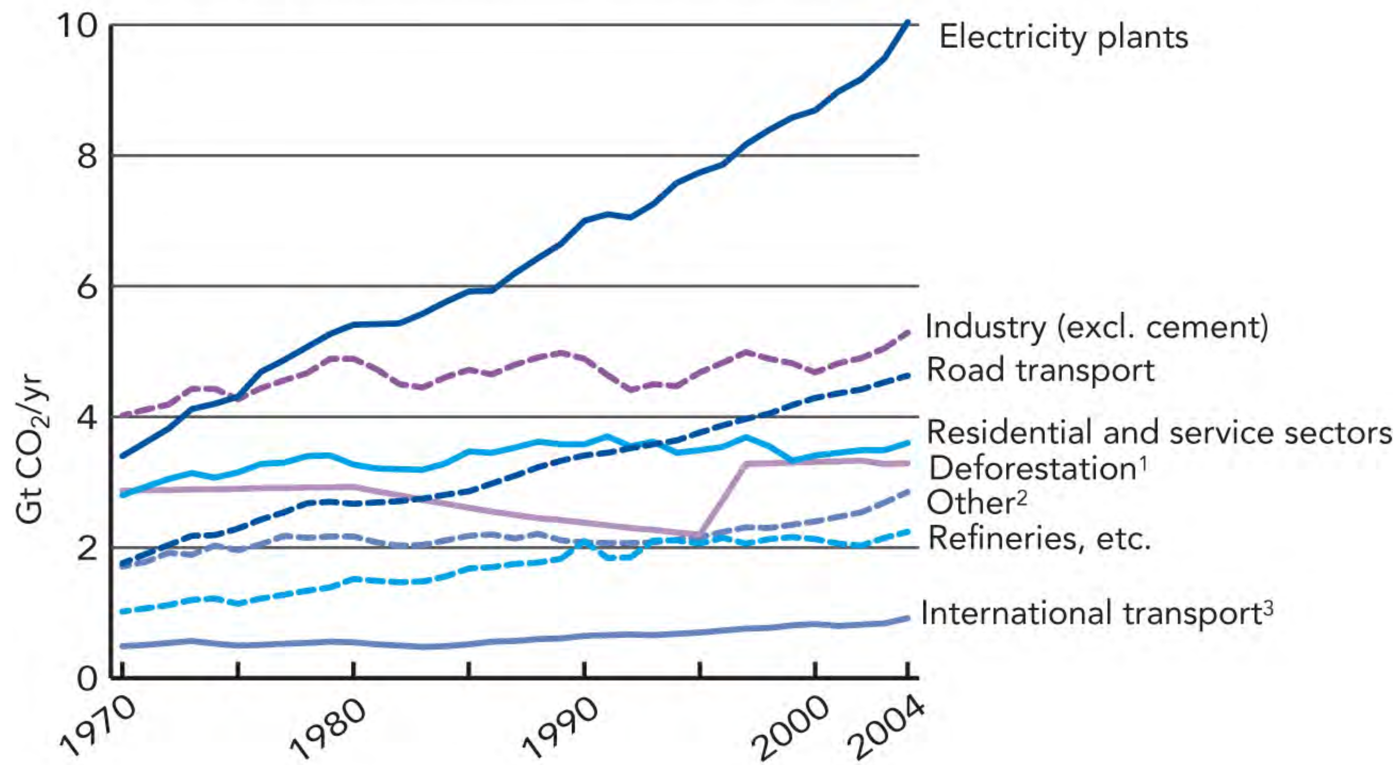
- First ever NEA outlook
- Responding to renewed interest in nuclear energy
- Intention to inform the debate

Why the renewed interest in nuclear energy?



Why the renewed interest in nuclear energy?

Figure 4.6: Sources of global anthropogenic CO_2 emissions



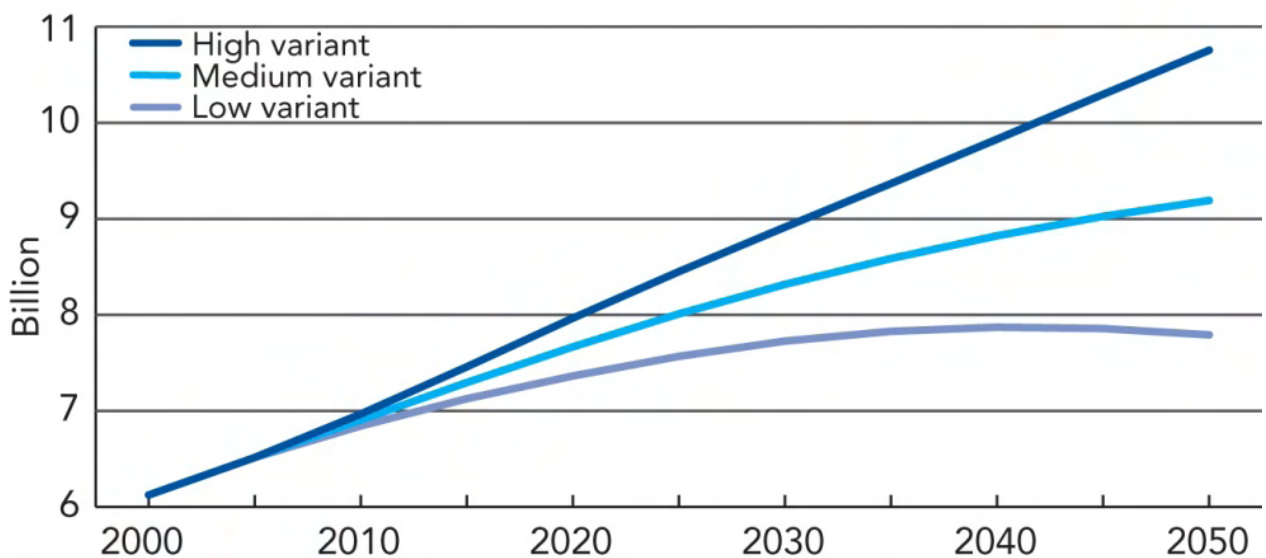
Why the renewed interest in nuclear energy?

Carbon-dioxide emissions from fossil-fired power plants by far the biggest and fastest-growing sources of CO_2

Business as usual to 2050

Population up by 50 %...

Figure 3.1: UN projections of world population

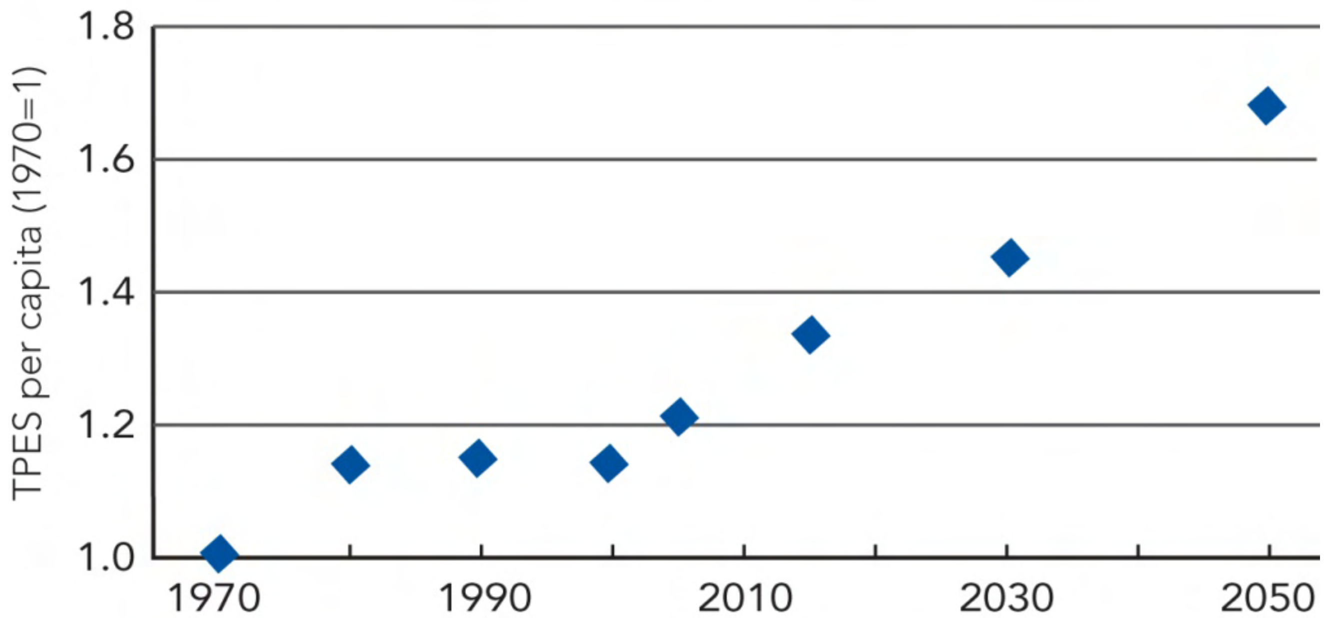


Source: UNPD (2006).

Business as usual to 2050

Energy demand up by 100 %...

Figure 3.2: Increase in TPES per capita

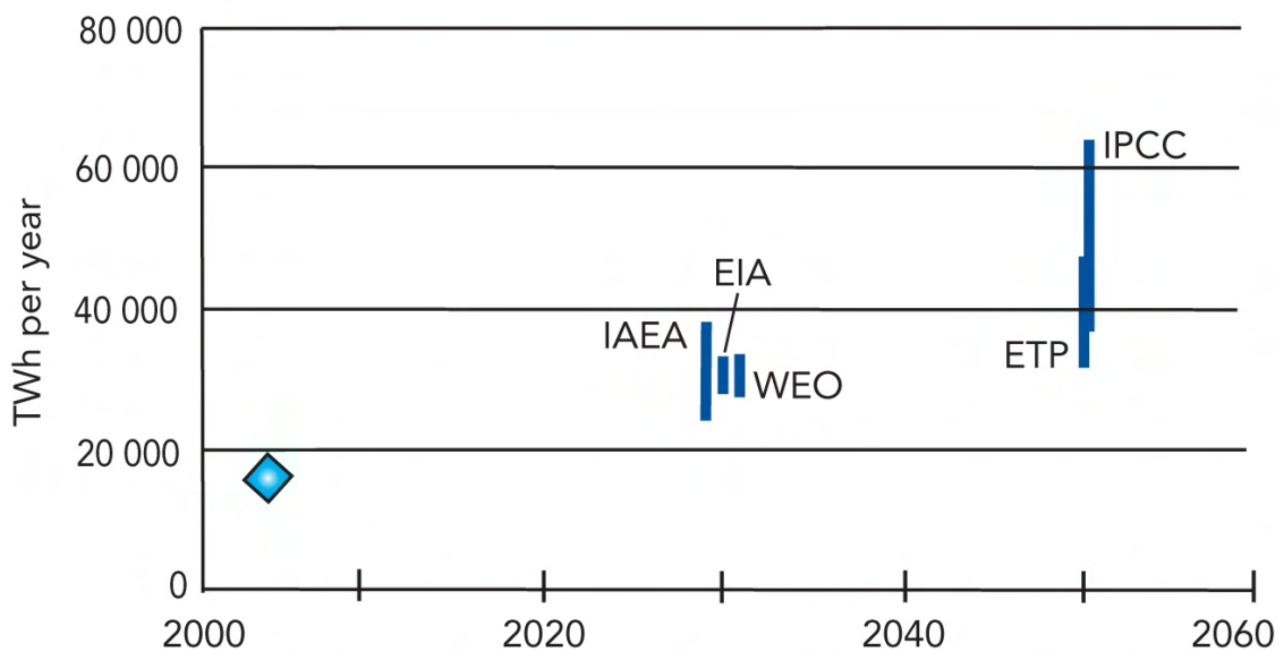


Sources: adapted from IEA data (2006a, 2006b).

Business as usual to 2050

Electricity demand up by 150 %...

Figure 3.5: Projected increase in electricity demand worldwide



Note: The vertical bars at 2030 and 2050 have been separated for ease of reading.

Business as usual 2050

Population up by 50 %...

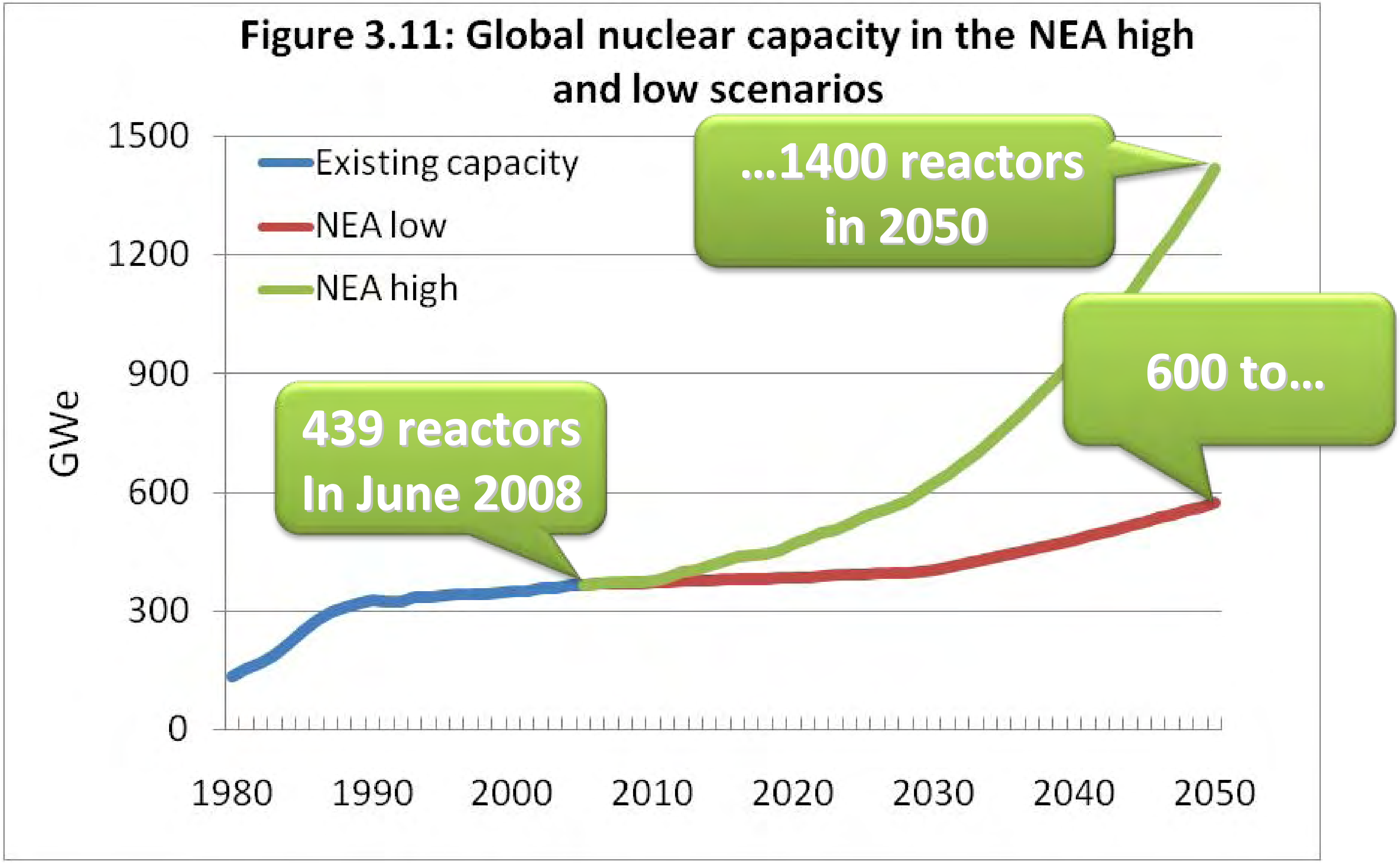
Energy demand up by 100 %...

Electricity demand up by 150 %...

CO_2 emissions per unit of energy consumption must be reduced by a factor of 4

Nuclear could make a significant contribution

Nuclear energy's potential role



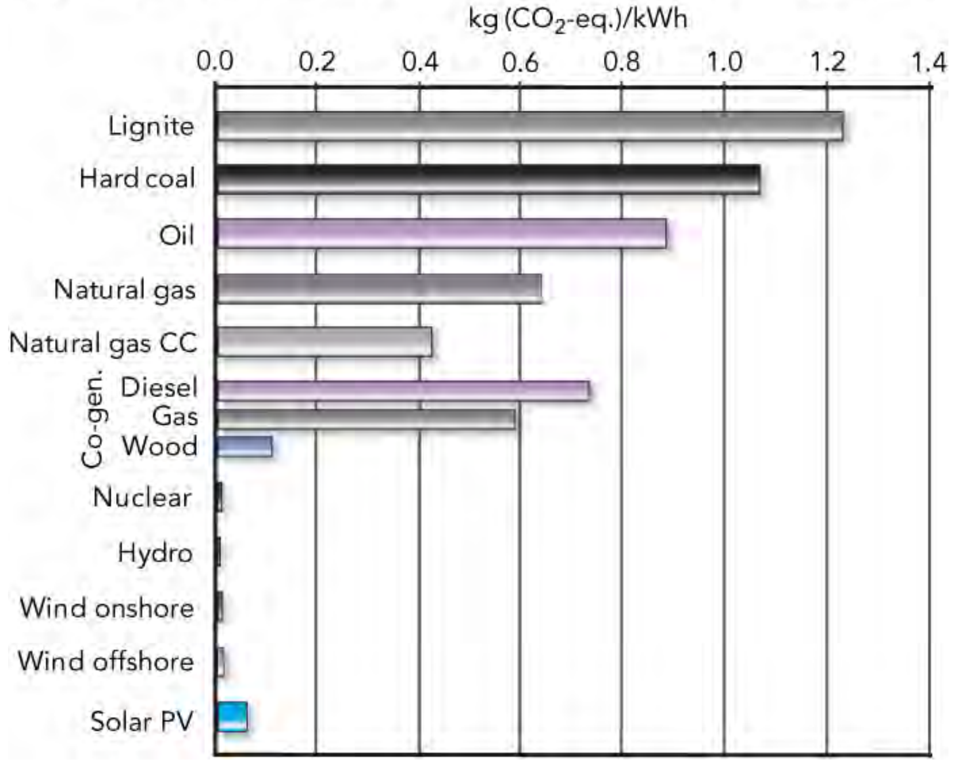
Nuclear could expand by a factor of nearly 4

OECD NEA: Nuclear Energy Outlook '08

Potential benefits of nuclear power

Virtually CO_2-free

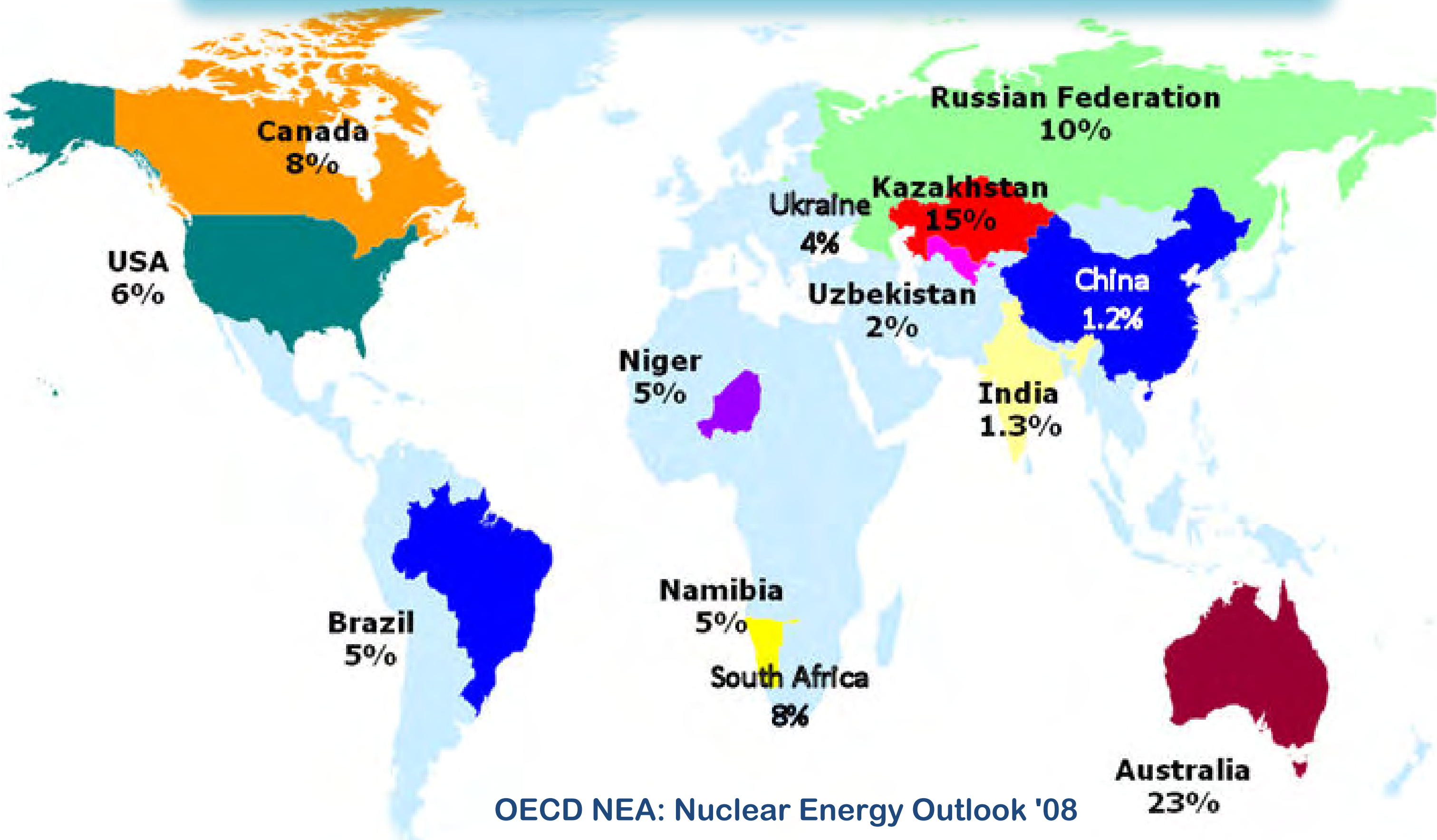
Figure 4.7: Greenhouse gas emissions of selected energy chains



OECD NEA: Nuclear Energy Outlook '08

Potential benefits of nuclear power

Diverse, politically stable sources of plentiful uranium

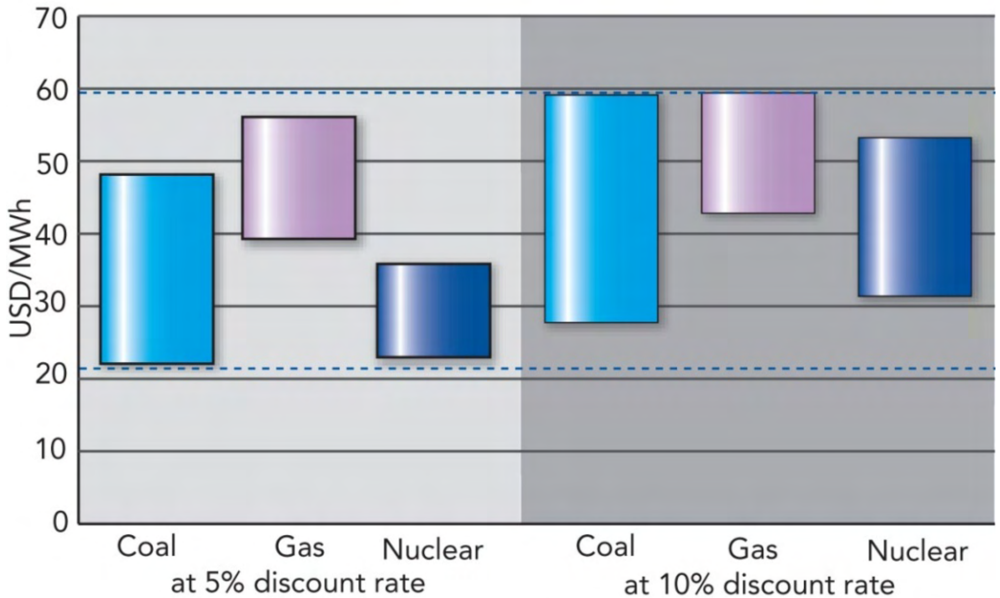


OECD NEA: Nuclear Energy Outlook '08

Potential benefits of nuclear power

Cost competitive and very insensitive to price of uranium

Figure 6.8: Range of levelised costs for nuclear, coal and gas power plants at 5% and 10% discount rates
(USD/MWh)

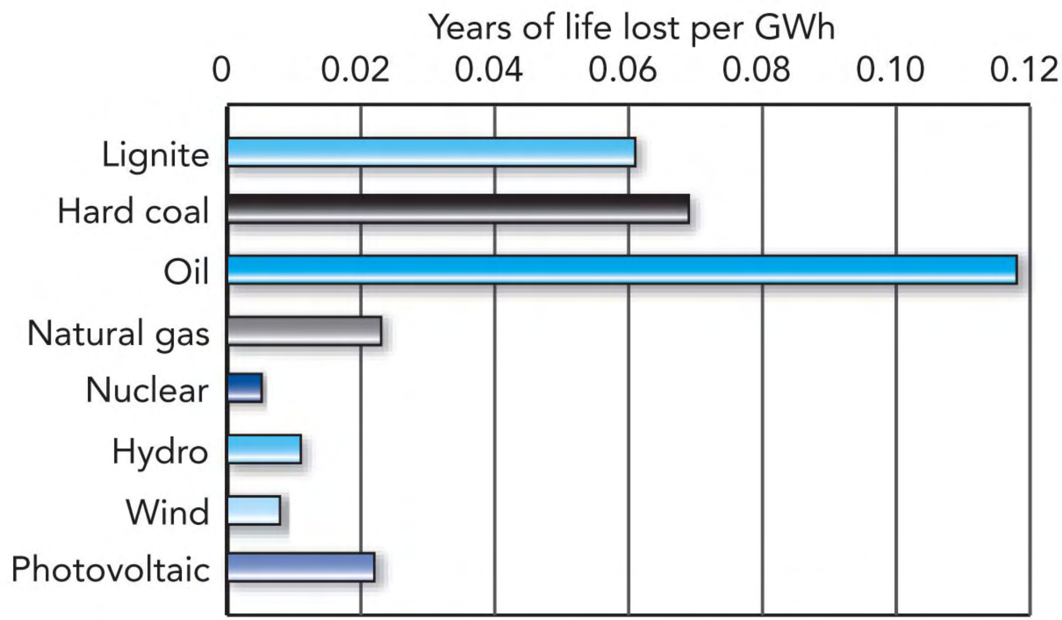


OECD NEA: Nuclear Energy Outlook '08

Potential benefits of nuclear power

Avoids significant health effects

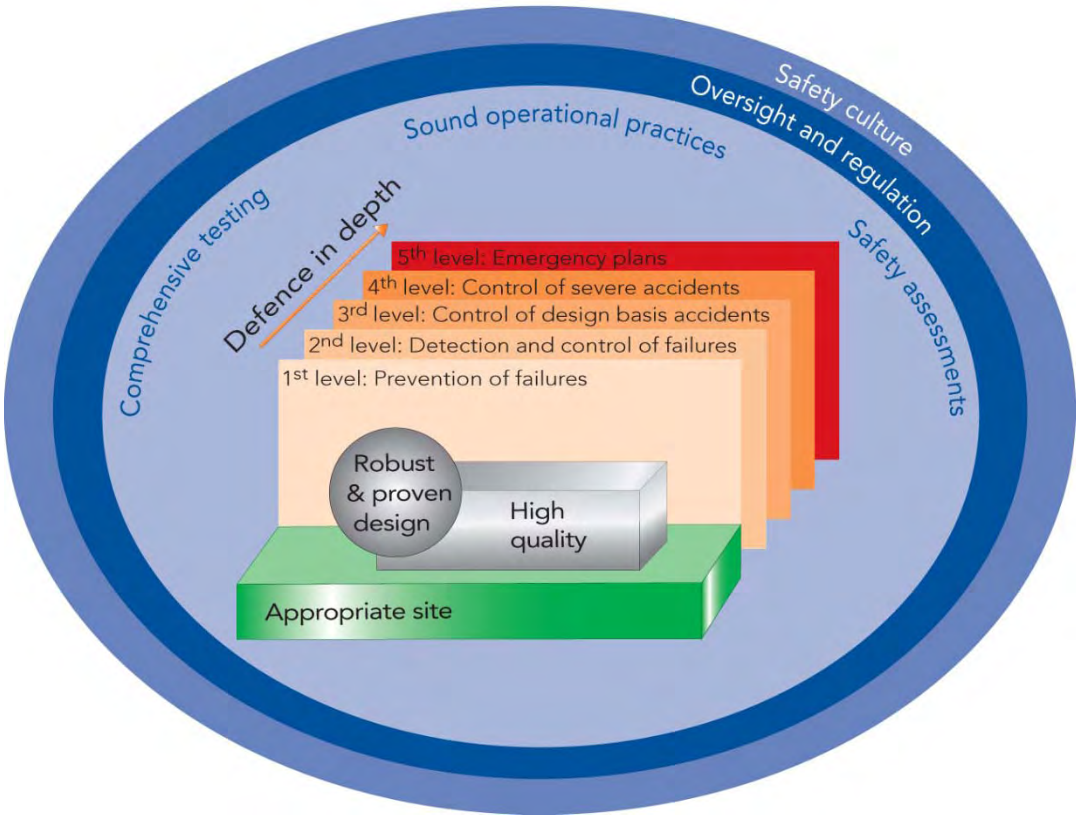
Figure 4.16: Mortality resulting from the emissions of major pollutants from German energy chains during normal operation in 2000



Source: based on Hirschberg *et al.* (2004).

Managing current and future challenges

Figure 7.1: Elements of nuclear safety

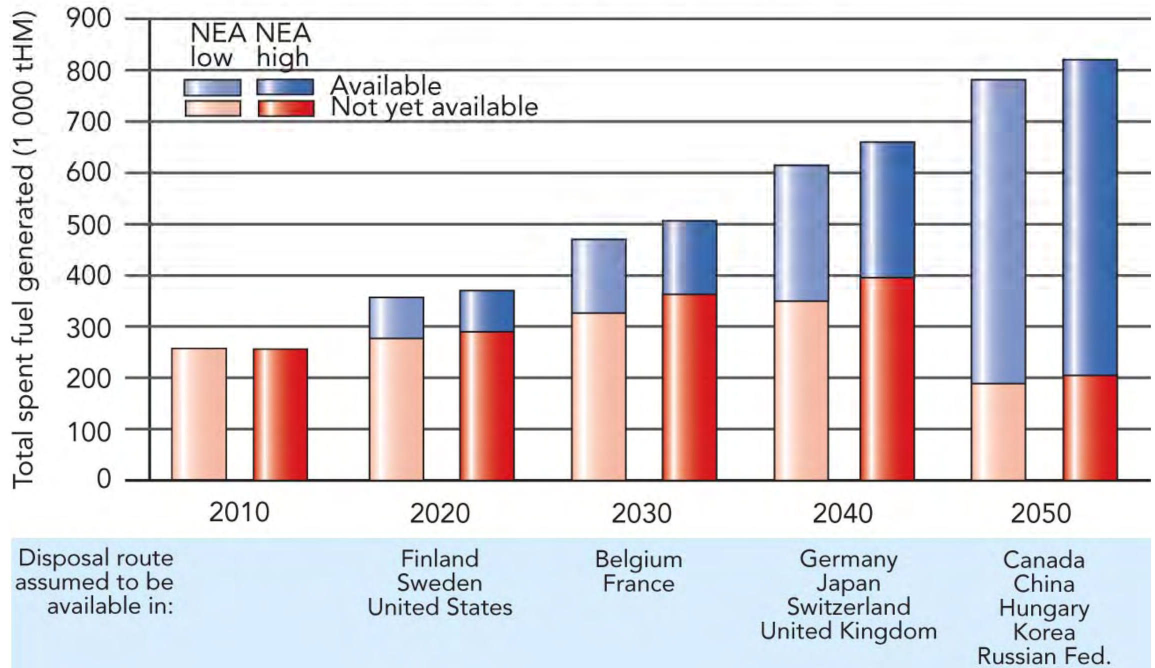


Unsafe?

Actually, safer than base load alternatives

Managing current and future challenges

Figure 8.5: Availability of disposal routes for HLW or SNF from nuclear electricity generation



Radwaste?

Actually, most disposable by 2050

Managing current and future challenges

Proliferation?

NPT largely successful, improved regime under discussion

1400 reactors in 2050?

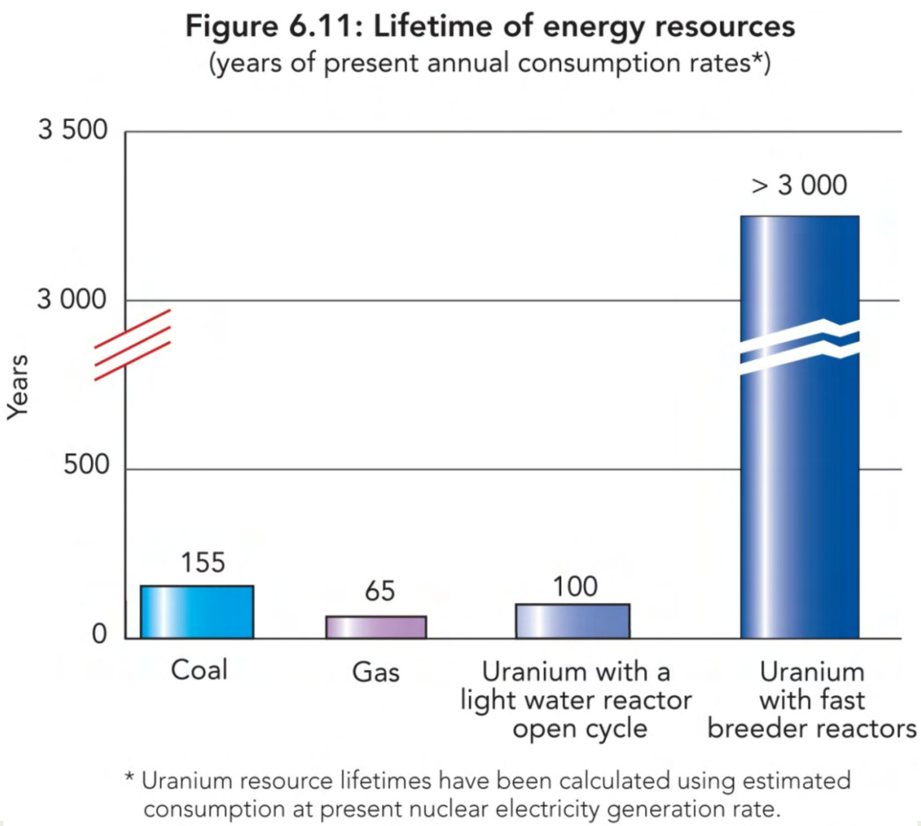
Today's reactors are fit for purpose and could provide for a significant expansion to 2050

Significant CO_2 alleviation now

Tomorrow's fast reactors can expand the energy available from uranium by up to 60 times

Vast resources of virtually CO_2-free energy

1400 reactors in 2050?



Vast resources of virtually CO_2-free energy

But!...

Governments have clear responsibilities:

- ensure maintenance of the skill base
- maintain continued effective safety regulation
- foster progress facilities for waste disposal
- maintain and reinforce international non-proliferation arrangements
- provide the stability (policy, regulatory, fiscal) investors require

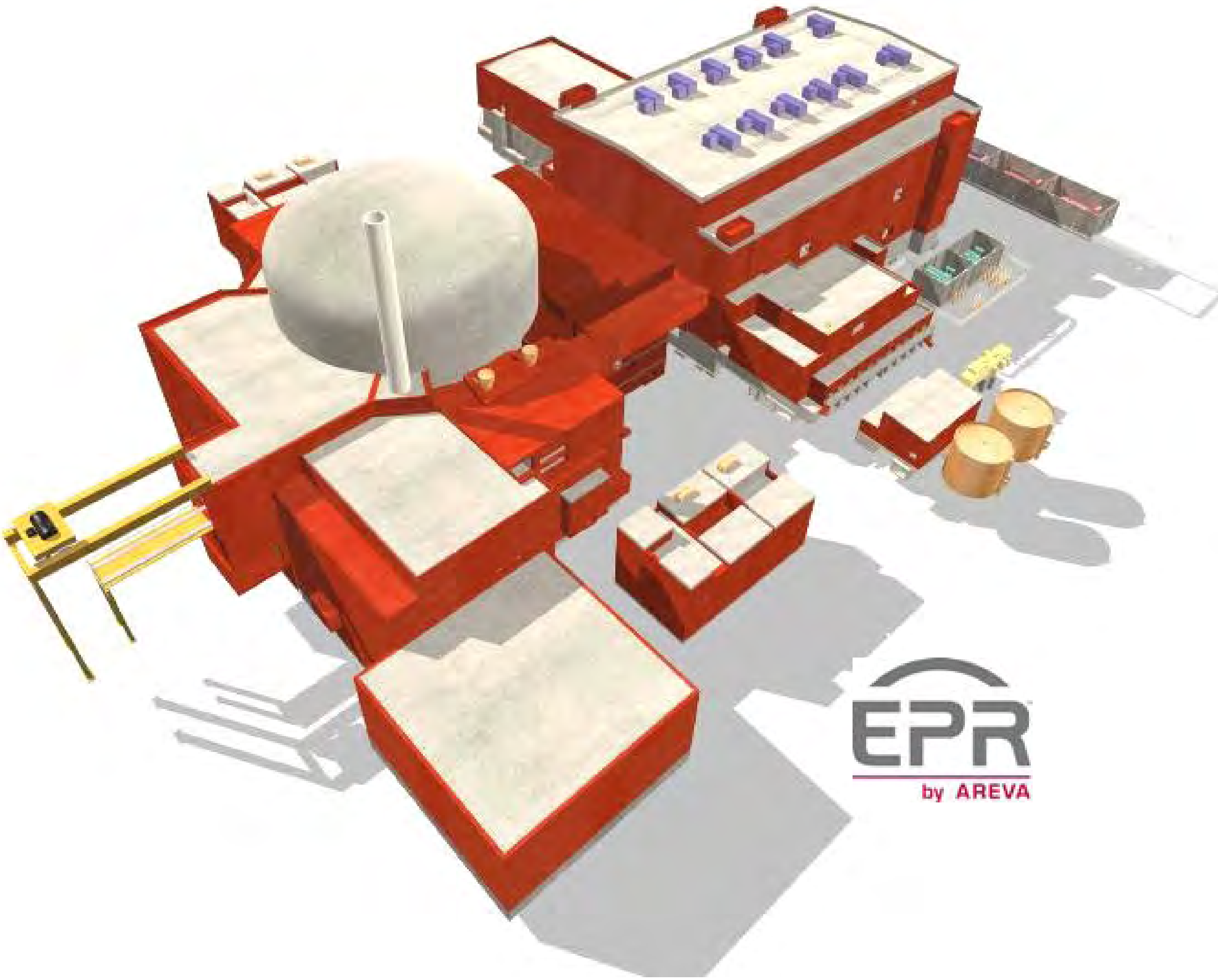
to enable nuclear energy's role in future sustainable energy mixes

The facts are all here…

Chapter 1. Current Status
Chapter 2. Programmes and Government Policies
Chapter 3. Projections to 2050
Chapter 4. Environmental Impacts of Energy Use and Power Production
Chapter 5. Uranium Resources and Security of Supply
Chapter 6. Providing Electricity at Stable and Affordable Costs
Chapter 7. Nuclear Safety and Regulation
Chapter 8. Radioactive Waste Management and Decommissioning
Chapter 9. Non-proliferation and Security
Chapter 10. Legal Frameworks
Chapter 11. Infrasturcture: Industrial, Manpower and R&D Capability
Chapter 12. Stakeholder Engagement
Chapter 13. Advanced Reactors
Chapter 14. Advanced Fuel Cycles

The US EPR™: Certainty in Safety

Thomas A. Christopher
President and CEO AREVA NP Inc.
CEO and Vice-Chairman AREVA Inc.


EPR
by AREVA

AREVA

The US EPR™: An Overview

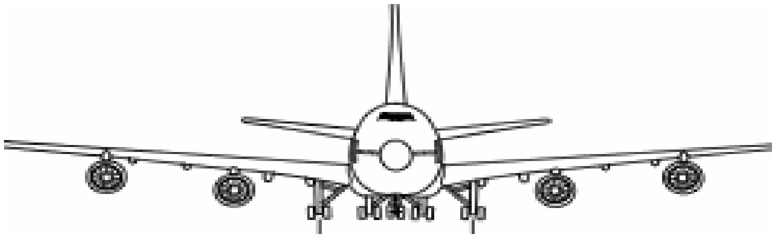
- Designed for airplane attack
- Designed for severe accidents
- Improved reactor core margins
- Improved environmental impact

The US EPR™: Built for Maximum Safety

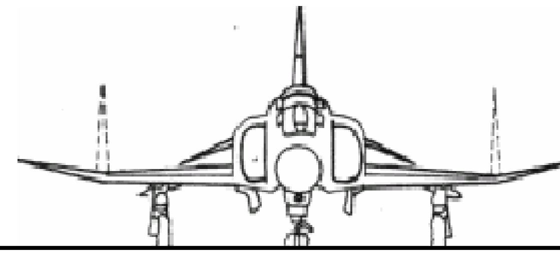
EPR™ Aircraft Hazard Protection in the Post 9-11 World

EPR Designed to withstand impact of:

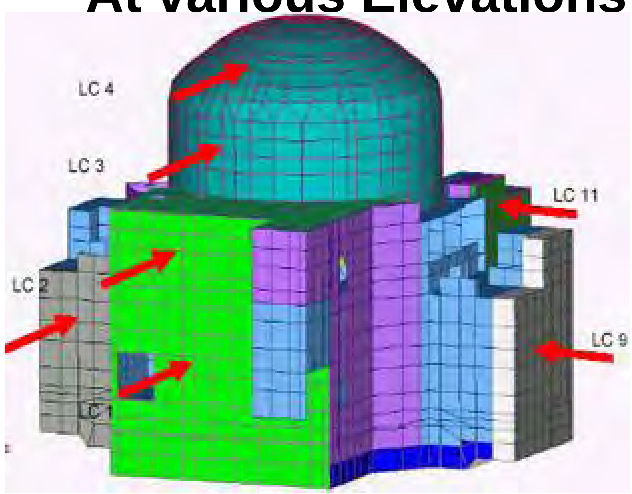
Large Commercial Jet



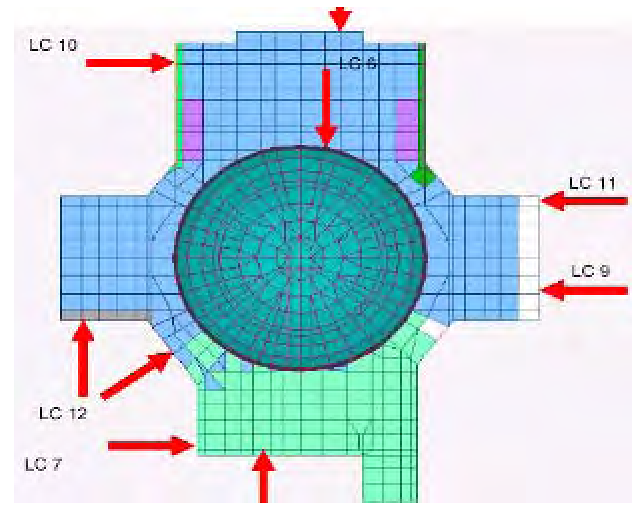
Military Aircraft



At various Elevations



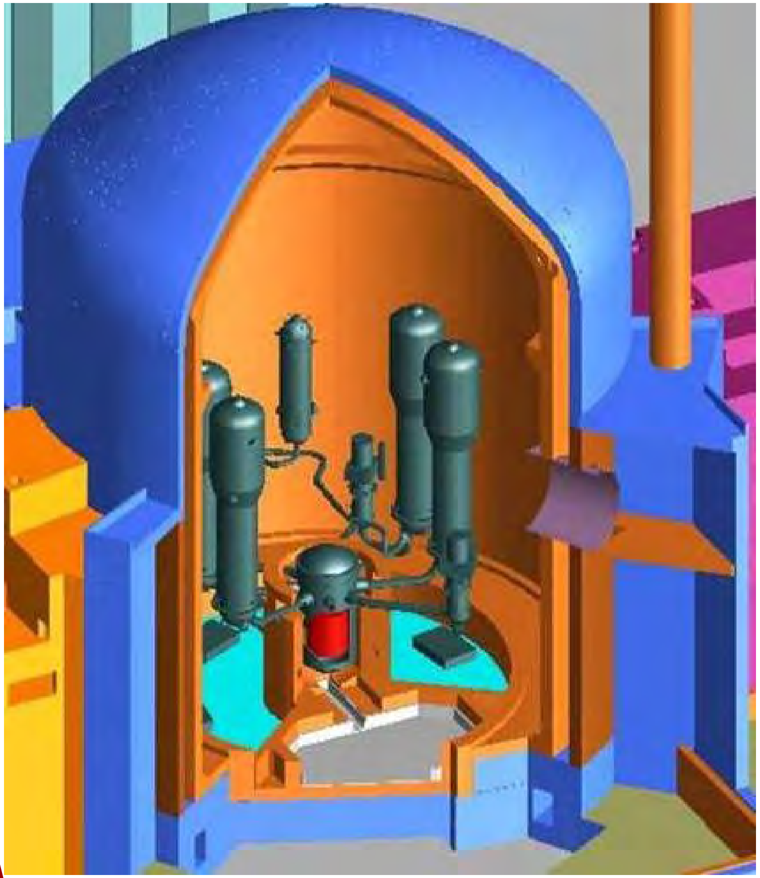
From different Sides



Simply, yes, the EPR resists commercial and military aircraft crashes.

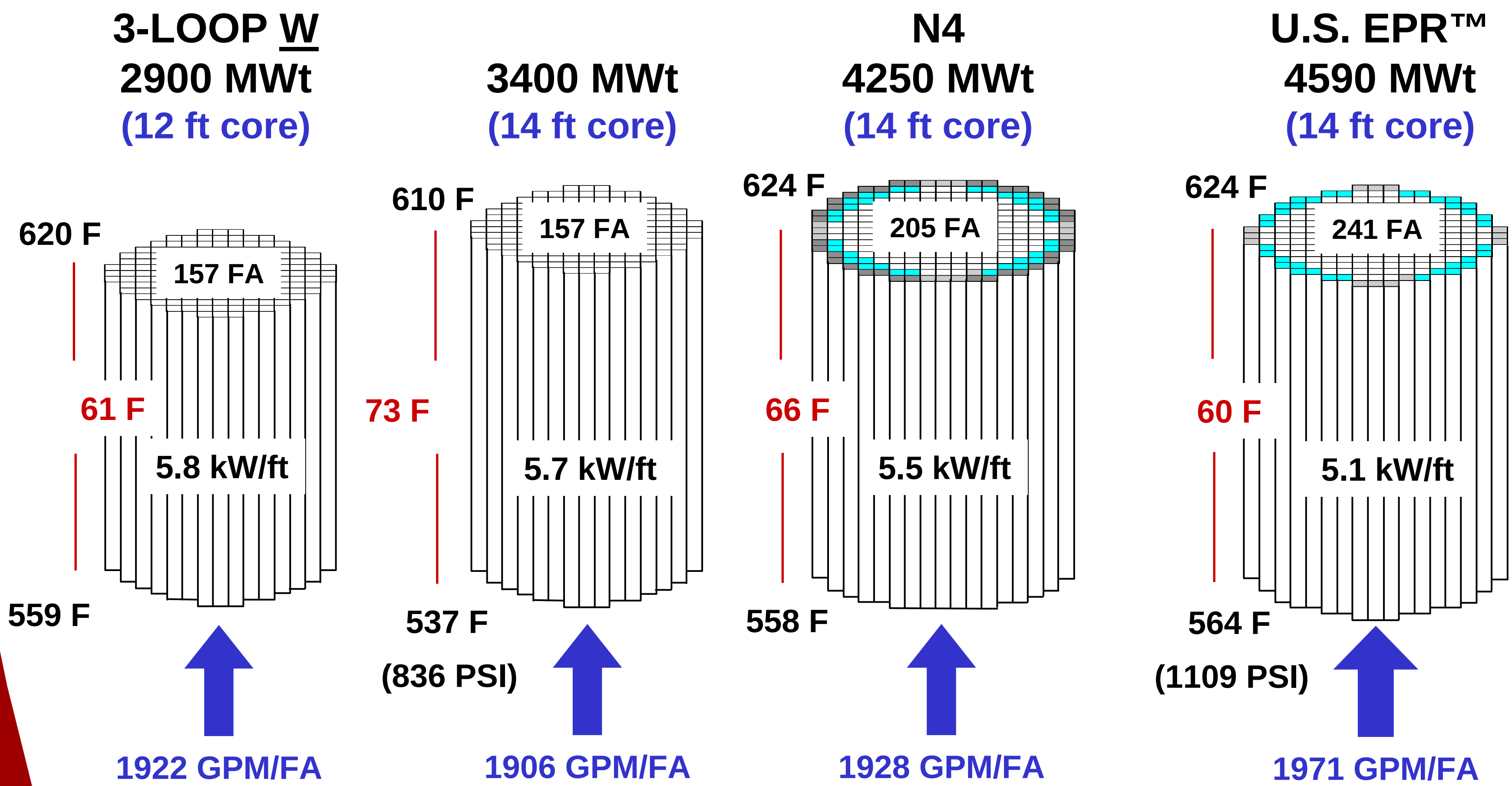
S A 2 -1

Severe Accident Mitigation:
Views of Corium Spreading Area & IRWST



U.S. EPR™ is designed for extremely unlikely core melt accident providing increased safety, certainty, and public acceptance

Reactor Core Design



U.S. EPR Eliminates Core Power Anomalies

Existing 2 Unit 3-loop Plant Station

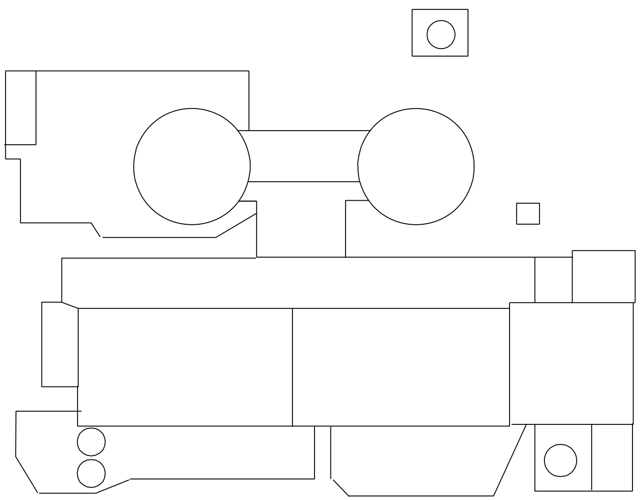
5,092 MW_{th}

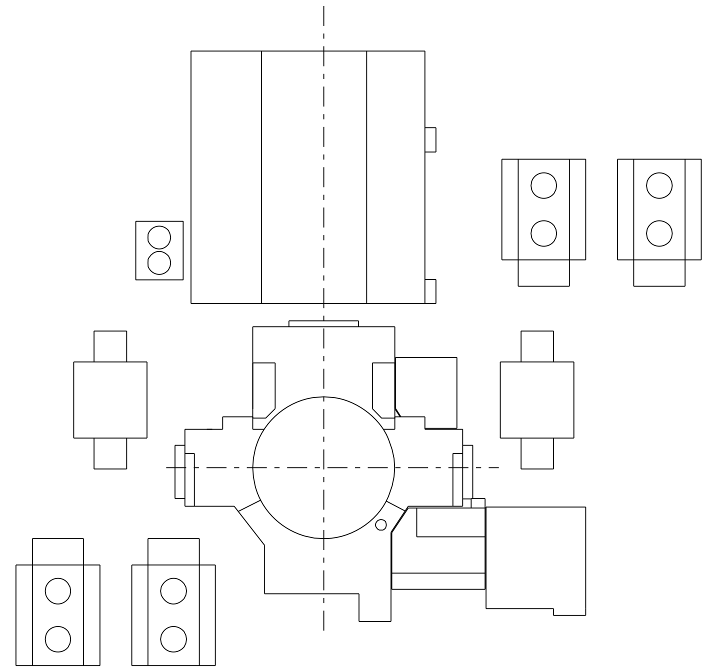
1,602 MWe

US EPR™

4,590 MW_{th}

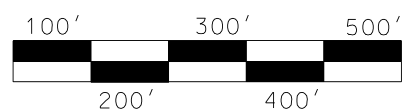
1,600 MWe





Water usage for heat sink rejection:

1,680,000 gpm



Water usage for heat sink rejection:

40,062 gpm

US EPR: 16% Less Heat Rejected to Environment

Major Reduction in Water Usage

Conclusion

> The US EPR™

- A major step forward in severe accident mitigation
- Substantial improvement in core margins
- A significant improvement in environmental impact

Argonne NATIONAL LABORATORY

... for a brighter future

Advanced Reactors and Fuel Cycles: Safety and Environmental Impacts

NCRP Annual Meeting
Washington, DC
March 2, 2009

Robert N. Hill, W.M. Nutt, and J.J. Laidler
Department Head – Nuclear Systems Analysis
Nuclear Engineering Division
Argonne National Laboratory

U.S. Department of Energy

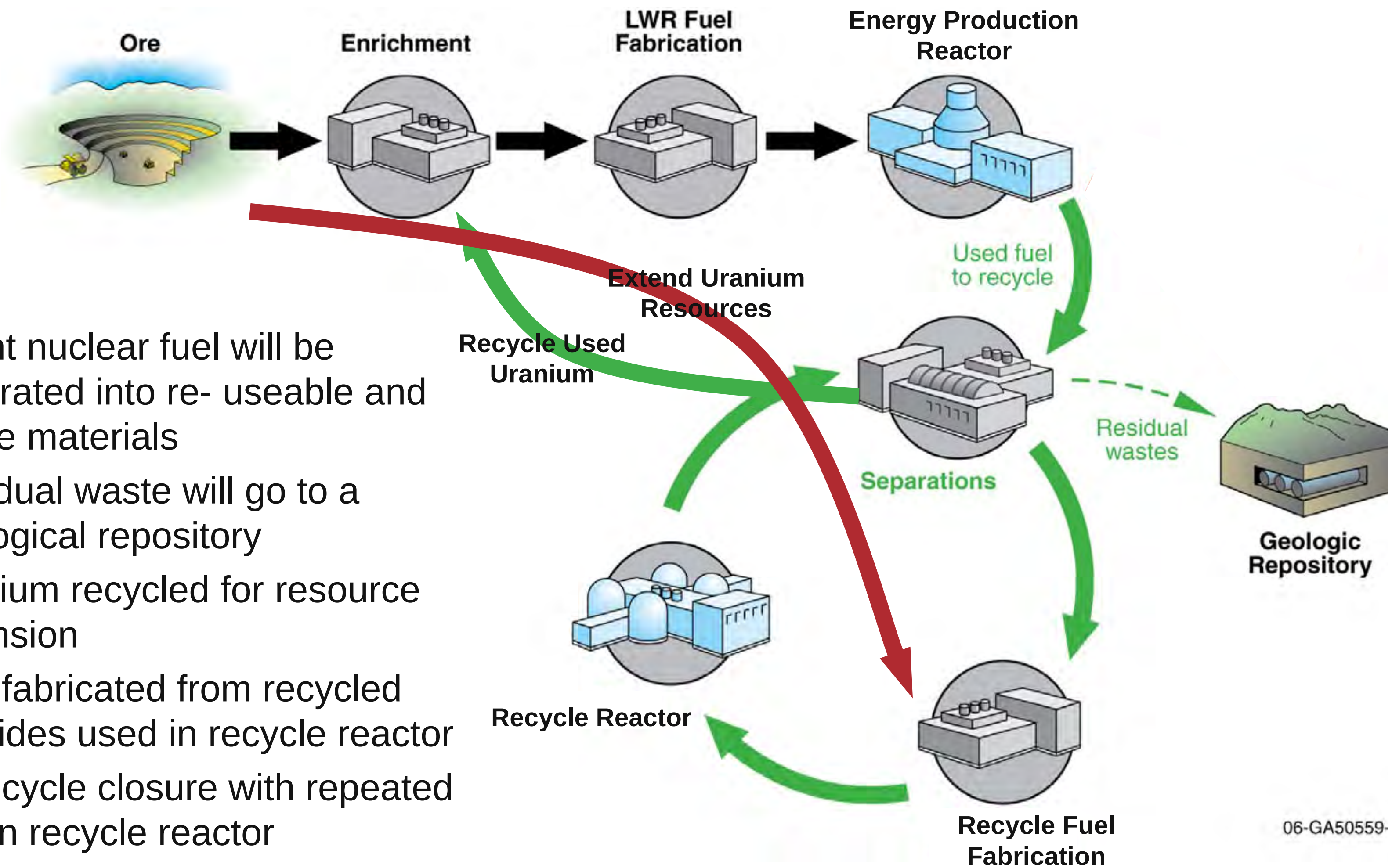
THE UNIVERSITY OF CHICAGO

A U.S. Department of Energy laboratory managed by The University of Chicago

Overview

- **Alternative Fuel Cycle Options**
- **Reactors (VHTR and SFR)**
- **Fuel Cycle Technology (separations and fuel fab)**
- **Waste Management**

AFCI is considering a variety of fuel cycle options: Closed fuel cycle with actinide management



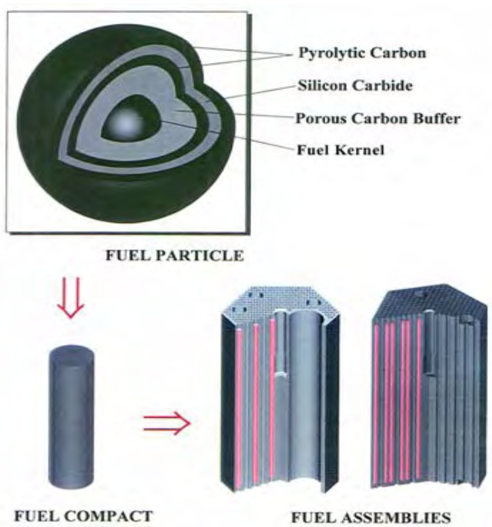
- Spent nuclear fuel will be separated into re- useable and waste materials
- Residual waste will go to a geological repository
- Uranium recycled for resource extension
- Fuel fabricated from recycled actinides used in recycle reactor
- Fuel cycle closure with repeated use in recycle reactor

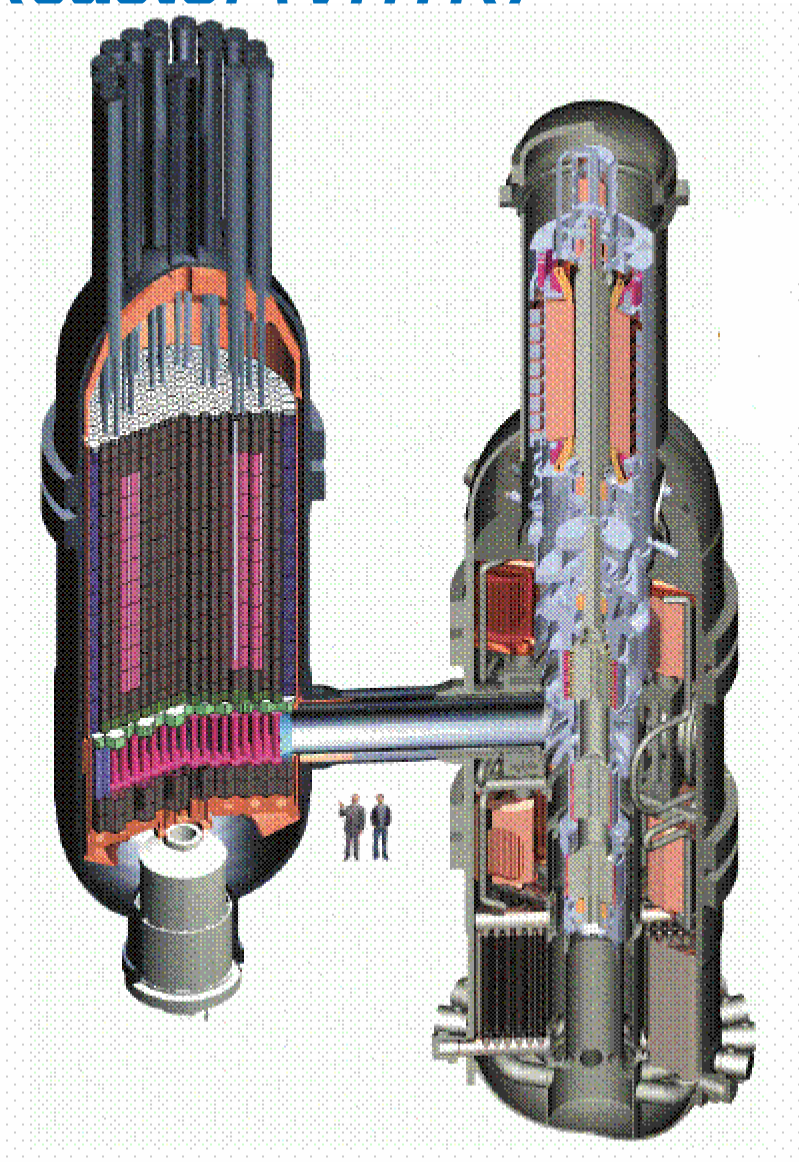
Generation IV Systems

System	Neutron Spectrum	Fuel Cycle	Size	Applications	R&D
Very High Temp. Gas Reactor (VHTR)	Thermal	Open	Med	Electricity, Hydrogen Production, Process Heat	Fuels, Materials, H_2 production
Supercritical Water Reactor (SCWR)	Thermal, Fast	Open, Closed	Large	Electricity	Materials, Safety
Gas-Cooled Fast Reactor (GFR)	Fast	Closed	Med to Large	Electricity, Hydrogen, Actinide Management	Fuels, Materials, Safety
Lead-alloy Cooled Fast Reactor (LFR)	Fast	Closed	Small	Electricity, Hydrogen Production	Fuels, Materials compatibility
Sodium Cooled Fast Reactor (SFR)	Fast	Closed	Med to Large	Electricity, Actinide Management	Advanced Recycle
Molten Salt Reactor (MSR)	Thermal	Closed	Large	Electricity, Hydrogen Actinide Management	Fuel, Fuel treatment, Materials, Safety and Reliability

Very High Temperature Reactor (VHTR)

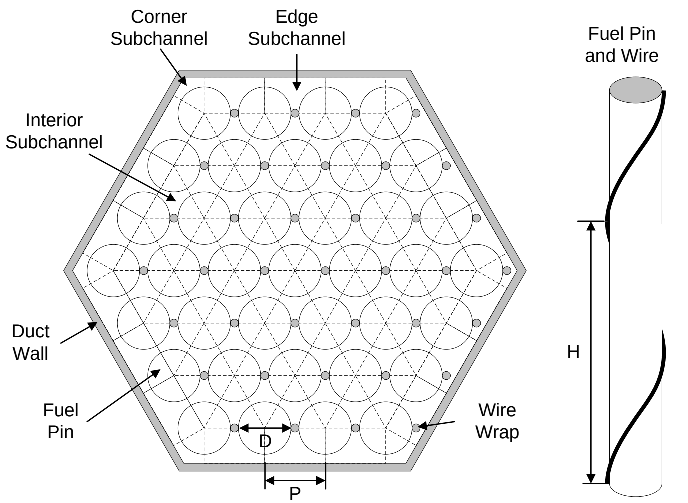
- High Temperature Applications
  - Direct gas Brayton cycle
- System Configuration
  - TRISO fuel particles
  - Low Power Density
  - Prismatic or Pebble Bed

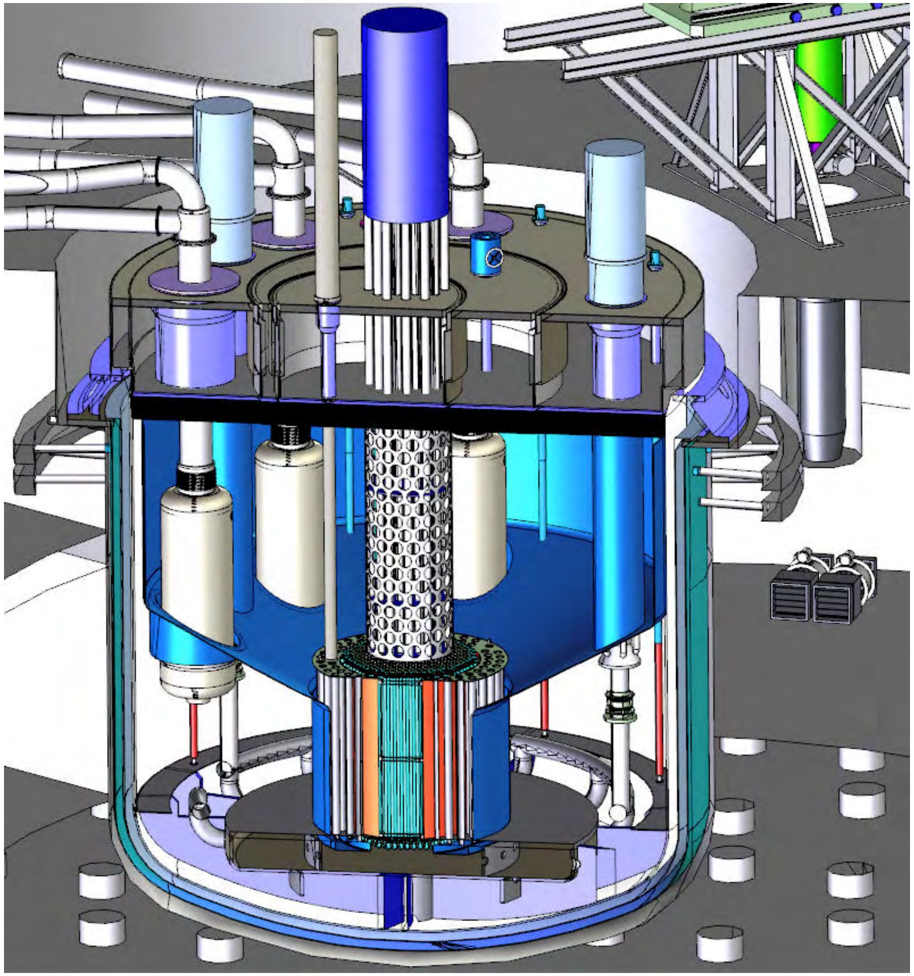




Sodium-Cooled Fast Reactor (SFR)

- Fuel Cycle Applications
  - Actinide Management
- System Configuration
  - Metal Alloy or Oxide Fuel
  - Pool or Loop Configuration
  - High Power Density





Reactor Characteristics

	Gen III ALWR	Gen IV VHTR	Gen IV SFR
Applications	electricity generation	electricity generation, heat supply	electricity generation, actinide management
Power, MW_{th}	3000-4500	600-800 (block) 300-400 (pebble)	800-3500 (loop or pool plant)
Power Density, W/cm^3	50-100	≤ 6.5	200-400
Primary Coolant (T_{Outlet}, °C)	H_2O (300-350)	He (850-1000)	Na (510-550)
Primary System Pressure (MPa)	15.5	7.1	0.1
Fuel Material	UO_2	UO_2, $UC_{0.5}O_{1.5}$	(U,TRU) oxide, metal alloy
Fuel Form	pellet	Triso coated particle	pellet or slug
Fuel Element / Assembly	square pitch pin bundle	hex block, pebble	triangular pitch pin bundle with duct
Moderator	light water	graphite	none
Number of coolant circuits	2	1 or 2	3
Core Structural Material	zirconium alloy	graphite	ferritic steel
Power Conversion Cycle	steam Rankine	direct or indirect He Brayton	superheated steam Rankine, or S-CO_2 Brayton

Safety Behavior of VHTR

- Inherent characteristics
  - Inert, single phase helium coolant
  - Refractory coated robust fuel particles prevent releases
  - High temperature stable graphite structure and moderator

- Passively safe design
  - Slow heat-up of large graphite structures
    - *In combination with low power density, implies long response times*
  - Passive decay heat removal by radiation to cavity cooling
  - Annular core with negative temperature coefficients
  - No coolant voiding and/or change in moderation with temperature

Safety Implications of SFR Design Approach

- Superior heat transfer properties of liquid metals allow:
  - Operation at high power density and high fuel volume fraction
  - Low pressure operation with significant margin to boiling
  - Enhanced natural circulation for heat removal
- Inherent safety design
  - Multiple paths for passive decay heat removal envisioned
  - Tailored reactivity feedbacks to prevent core damage
- High leakage fraction implies that the fast reactor reactivity is sensitive to minor geometric changes
  - As temperature increases and materials expand, a net negative reactivity feedback is inherently introduced
- Favorable inherent feedback in sodium-cooled fast reactors (SFR) have been demonstrated
  - EBR-2 and FFTF tests for double fault accidents

Occupational Exposure

Reactor Type	Site Exposure (man-rem)	Specific Exposure (man-rem/MWe-y)
LWR – 1990-94	~300	0.25
BWR – 2006	143	0.17
PWR – 2006	87	0.10
FFTF	4	0.07
PHENIX	6.5	0.03
PRISM design	<20	<0.05
Peach Bottom and Fort St. Vrain	3	0.2
Large HTGR design	51	0.07

- Personnel exposure has greatly decreased with LWR operational experience
- Low doses observed for test and demonstration advanced reactors
  - More remotized primary system
  - Despite frequent fuel handling expected for test systems

Regulatory Drivers:
40 CFR 190 – Total Fuel Cycle Release

Nuclide	*Allowable Release*	*Reduction Required to Meet 40CFR190 Limit*
Krypton-85	50,000 Ci/GWe-y	None
Iodine-129	5 x 10^{-3} Ci/GWe-y	None
Transuranics	5 x 10^{-4} Ci/GWe-y	>1 x 10^{5} *

* Necessitates high recovery factor for transuranics as well as highly-durable waste form for containment of residual transuranics

Fuel Cycle Facilities

- A variety of separations options are being considered
  - Conventional PUREX, safe operation but proliferation concerns
  - Advanced aqueous alternatives, no pure plutonium separation
  - Electrochemical dry process, limited application at EBR-2

- Two main alternatives for recycle fuel fabrication
  - Mixed oxide for utilization in LWR or fast reactor
  - Metal alloy fuel for utilization in fast reactor

- In both facility types, limiting the loss fraction of transuranics will be critical to meet waste management goals and 40 CFR 190 criteria

- With regard to environmental protection, low occupational doses have been demonstrated in operating separations plants
  - However, limits for volatile fission products may be an issue as existing plant's approach for release and venting may not be applicable in U.S.

Regulatory Drivers: 10 CFR 20

(Allowable release, Curies/m^3)

	Radionuclide	*In Air, at Site Boundary*	*In Water*	Ci/m^3/t SNF
Gases	Tritium	1 x 10^{-7}	1 x 10^{-3}	6.0 x 10^{-4}
	Carbon-14 (as CO_2)	3 x 10^{-7}	-	5.0 x 10^{-4}
	Krypton-85	7 x 10^{-7}	-	6.6 x 10^{-2}
	Iodine-129	4 x 10^{-11}	2 x 10^{-7}	6.1 x 10^{-2}
Solids	Technetium-99	2 x 10^{-6}	6 x 10^{-5}	1.1 x 10^{-4}
	Strontium-90	3 x 10^{-11}	5 x 10^{-7}	2.5 x 10^{-4}
	Cesium-137	2 x 10^{-10}	1 x 10^{-6}	8.8 x 10^{-4}
	Uranium-238	3 x 10^{-12}	3 x 10^{-7}	4.8 x 10^{-2}
	Plutonium-239	2 x 10^{-14}	2 x 10^{-8}	3.8 x 10^{-4}
	Neptunium-237	1 x 10^{-14}	2 x 10^{-8}	5.5 x 10^{-4}
	Americium-241	2 x 10^{-14}	2 x 10^{-8}	5.2 x 10^{-5}

Advanced Nuclear Fuel Cycle - Waste Management

- Waste management is an important factor in developing and implementing an advanced closed nuclear fuel cycle
  - The waste management system is broader than disposal (processing, storage, transportation, disposal)
  - Deep geologic disposal will still be required
  - Disposal of low level and intermediate level (GTCC) wastes will be required
    - *Volumes potentially larger than once-through*
- An advanced closed nuclear fuel cycle would allow for a re-optimization of the back-end of the current once-through fuel cycle, taking advantage of:
  - Minor actinide separation/transmutation
  - Heat producing fission product (Cs/Sr) management (i.e., decay storage)
- Decisions must consider this entire system
  - Regulatory, economic, risk/safety, environmental, other considerations

Advanced Nuclear Fuel Cycle – Potential Benefits

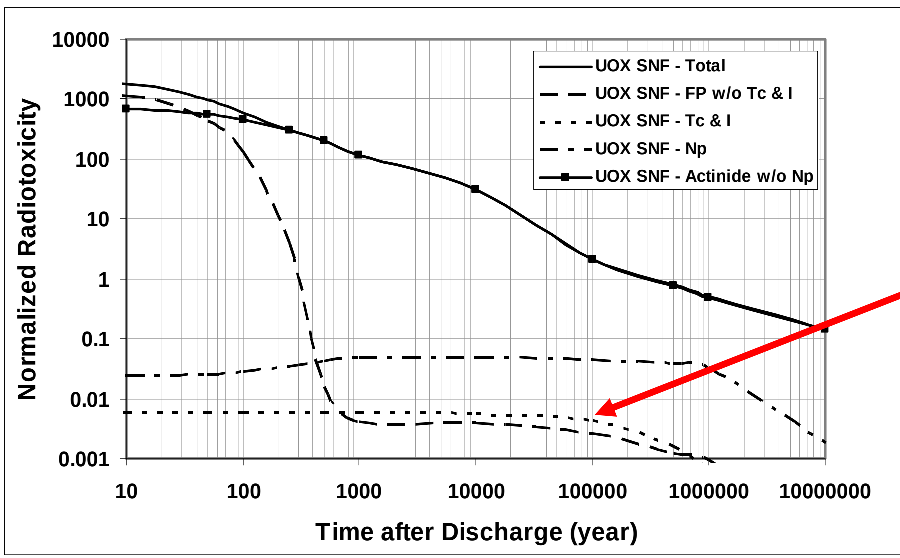
- Reduction in the volume of HLW that must be disposed in a deep geologic disposal facility as compared to the direct disposal of spent nuclear fuel
  - Factor of 2-5 reduction in volume as compared to spent nuclear fuel
  - Intermediate-level (GTCC) and low-level volumes could be large and disposal pathways would have to be developed

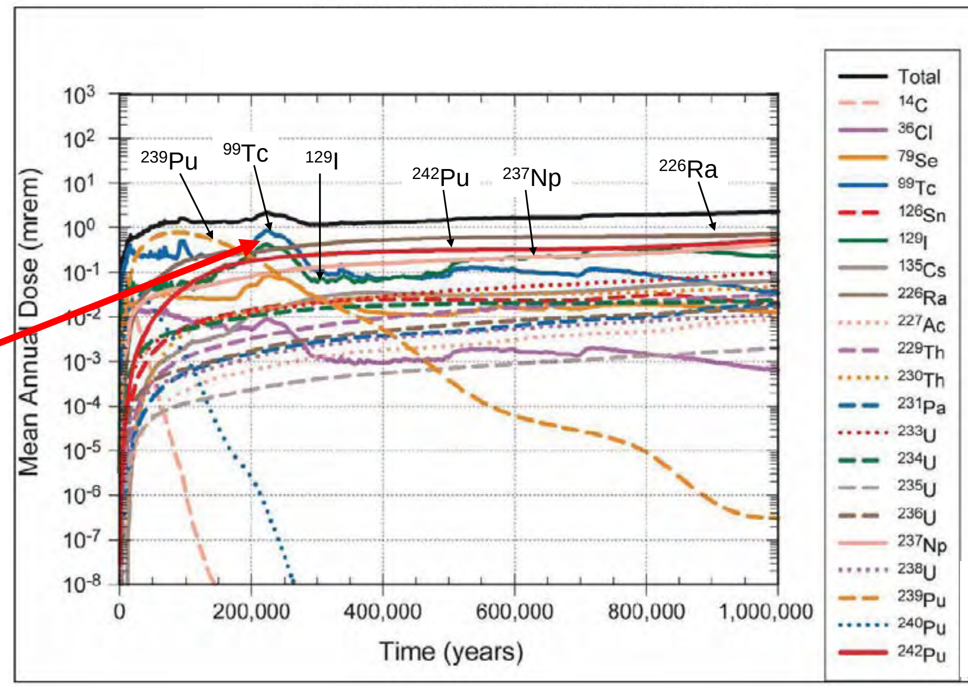
- Reduction in the amount of long-lived radioactive material (e.g., minor actinides) that must be isolated in a geologic disposal facility (reduction of source term)
  - Potential for re-design of engineered barriers
  - Advanced waste forms could result in improved performance and reduced uncertainty over the very long time periods

- Reduction in decay heat allowing for increased thermal management flexibility, potentially increasing emplacement density
  - Increased loading density - better utilization of valuable repository space

Waste Hazard and Risk Measures

- Radiotoxicity reflects the hazard of the source materials
  - transuranics dominate after about a 100 years. The fission products contribution to the radiotoxicity is small after 100 years
- Radiotoxicity alone does not provide any indication of how a geologic repository may perform
  - Engineered and natural barriers serve to isolate the wastes or control the release of radionuclides



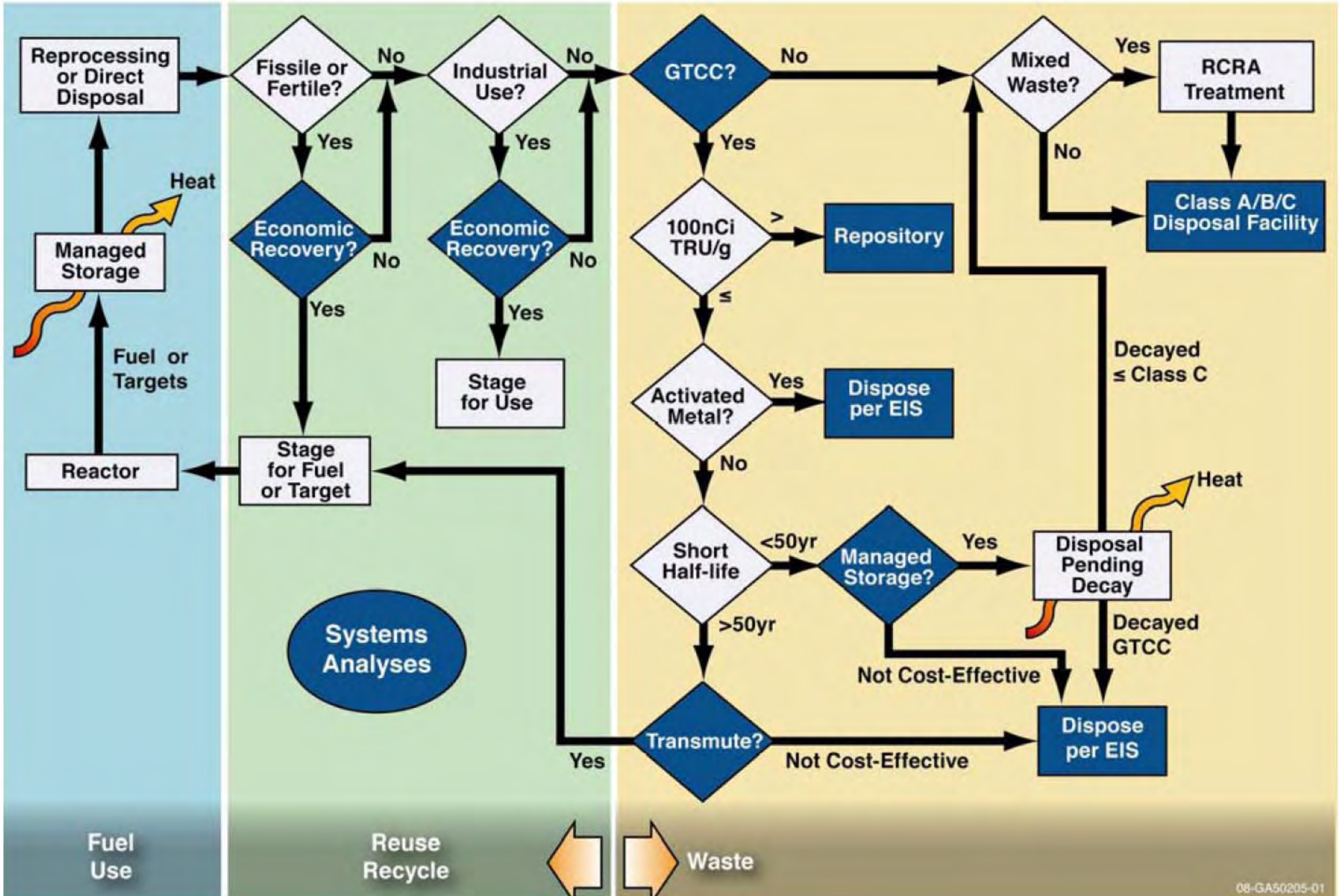


Waste Management System for Advanced Fuel Cycle

- AFCI Integrated Waste Management Strategy establishes the framework for analyzing and optimizing the waste management system
  - Emphasizes recycle and reuse, but based on economic recovery evaluation factoring in value of material and cost avoidance of disposal
  - Considers need for industry to have a reliable system to routinely transport nuclear materials and dispose wastes
  - Considers disposal options based on the risk of the waste streams and waste forms
    - *Rather than requiring all waste be disposed as HLW in a geologic repository*
    - *Requires change to existing waste classification system embodied in current regulatory framework*
  - A key aspect is the inclusion of managed storage facilities where isotopic concentrations, and heat, are allowed to decay prior to storage

- Evaluation of alternatives and options are being performed under the context of the IWMS

Integrated Waste Management Strategy – Logic Diagram



New Nuclear Power Stations in the UK

David Bennett

Environment Agency, UK

Scene setting

- 10 nuclear power stations still operating
- Produce 16 % of UK electricity
- Two regulators:
  - safety and security (Nuclear Installations Inspectorate)
  - environment (Environment Agency - in England and Wales)

Environment Agency

January 2008 new Government policy on nuclear power

"… in the public interest that new nuclear power stations should have a role to play in future energy mix…;

Why nuclear?

- low carbon
- secure/dependable

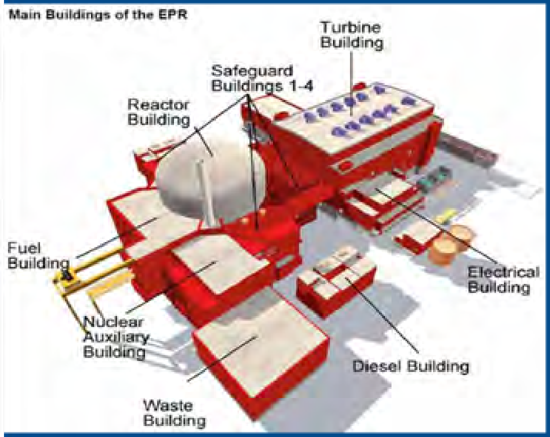
Why now?

- substantial new capacity required in next 20 y

Environment Agency

What are the regulators doing?

- ‘Generic design assessment’ (GDA) - work with reactor vendors



AREVA/EDF

EPR

1,600 MW

Westinghouse

AP1000

1,100 MW

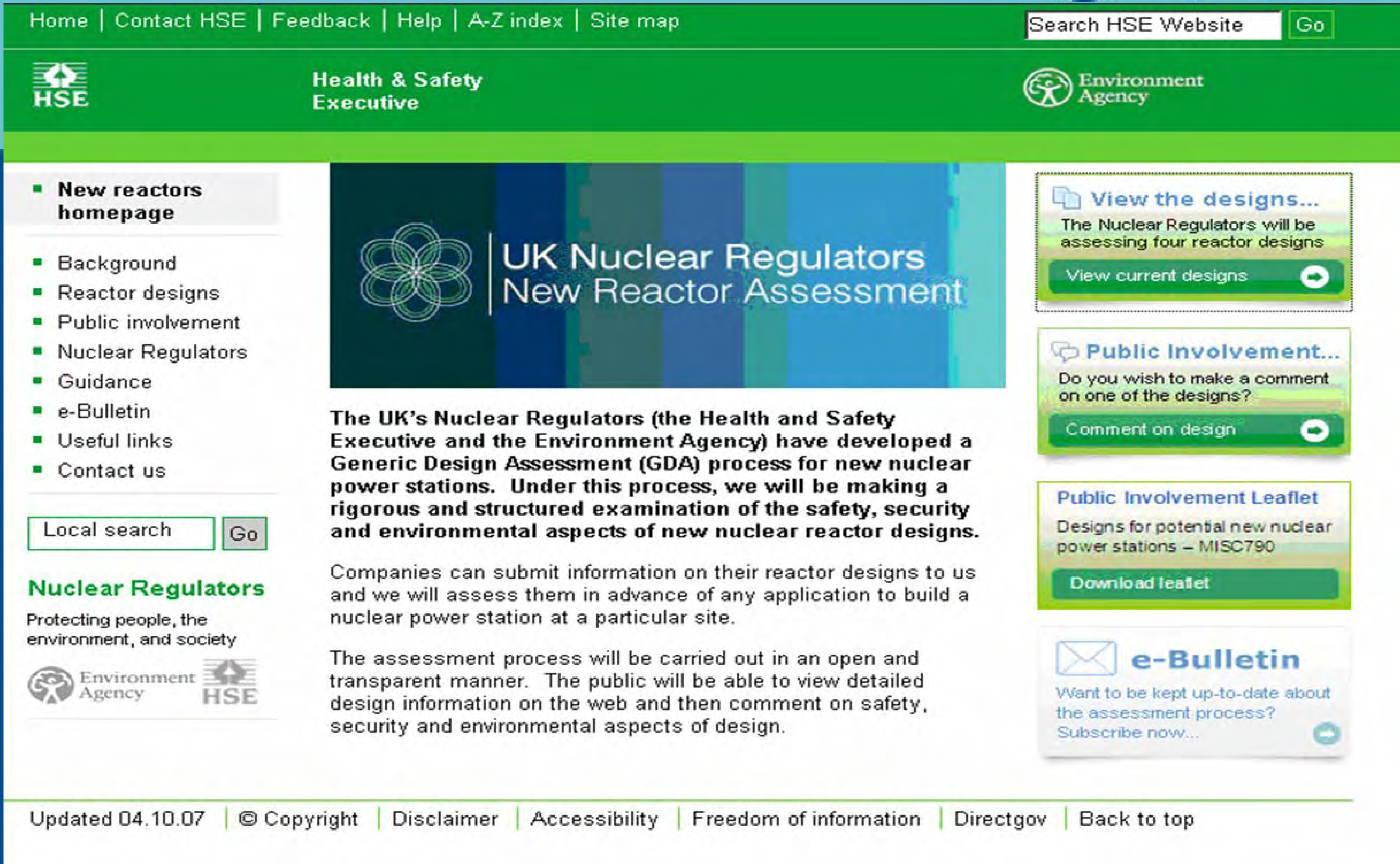
- Preliminary work with potential reactor operators

GDA - what is it?

- Early regulatory scrutiny of design
- Both regulators work together as single project
- Open and transparent process
- Endpoint - statement on licensability of design
- Innovative approach in UK

GDA - progress

Public Scrutiny



www.hse.gov.uk/newreactors

GDA - advantages

- For regulators: early engagement
- For vendors: reduced project risks
- For wider stakeholders: increased confidence

GDA - challenges

- Vendors' documents - not completed
- Overseas assessments:
  - not completed
  - different basis from UK regulatory approach
- Recruitment of safety assessors

Potential new power station operators

- Considerable interest!
- We are setting out our expectations = world class performance
- Successful GDA will ease site-specific licensing. Main interests:
  - licensees organisation
  - site-specific issues

Experience Feedback on Radiation Protection In Nuclear Power Generation: Japanese Perspective

Shojiro Matsuura
Nuclear Safety Research Association

Shizuyo Kusumi
Nuclear Safety Commission, Japan

Overview on Nuclear Power Reactors in Japan

1. Commercial Nuclear Power Plans (2008)
   - NPPs in operation: 55 plants (49,315 MWe)

     BWR: 32 plants (29,949 MWe) including ABWR (4 plants)

     PW：23 plants (19,366 MWe)
   - NPPs under construction : 2 plants (2,285 MWe)
   - NPPs preparing for construction: 11 plants (14,945 MWe)

2. Prototype Future Reactors constructed:
   - Monjyu (prototype fast breeder reactor)
   - HTTR (test reactor for high temperature gas reactor)

LWR Improvement and Standardization Program: assisted by government

Main objective of the program: Reduction of radiation exposure of NPP workers

Both of BWRs and PWRs were involved in the program.

Phase-1 of the program started in 1975 and Phase-2 followed.

Main items of improvement:

- crud reduction based on experience and knowledge of water chemistry
- utilization of low or non-Co metals
- decontamination of reactor well, pipe lines, steam generator
- additional shielding for highly radioactive components
- utilization of automatic system for maintenance and measurement works

Development of ABWR and APWR in the Phase-3: Gen-III evolutional LWR

- utilization of experience of the Phase-1 and Phase-2 improvement works
- many fundamental improvement from the design stage
- enhancement of reactor safety assurance
- increase of economical performance

Reduction of Occupational Radiation Exposure due to the improvement program

- annual collective dose (man-Sv/plant) around 1980: ~ 6
- gradually reducing the dose along steps of the improvement program
- annual collective dose (man-Sv/plant) after 1990: ~ 1.5
- additional efforts required in technological and managerial improvement
- target annual collective dose (man-Sv/plant) in future: 0.1

Launch of the Next Generation LWR Development Program in April 2008

Target on the year around 2030: Replace of many of present NPPs

Main items of development: Very high performance of safety and economy

- utilization of higher enriched fuel: reduction of SF and high operation rate
- improvement of material for SG and reactor internal component
- development of water quality control based on water chemistry
- development of earthquake-proof technology
- reduction of construction time by using improved technology
- enhancement of safety based on combination of passive and active components

Nuclear Energy in the United States 2009

Alex Marion
Vice President - Nuclear Operations
Nuclear Energy Institute

NCRP 2009 Annual Meeting
Bethesda, MD
March 2, 2009

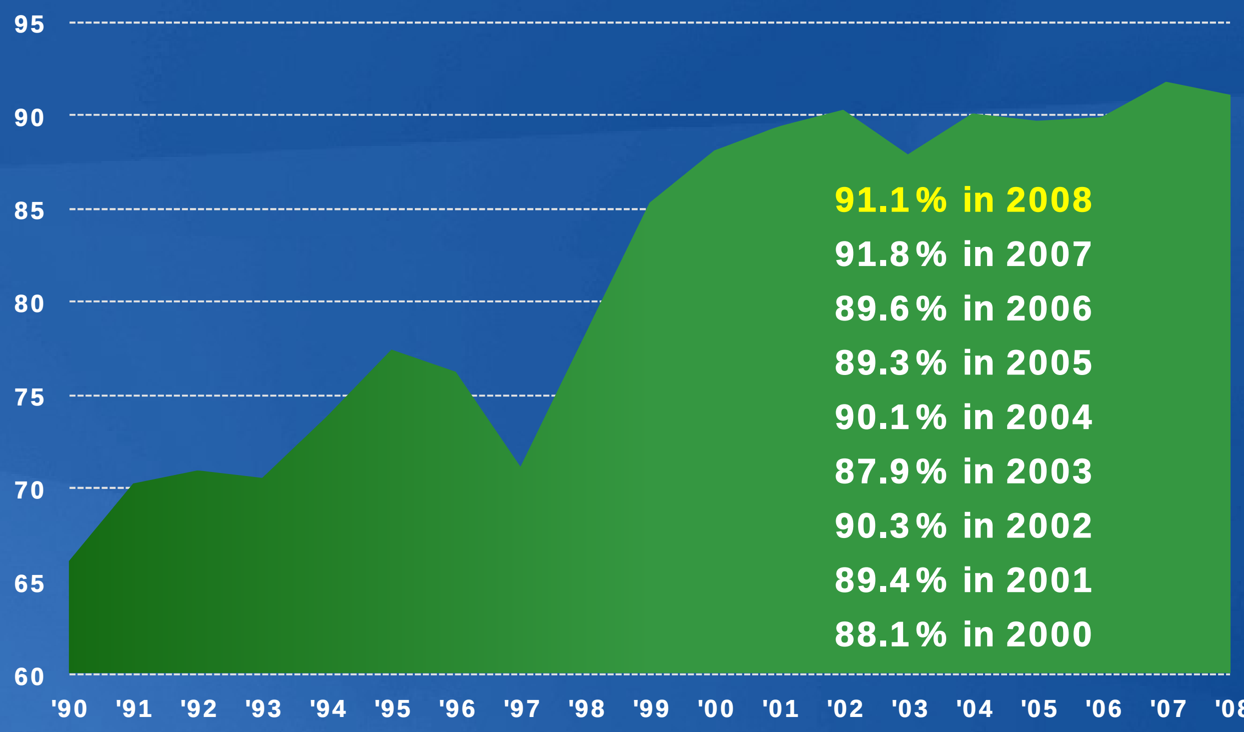
NEI
NUCLEAR ENERGY INSTITUTE

Sustained Reliability

U.S. Nuclear Plant Average Capacity Factor

Highlights

- Refueling outages: 66 in 2008, 56 in 2007
- Average outage duration: 37.6 days in 2008, 40.4 days in 2007



Sources: Ventyx Velocity Suite, U.S. Energy Information Administration, U.S. Nuclear Regulatory Commission, NEI estimate for 2008

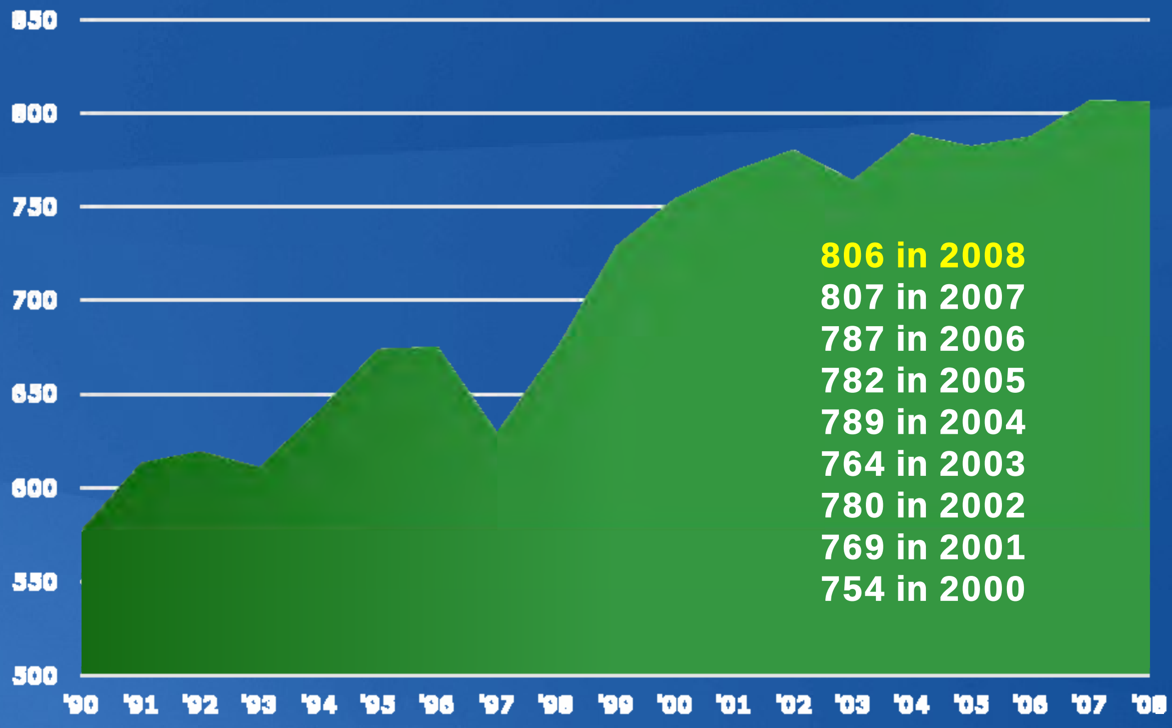
NEI

Steady Output From the Operating Plants

U.S. Nuclear Generation (billion kilowatt-hours)

Highlights

- 5,640 MW of power uprates approved since 1977
- 595 MW of uprates under review
- 2,882 MW of uprates expected by 2013

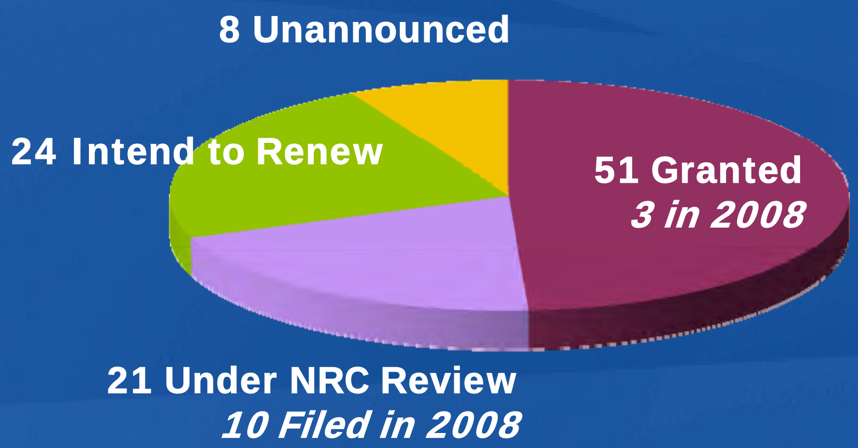


Sources: Ventyx Velocity Suite, U.S. Energy Information Administration, U.S. Nuclear Regulatory Commission, NEI estimate for 2008

NEI

Other Key Highlights From 2008

License Renewals Continue ...



Source: U.S. Nuclear Regulatory Commission

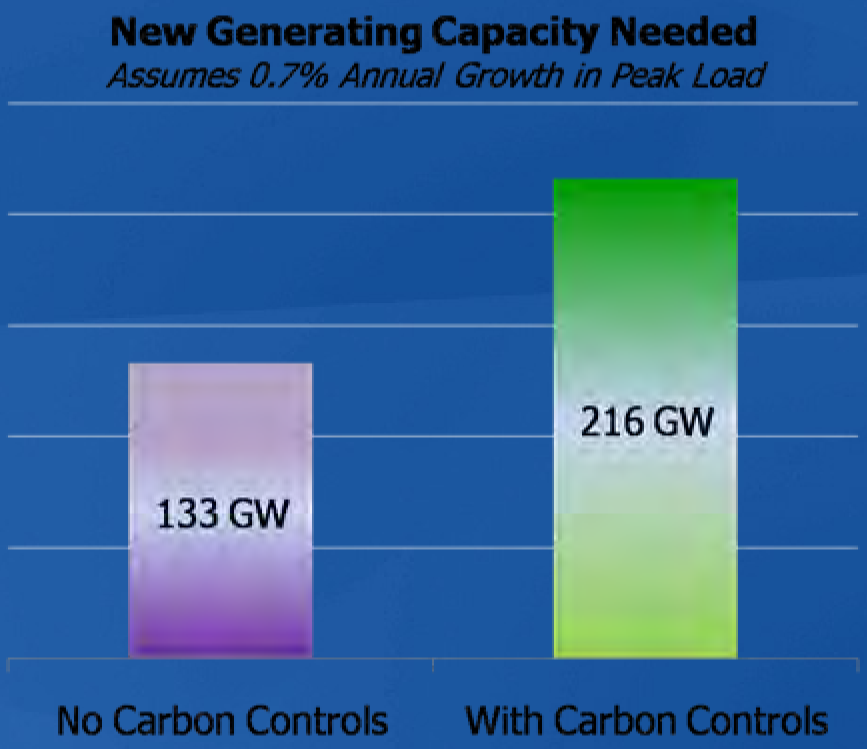
... And America's 105th Plant Is Well Under Way

- TVA sanctioned Watts Bar 2 completion in August 2007
- 5-year, $2.5 billion project
- On schedule and on budget for April 2012 construction completion
- Currently employs 1,500 people on-site

NEI

The Business Case for Nuclear Power

- Need for new baseload capacity
- Constraints on carbon emissions
- Solid business case for new nuclear plants at commercial operation in 2016 and beyond



Source: The Brattle Group, "Transforming America's Power Industry: The Investment Challenge 2010-2030," November 2008

New Nuclear Power Plants Will Be Competitive

- FP&L: Nuclear superior in 8 of 9 scenarios
- Progress: Nuclear "better than AFBC, pulverized coal and coal gasification"
- Brattle Group analysis:

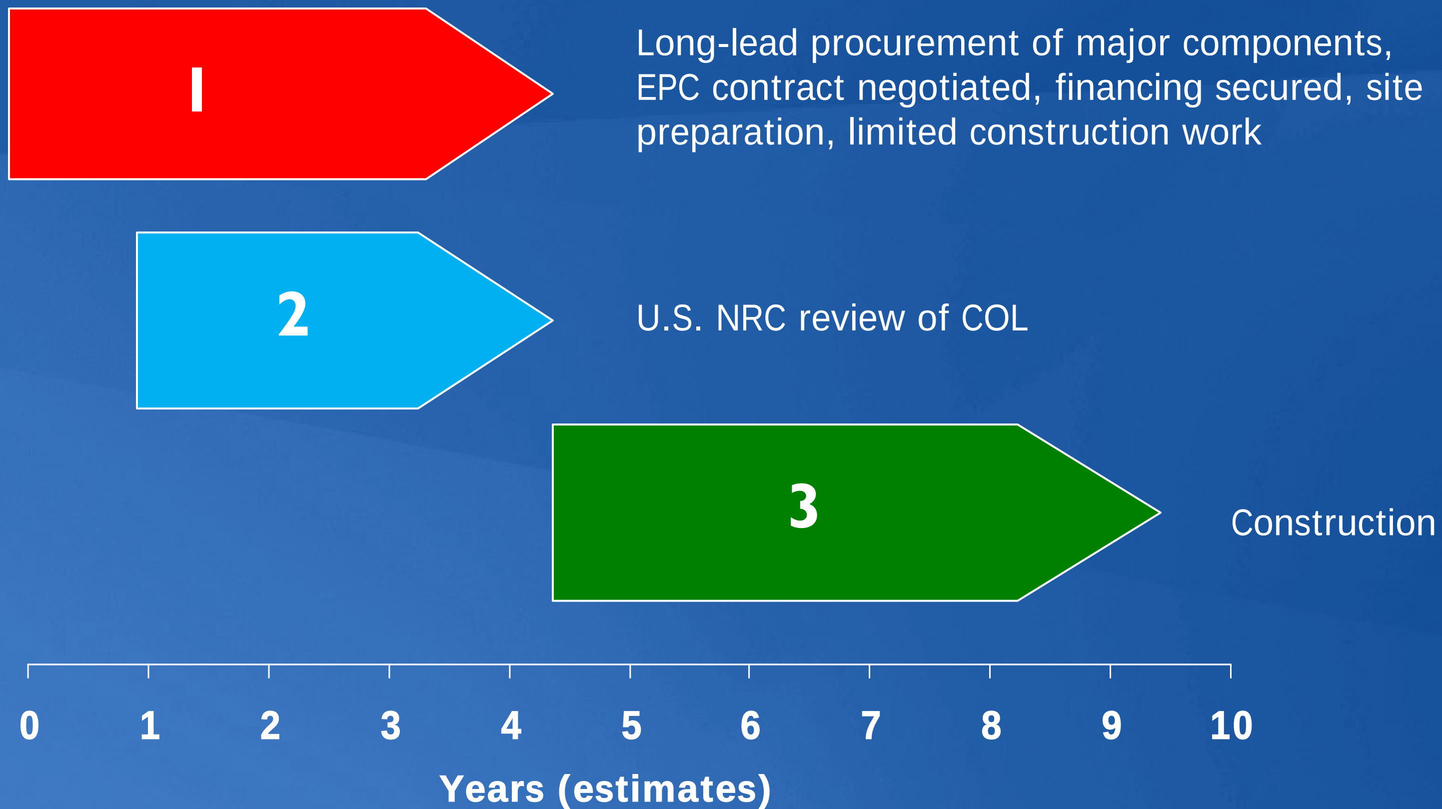
Technology	Nuclear	SCPC w/CCS	IGCC w/CCS	Gas CC w/CCS
Capital Cost ($/kWe)	4,038	4,037	3,387	1,558
Levelized Cost ($/MWh)	83.40	141.90	124.50	103.10

Source: "Integrated Resource Plan for Connecticut," The Brattle Group, January 2008

NEI

Road Map to Commercial Operation

Building a new nuclear plant is not a one-step process or decision. It is a sequence of decisions, which provides substantial flexibility.



Progress Toward New-Plant Development

2007

- 3 early site permits granted
- 2 design certifications submitted
- 4 COL applications submitted

2008

- 1 design certification submitted
- 13 COL applications submitted
- 3 engineering and procurement contracts signed
- Fabrication of long-lead components

2009-2010

- Site excavations begin
- 1 early site permit expected
- Additional COL applications

NEI

Radiation Protection at U.S. Nuclear Power Plants Today and Tomorrow

Mike Blevins

March 2, 2009

NUCLEAR ENERGY INSTITUTE

Today

- Collective and individual occupational radiation doses are at an all time low
- Public radiation doses are at a small fraction (<1 %) of regulatory limits and well within guidelines that define ALARA
- Plant radiation protection staff are highly trained, qualified and experienced

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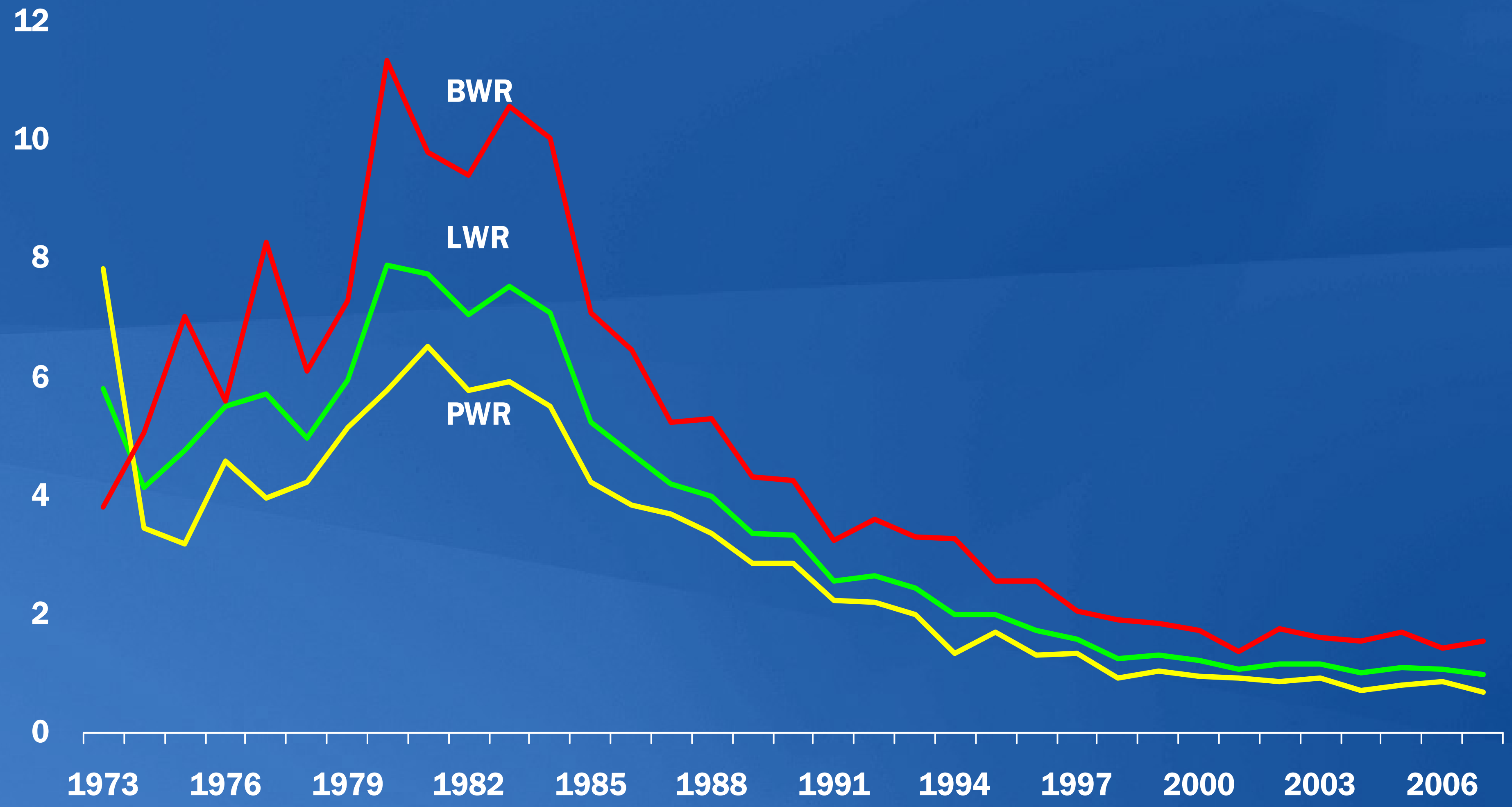
Average Collective Dose Per Reactor

1973-2006 (person-Sv)



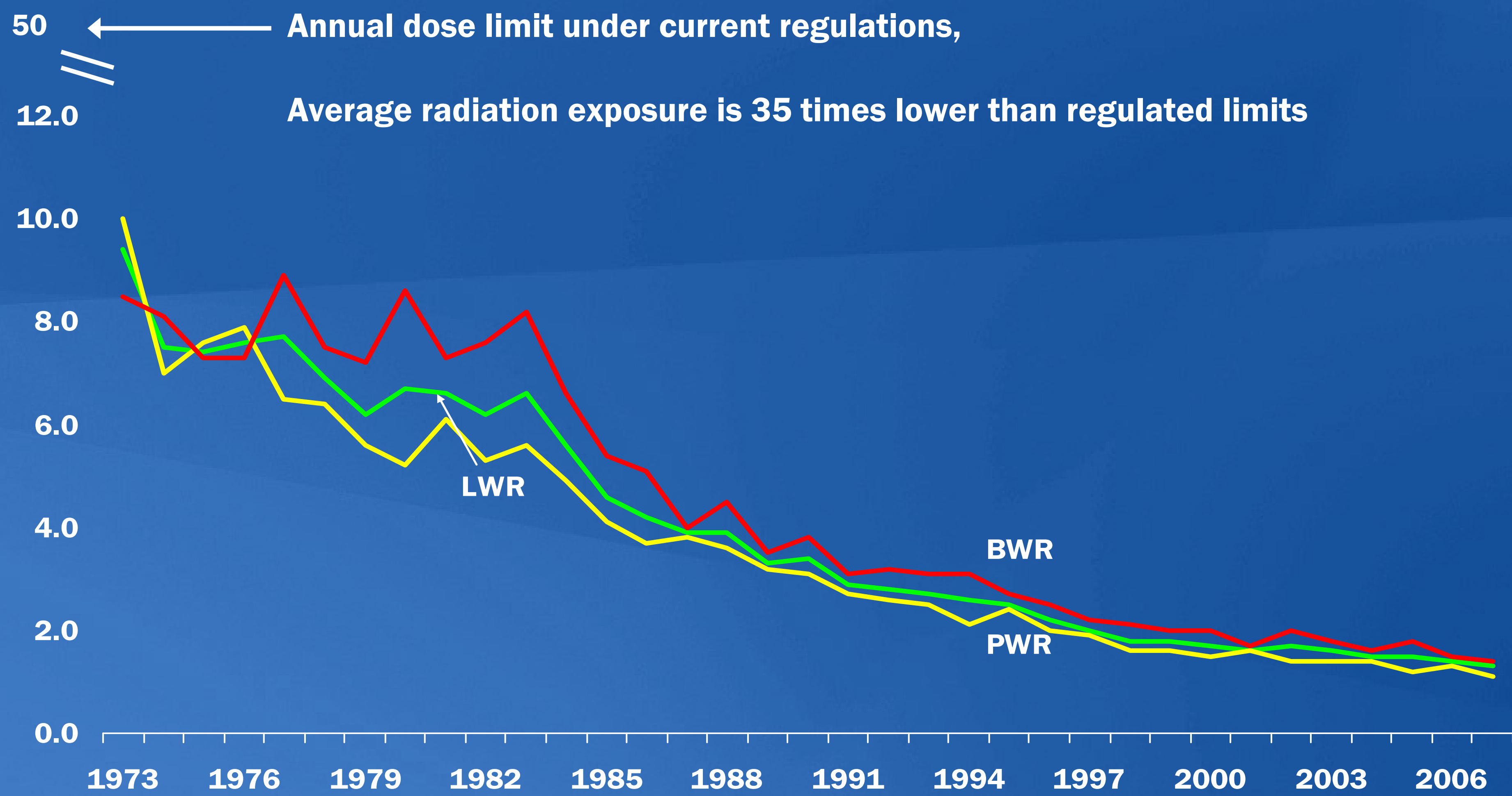
NEI

Source: Nuclear Regulatory Commission - Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2006

Updated: 5/08

Average Measurable Dose Per Worker

1973-2006 (mSv)



NEI

Source: Nuclear Regulatory Commission - Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2006

Updated: 5/08

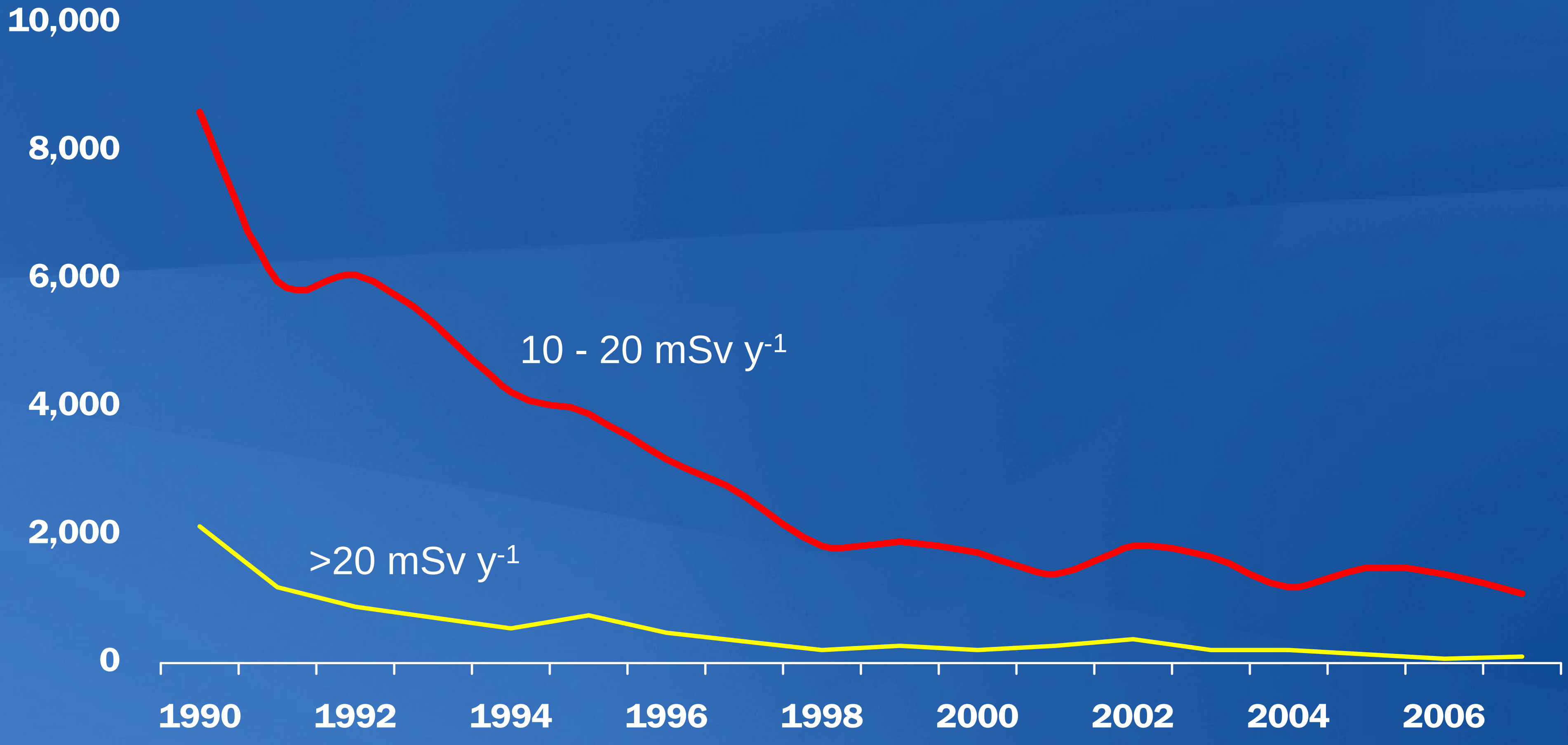
Tomorrow

- **Scientific understanding of radiation risk is increasingly complex**
  - *Cellular and molecular biology and non-cancer health effects*
- **Emerging radiation protection standards**
  - *Lower dose limits and new concepts*
- **Increased limitations on workforce and infrastructure**
  - *People, equipment and services*
- **Challenges to public trust and confidence in us and our radiation safety programs**
  - *Confusing and conflicting information with little or no context*

NEI

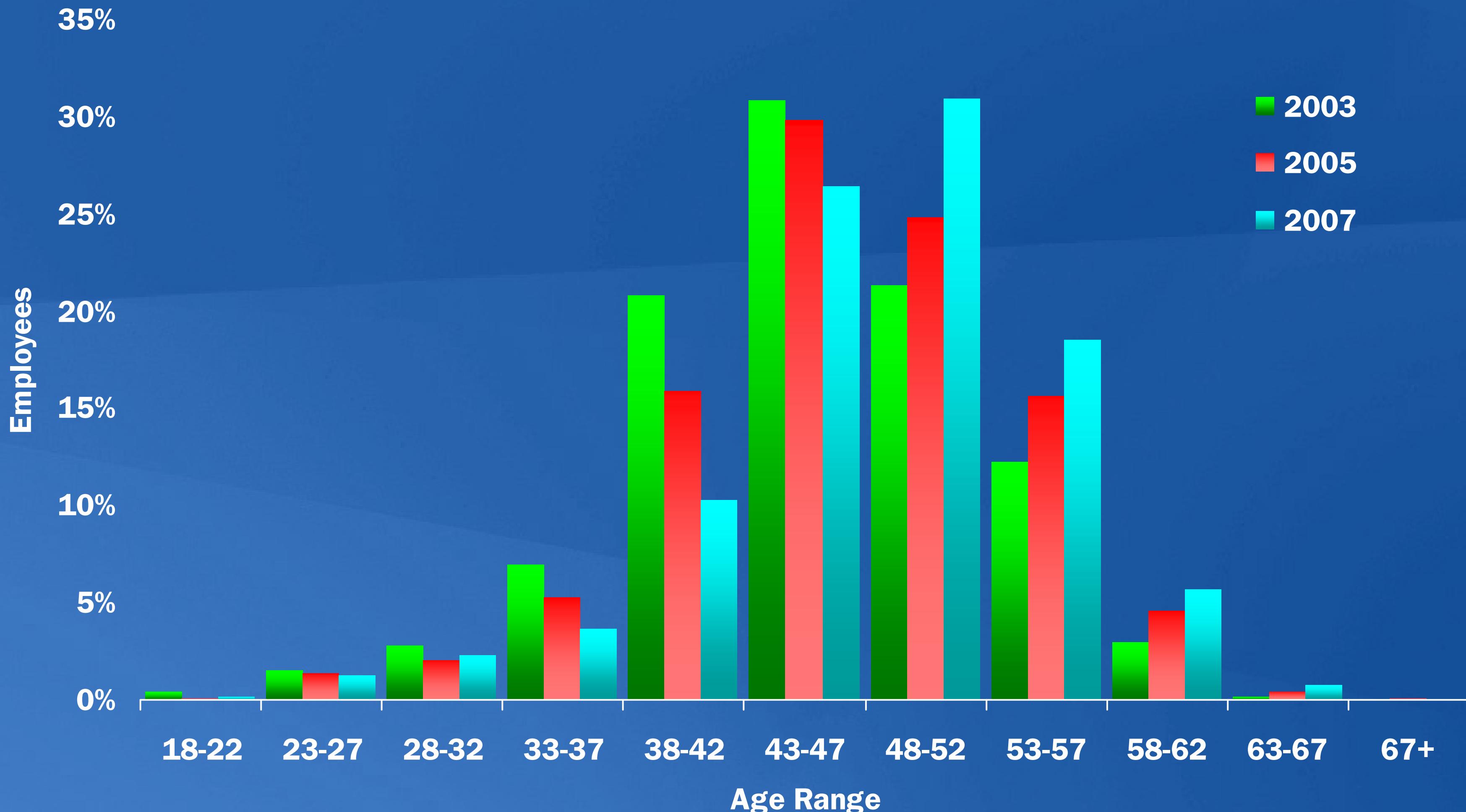
Annual Individual Worker Exposure at U.S. Nuclear Power Plants

1990-2006 (number of workers per year)



Source: Nuclear Regulatory Commission - Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2006
Updated: 5/08

Nuclear Generation Radiation Protection Distribution by Age

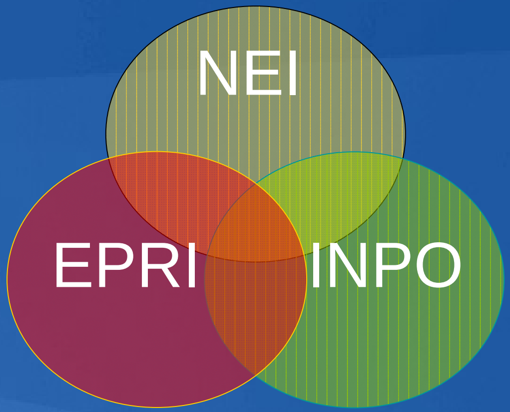


Source: 2007 NEI Pipeline Survey

Partners in Creating Radiation Protection 2020

Radiation Protection Managers

Chief Nuclear Officers



NEI = policy
INPO = performance
EPRI = research

NEI

Goal

Reshape radiation protection at nuclear power plants to achieve significant improvements in safety performance and cost-effectiveness

Objectives

1. Inform and influence radiation protection regulations
2. Reduce radiation fields
3. Improve technologies utilization
4. Standardize radiation protection practices
5. Align radiation protection workforce supply & demand
6. Improve radiation protection transparency and openness

Principles

1. Radiation is managed safely
2. Radiation doses are ALARA
3. Step-change improvements are needed
4. Dose is the bottom-line metric
5. Workers and the public need to be informed and involved
6. Radiation protection is global

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Ongoing Industry Actions

- Reduce radiation fields (EPRI)
  - Collect and analyze radiation field data
  - Corrosion, transport and activation mechanisms
  - Effects of surface treatments and chemical additions
- Improve technologies utilization (EPRI)
  - Inspection and welding
  - Communication and monitoring
  - Shielding and scaffolding
- Workforce (NEI)
  - Activities to improve radiation protection workforce pipeline

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2009-2010 Projects

1. Determine feasibility & process for radiation protection standardization (INPO) –June 2009
2. Determine impacts of new radiation protection regulations & recommended industry actions (NEI) – November 2009
3. Evaluate permanent and temporary radiation protection staff utilization (NEI) –2010
4. Evaluate improvements to radiation protection transparency & openness (NEI) - 2010

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Radiation Protection is Global

- We are already sharing workers and radiation protection technicians
- We are all projecting a shortfall in new radiation protection staff
- We have common challenges with human performance and safety culture issues
- We have learned that an event at one of our plants is an "event" at all of our plants
- Any conflicting or confusing information about radiation safety affects us all

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Some Global Opportunities?

- Common standards and expectations for:
  - Radiation workers
  - Radiation protection technicians
- Common approaches to human performance & safety culture in regard to radiation protection
- Common protocols for public communication about radiation & radiation safety
- Global occupational dose tracking system
- Global "heads-up" information sharing system

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WNA Worldwide Overview on Front-End Nuclear Fuel Cycle's

Growth (Supply and Demand) and Health, Safety and Environmental (HSE) Issues

Sylvain Saint-Pierre
Director for Environment and Radiological Protection
World Nuclear Association

2009 Annual Meeting of the US NCRP

Future of Nuclear Power Worldwide: Safety, Health and Environment

Bethesda, Maryland, USA

March 2-3, 2009

World Nuclear Association

World Nuclear Association (WNA)

The trade association of the global nuclear industry with a worldwide membership

- Based in London, UK
- **WNA: http://www.world-nuclear.org**
- **WNN: http://www.world-nuclear-news.org**

Our membership makes us unique, global and truly representative

- Over 150 industry enterprises from over 30 countries
- Over 90 % of world uranium production and nuclear power generation

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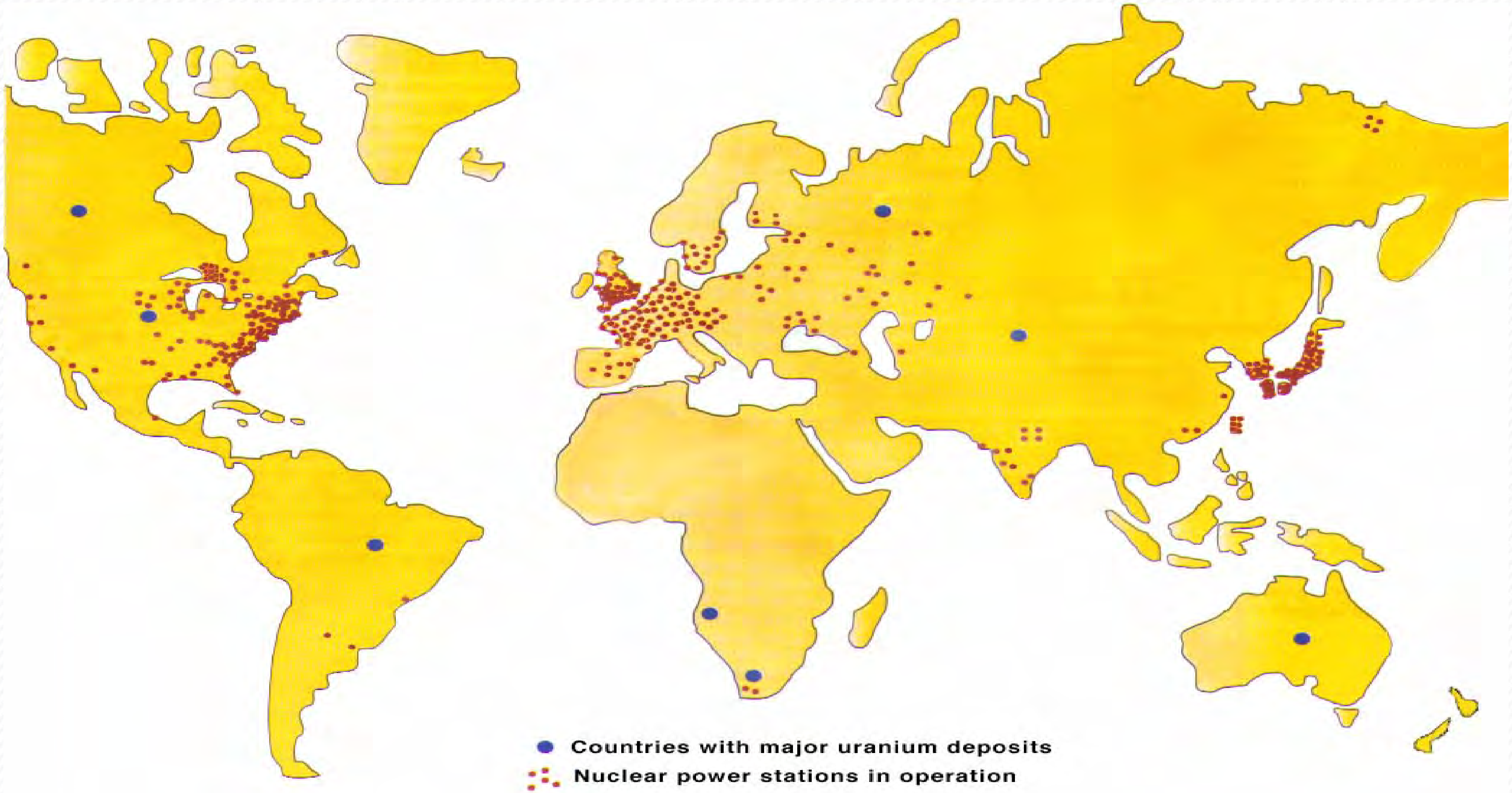
World Uranium and Nuclear Power



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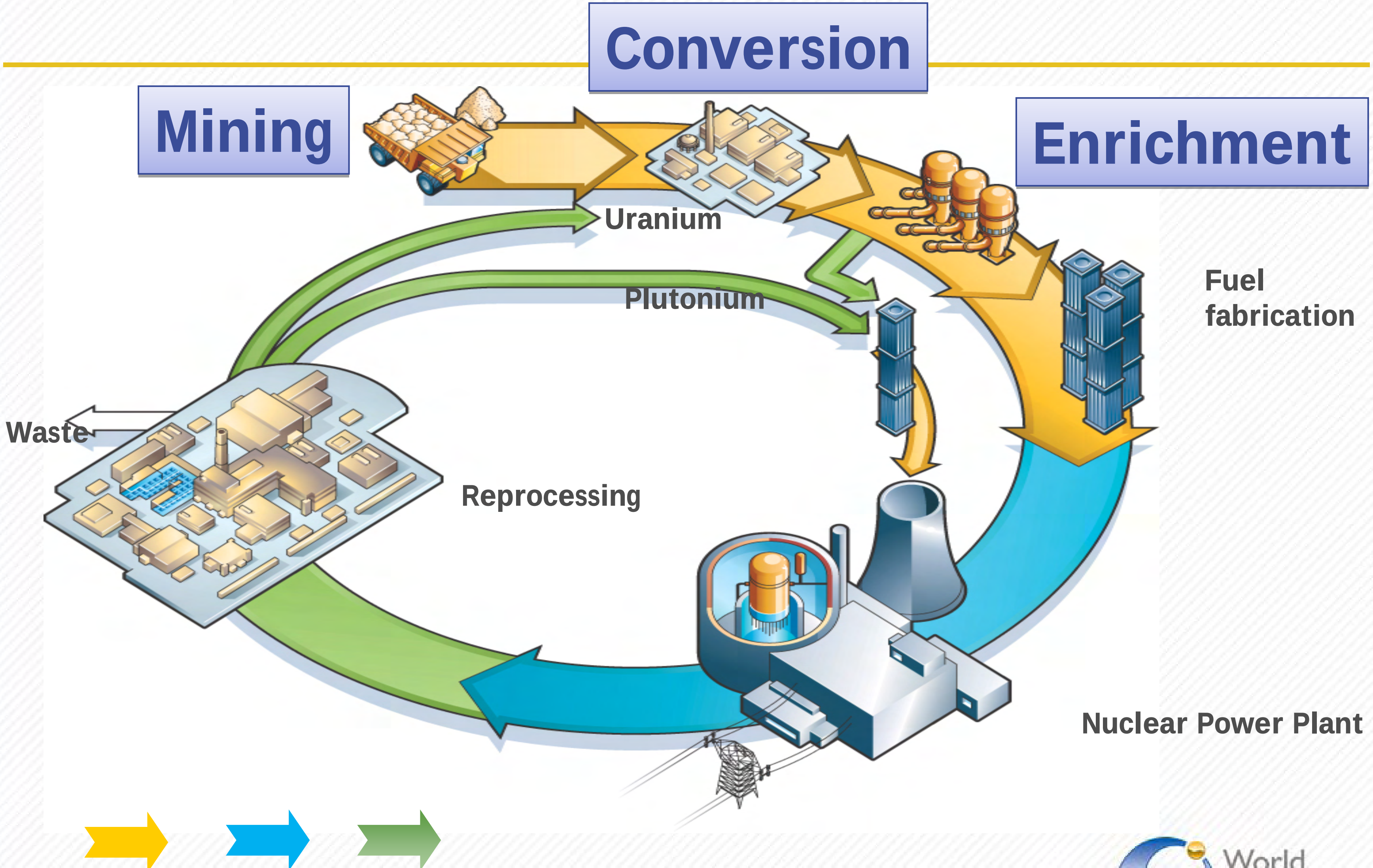
The Nuclear Fuel Cycle



Front-end

Reactors & Services

Back-end

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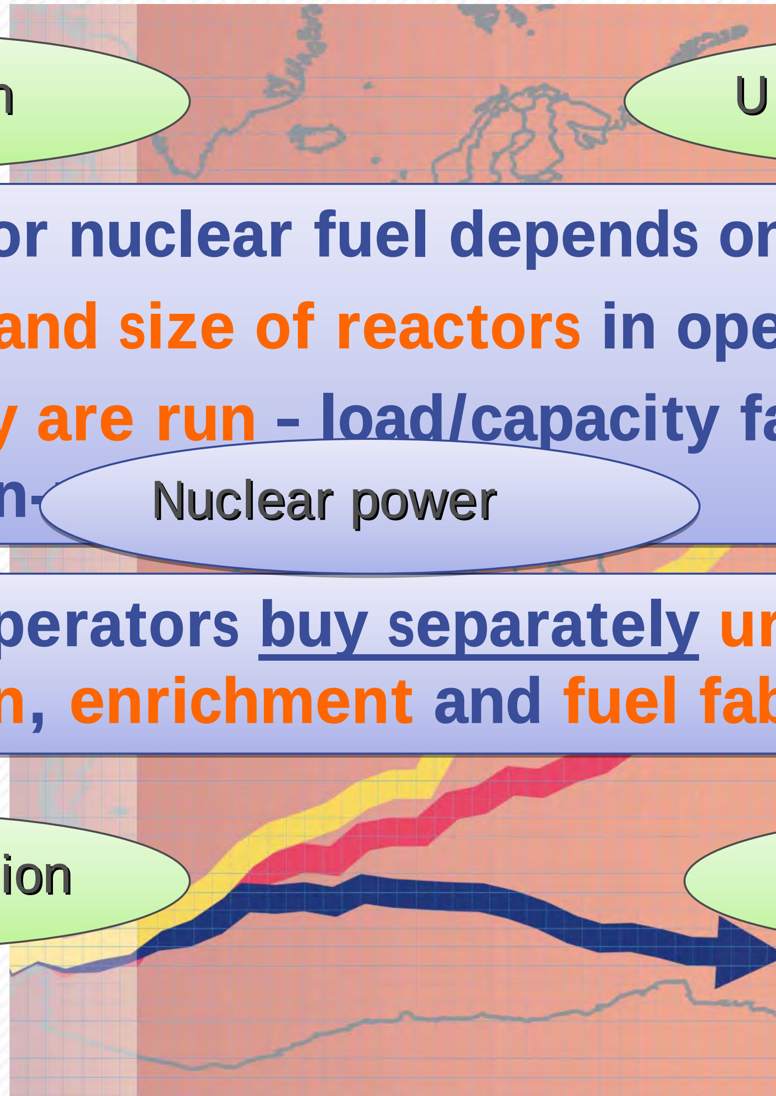
World Reference : WNA’s Market Report



U production

U conversion

Demand for nuclear fuel depends on two factors

- **Number and size of reactors in operation**
- **How they are run – load/capacity fa**

level, burn-

Nuclear power

Growth depends on Supply and Demand!

Reactor operators buy separately ur

conversion, enrichment and fuel fabrication services

Fuel fabrication

U enrichment

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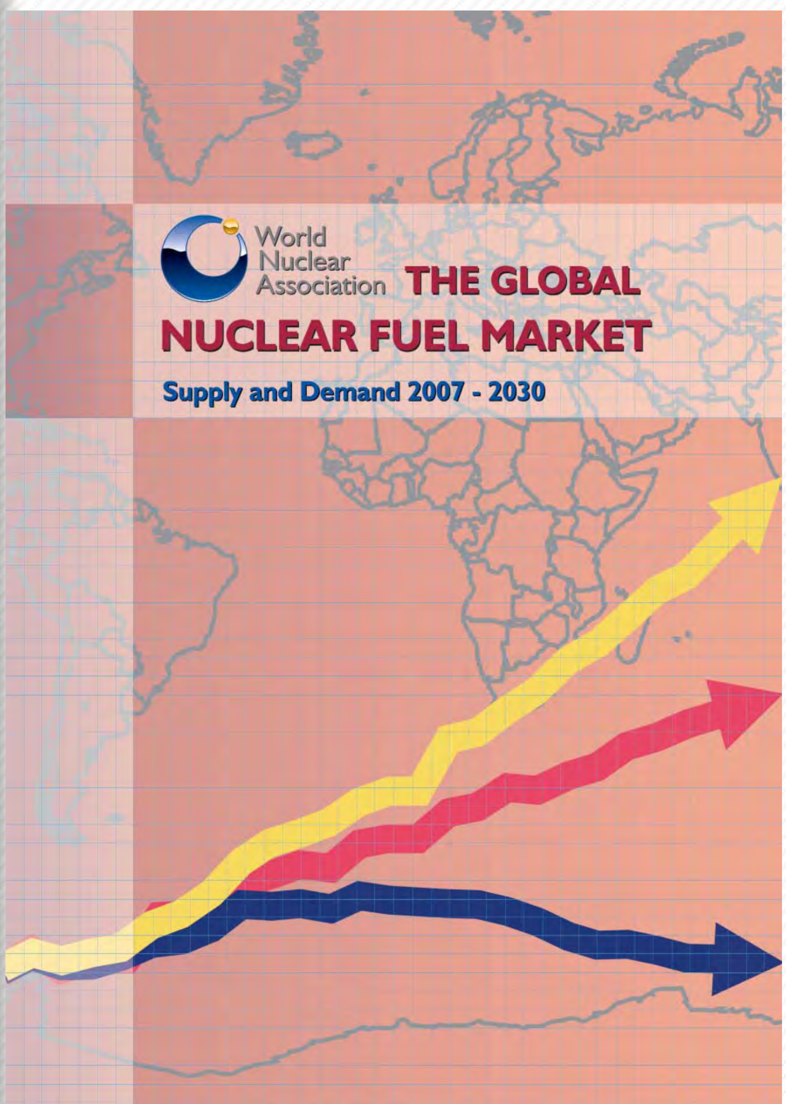
World Reference : WNA's Market Report



Considers 3 scenarios approach to nuclear power demand (2007-2030):

- **Reference case**
- **Upper case**
- **Lower case**

Generic assumptions underlie each scenario on:

- **nuclear economics**
- **public acceptance**
- **impact of climate change debate and electricity market structure**

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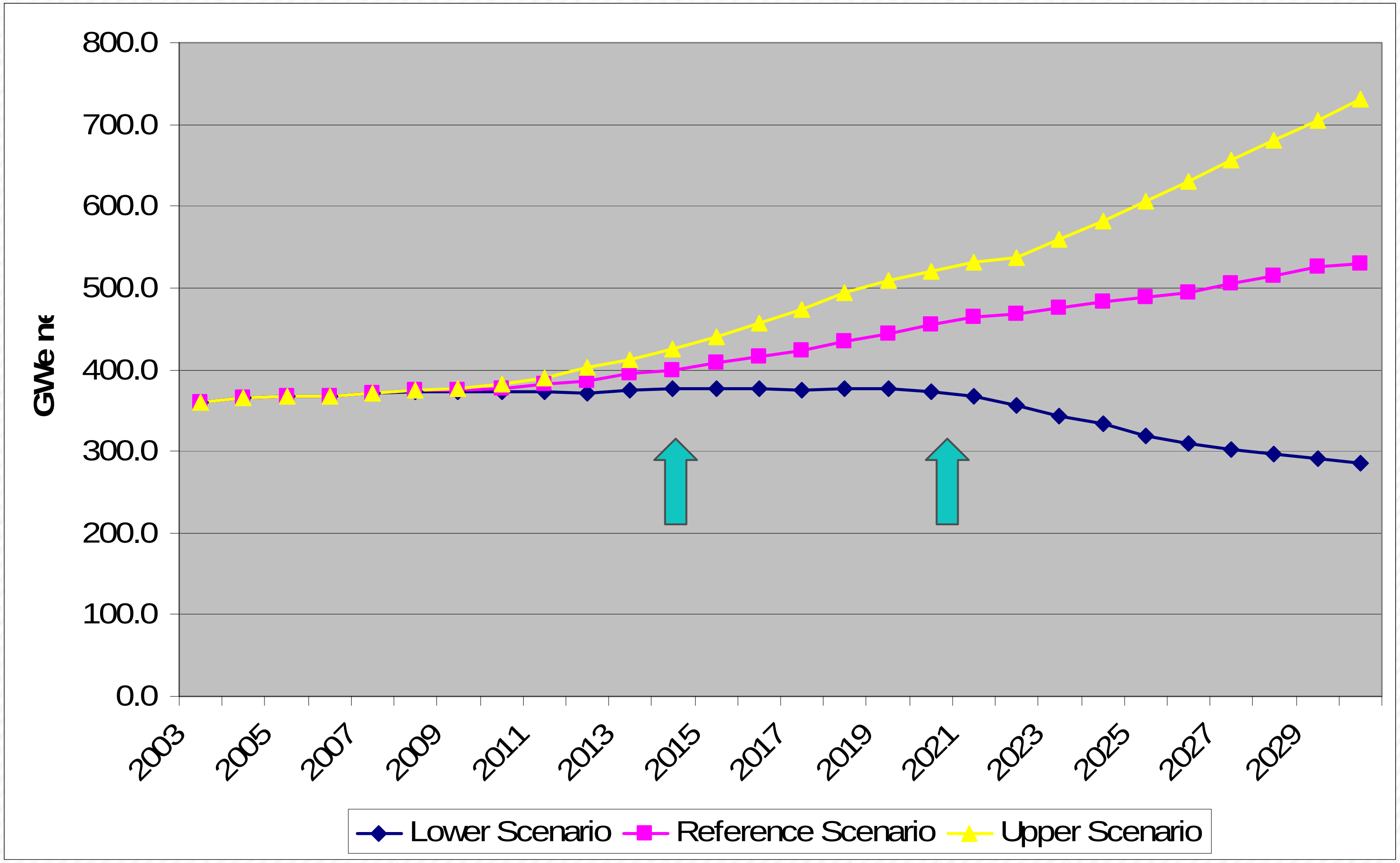
Nuclear Power Capacity to 2030 (Gwe net)



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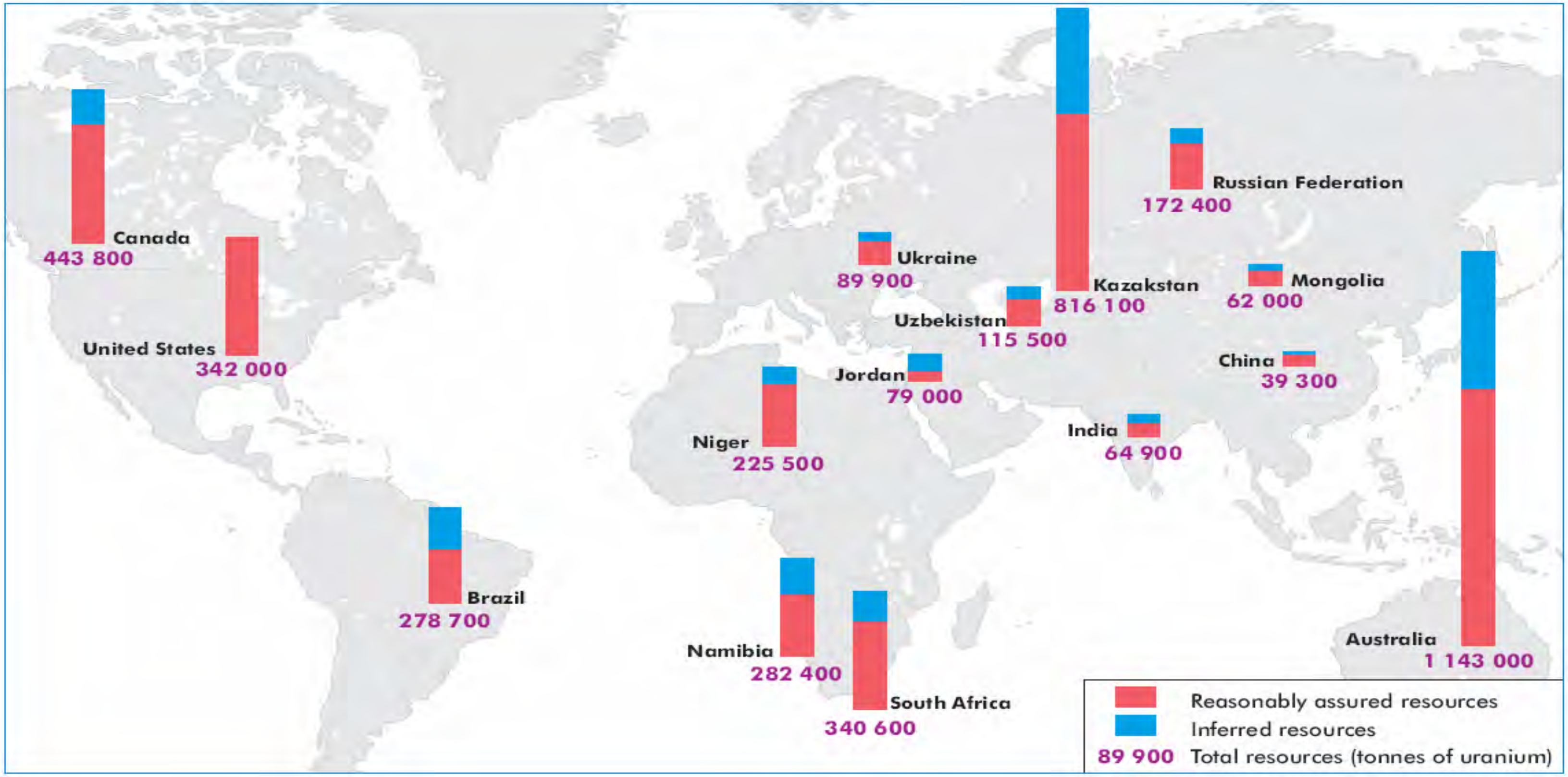
Distribution of Uranium Resources



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World Uranium Production 2006 (tU)

Canada	9,862
Australia	7,594
Kazakhstan	5,279
Niger	3,431
Russia	3,262
Namibia	3,067
Uzbekistan	2,260
USA	1,762
Others	3,009
Total	39,526 tU

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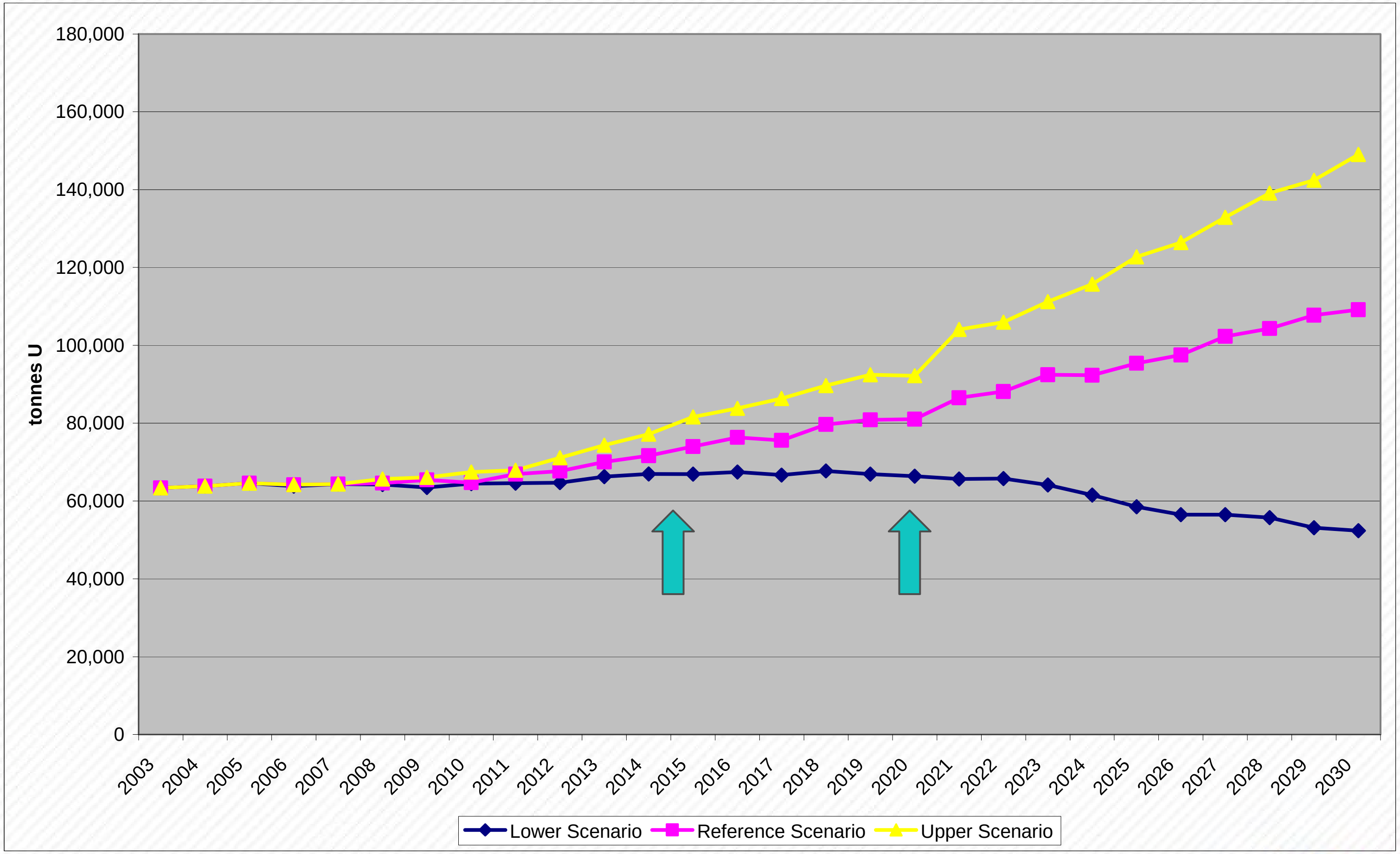
Uranium Requirements to 2030 (tU)



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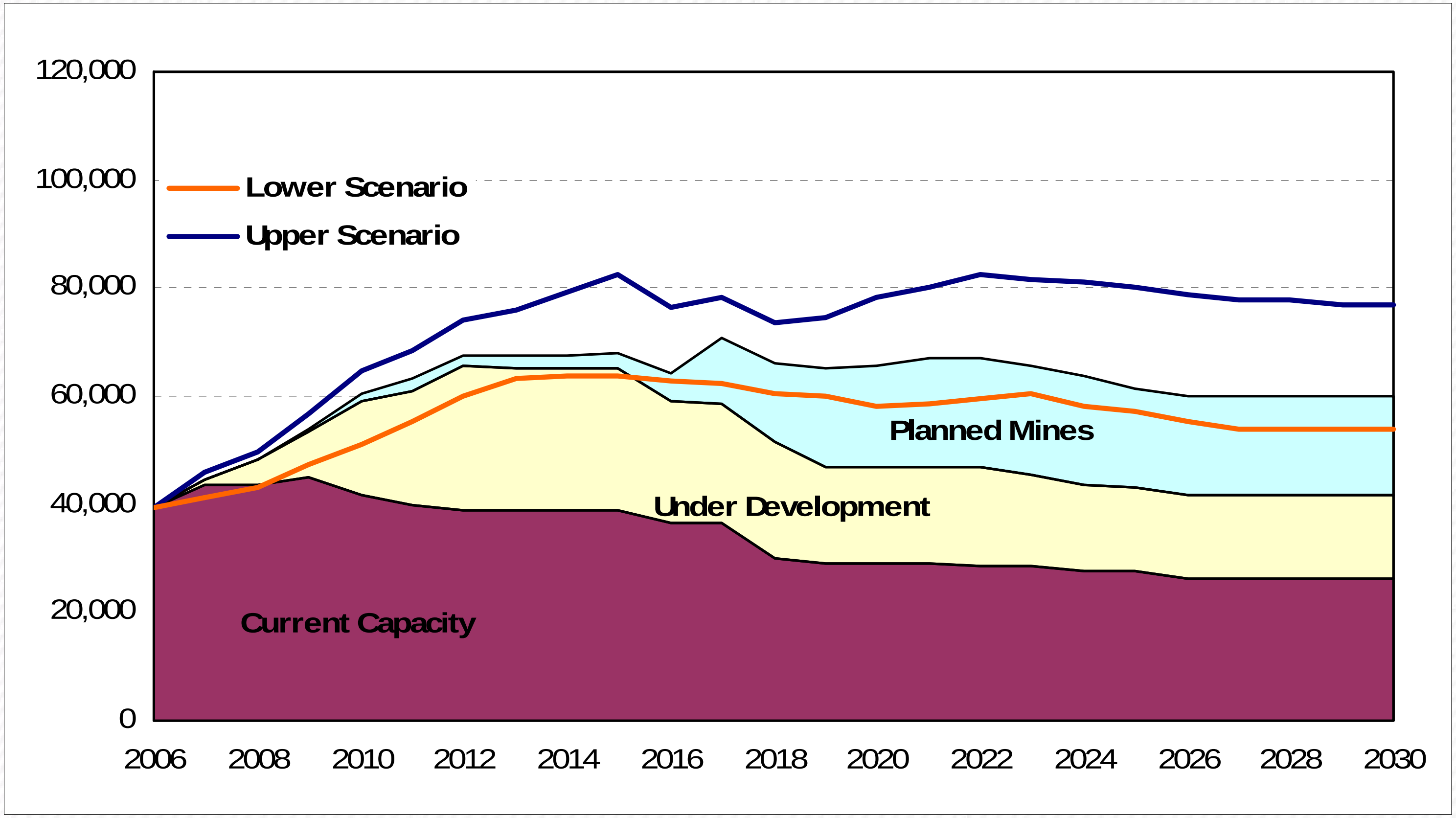
Uranium Mining (primary supply) to 2030 (tU)



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Uranium Mining Outlook

1. Uranium market has sound supply up to 2015-20 but meeting demand becomes likely more challenging thereafter

2. Primary uranium supply (mining) needs to rise sharply to meet rising market demand
   - Canada and Australia will expand, key increases from Kazakhstan, new producing countries in Africa

3. *In situ* leach (ISL) will represent a greater share but conventional mining is to remain dominant

4. Secondary supplies will remain important:
   - Ex-military material, commercial inventories, MOX-RepU

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Conversion - Basics

Enrichment for light water reactors (PWR) requires conversion to UF_6 [serves 90% of all nuclear reactors]

CANDU reactors require direct conversion to UO_2

5 major UF_6 conversion suppliers – Cameco, Springfields, Comurhex, ConverDyn and Rosatom

UO_2 conversion by Cameco and domestic suppliers in Argentina, China, India and Romania

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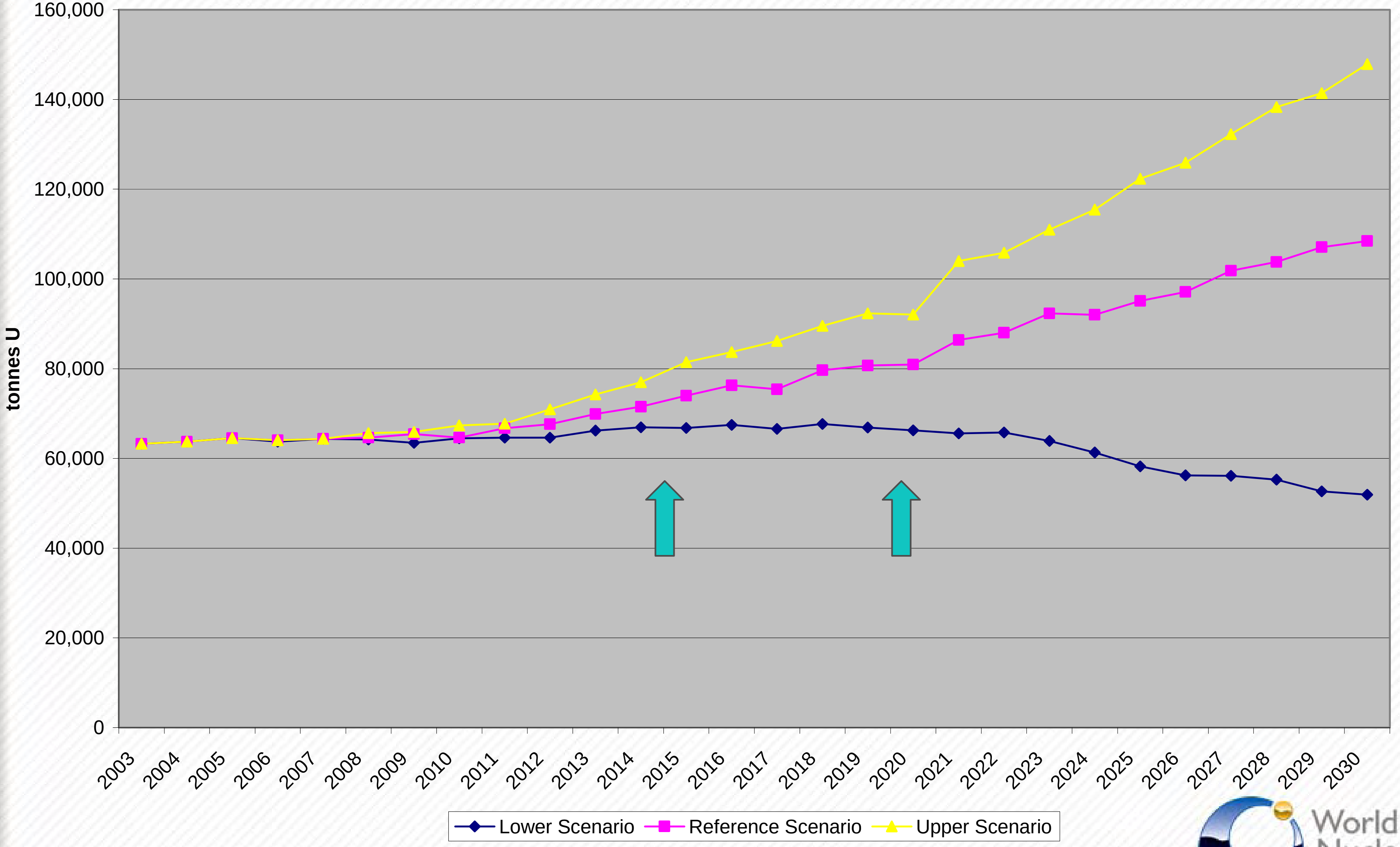
UF_6 Conversion Requirements to 2030 (tU)



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Uranium Conversion Outlook

1. UF_6 conversion will expand to cope with rising demand
   - Replacement of present plant in France, and expansion of facilities elsewhere

2. Small-scale UO2 conversion facilities may continue in a few countries but Cameco will remain dominant

3. World UF_6 conversion demand will rise steadily in line with overall U requirements

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Enrichment - Basics

U-235 is enriched from 0.71 % (natural) to 3 - 5 % (typical): [such fuel is needed for 90 % of power reactors]

2 main technologies - older gaseous diffusion and more recent centrifuges

Investment in laser enrichment so far remains unrewarded by commercial application

Note: Effort to enrich measured in Separative Work Units (SWUs)

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Enrichment – Supply

4 large suppliers of primary enrichment services

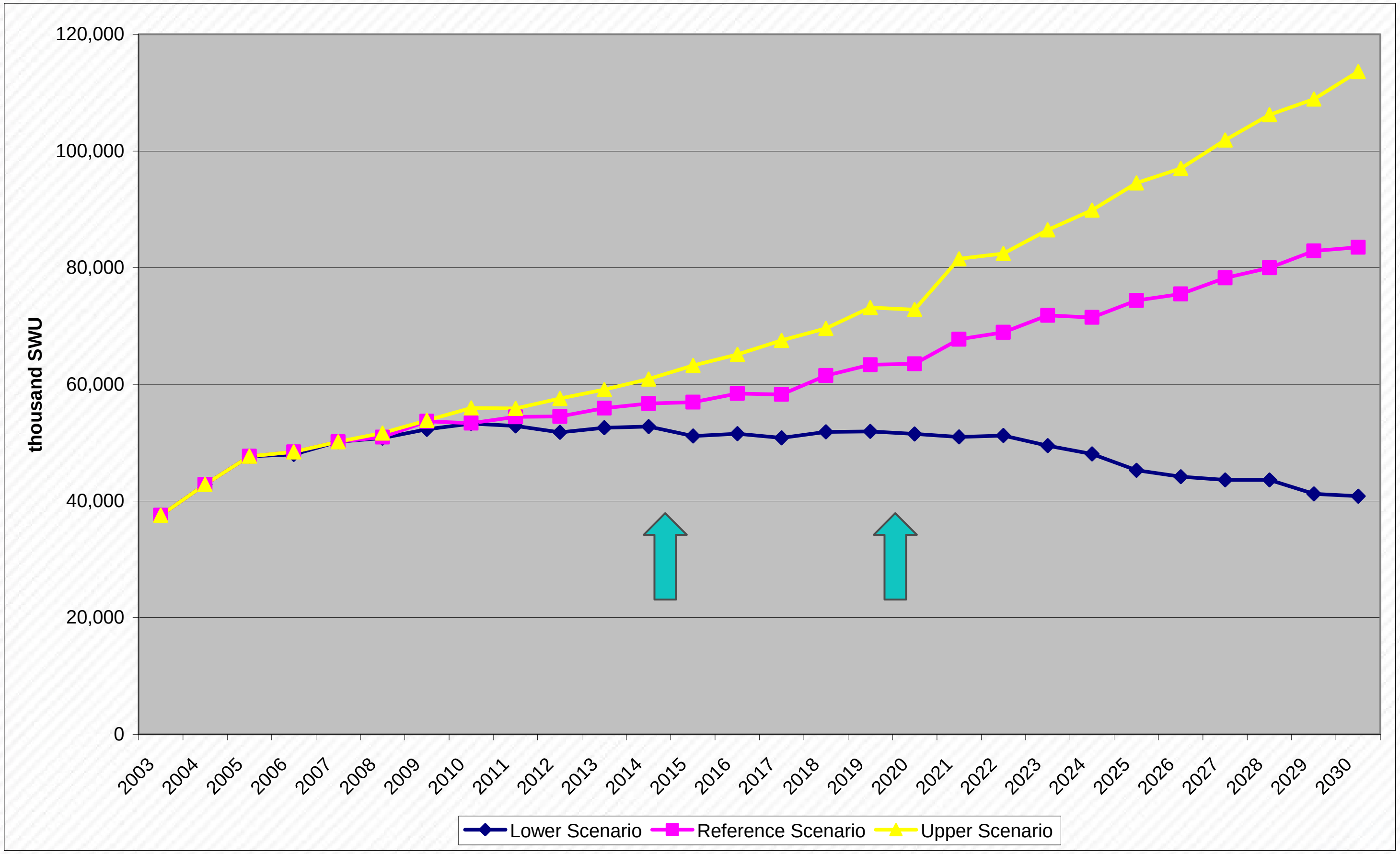
– USEC (USA), Areva (France), Urenco (Western Europe) and Rosatom (Russia)

USEC and Areva use gas diffusion, Urenco and Rosatom use centrifuges

JNFL (Japan) and CNNC (China) also primary suppliers

Heavy current investment in new centrifuge plants by USEC, Areva and Urenco **in USA** and by Areva **in France**

Enrichment Requirements to 2030



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Uranium Enrichment Outlook

1. The key change is the gradual replacement of older gas diffusion plants (France, USA) by gas centrifuge plants

2. Elsewhere, Western Europe and Russia will likely expand their centrifuge capacity

3. Investors in the SILEX laser technology will try to commercialise it within the next 5 y

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Qualitative Overview of HSE Issues

	Mining			Milling	Conversion	Enrichment
	Open Pit	U/G mine	ISL			
	U ore	U ore	U solution	U sol/U conc	U form	U form
Occupational H&S						
• Hazard						
- Conventional	+	++	-	-	-	-
- Chemical	-	-	-	+	+	+
- Radioactive	+	++	-	+	+	-
- Criticality	-	-	-	-	-	+
Environment						
• Footprint	+	-	-	+	-	-
• Hazard						
- Chemical	-	-	+	+	++	++
- Radioactive	-	-	-	-	-	-
- Heavy Metals	+	-	+	+	-	-
Waste						
• LLW	++	+	+	++	-	-

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HSE Issues Outlook

1. No key HSE issues are foreseen for the global expansion of conversion and enrichment
   - Greater performance from plant upgrades and new plants
   - Much lower energy consumption for centrifuge plants

2. Performance is expected to continue improving in U mining countries with well established reg. regime

3. Real HSE challenges point at new U mining countries without sufficiently developed reg. regime
   - Recognizing the importance of this, the global industry has issued a new WNA policy

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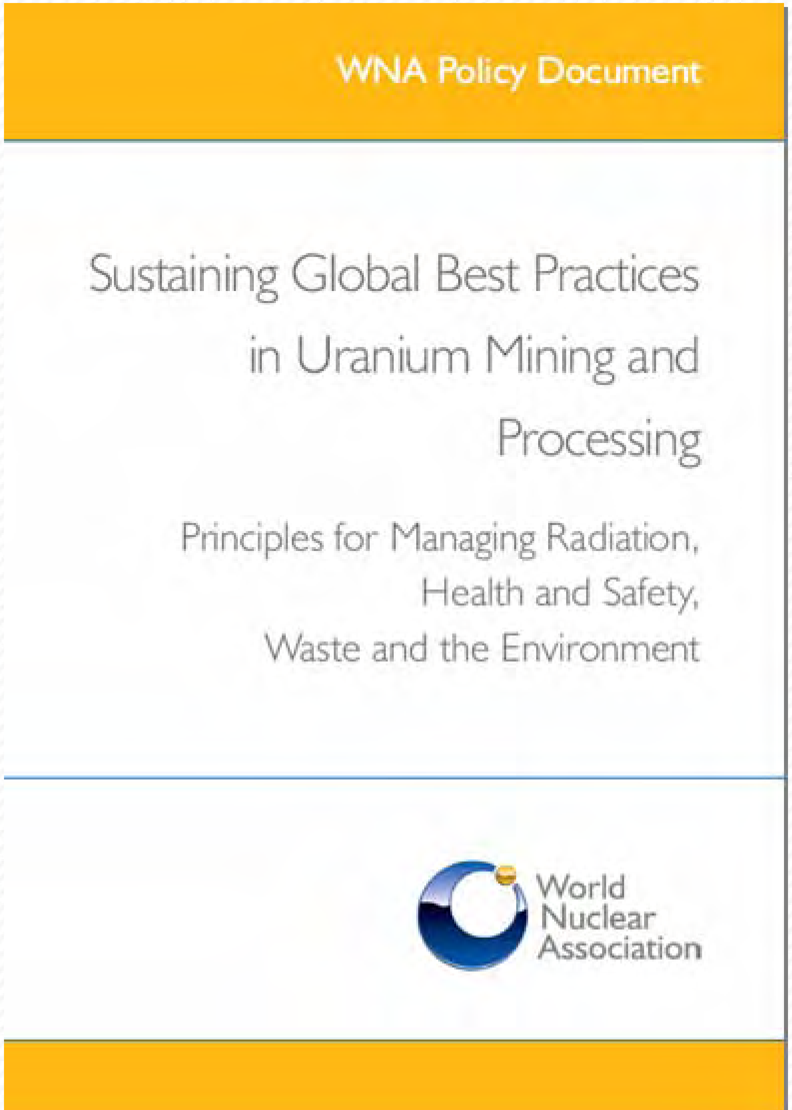
New WNA Policy on U Mining (HSE Issues)

http://www.world-nuclear.org/reference/reports.html


WNA Policy Document

Sustaining Global Best Practices in Uranium Mining and Processing

Principles for Managing Radiation, Health and Safety, Waste and the Environment

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The top tier policy gap has been filled (Jan08)!

New WNA policy endorses:

- •WNA Charter of Ethics
- •WNA Principles of Uranium Stewardship
- •ICMM SD Principles
- •Compliance with applicable conventions, laws,…including the IAEA Safety Principles

Outgrowth from an IAEA cooperation project

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The Biggest Broad Challenge

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World Challenge on Energy & Environment-Health

At the core of this world challenge:

1. Choices in low-carbon energy sources

2. Climate change

3. Environment and health

International organisations such as UN and OECD are urged to act/help much more

- **starting from UN/IAEA and OECD/NEA**

2nd Broad Challenge: Integrated Safety

The path for achieving integrated safety has been clearly set at the IAEA top level:

'*Harmonization of the Global Safety Regime*'

- **Common to all safety fields, including RP**

- **Top-down from the IAEA Safety Fundamentals, SF-1**

- **Goal - A complete set of fully integrated IAEA safety standards should:**

'*consist of a manageable number of publications each of them being as concise as possible and addressing the essence of the safety issues*'

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3rd Broad Challenge:
Improve RP policies for the public at low doses

Epidemiology: Radiation risk is inconclusive below 100 - 200 mSv (*i.e.*, low doses)...Yet...

RP community has been complacent about a ‘loose’ application of the assumed ‘down-to-zero’ risk model (LNT) at very low doses

- **Irrespective of the unlikely existence of a (universal) scientific threshold**

The practical reality differs greatly. Assuming LNT is sometimes fine and sometimes not

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3rd Broad Challenge:
Improved RP policies for the public at low doses

Examples for which assuming LNT is fine

- Day-to-day plant activities such as:
  - contamination control
  - worker dose-task monitoring (down to µSv)

Examples for which assuming LNT is not fine

- Estimating risk from collective doses
- Worker compensation schemes
- RP policies for the public down to a fraction of mSv y^{-1}, µSv y^{-1}, and even nSv y^{-1}!

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3rd Broad Challenge…

Control of public exposures, within the usual scope of nuclear safety regulator, is too restrictive

…Otherwise it is permissive

- **Nuclear industry versus medical, air transport, other industries**

RP policies are currently imbalanced

… Hard to see how the scope <1 mSv y^{-1} is part of real environmental and public health protection

- **Clearly, one cannot say that there is a real trade-off between health detriment & notions likes equity, benefits, voluntary choices,…**

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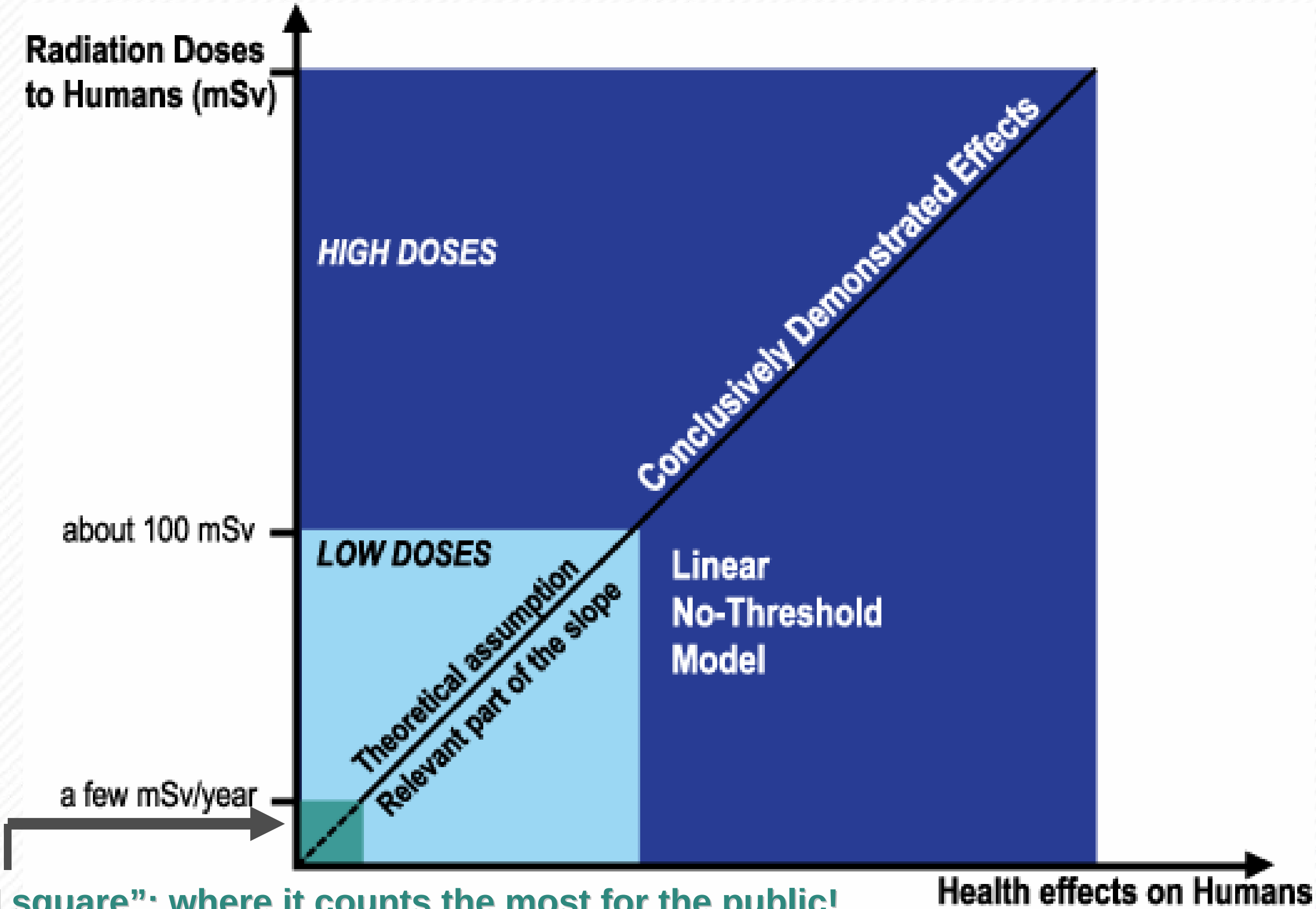
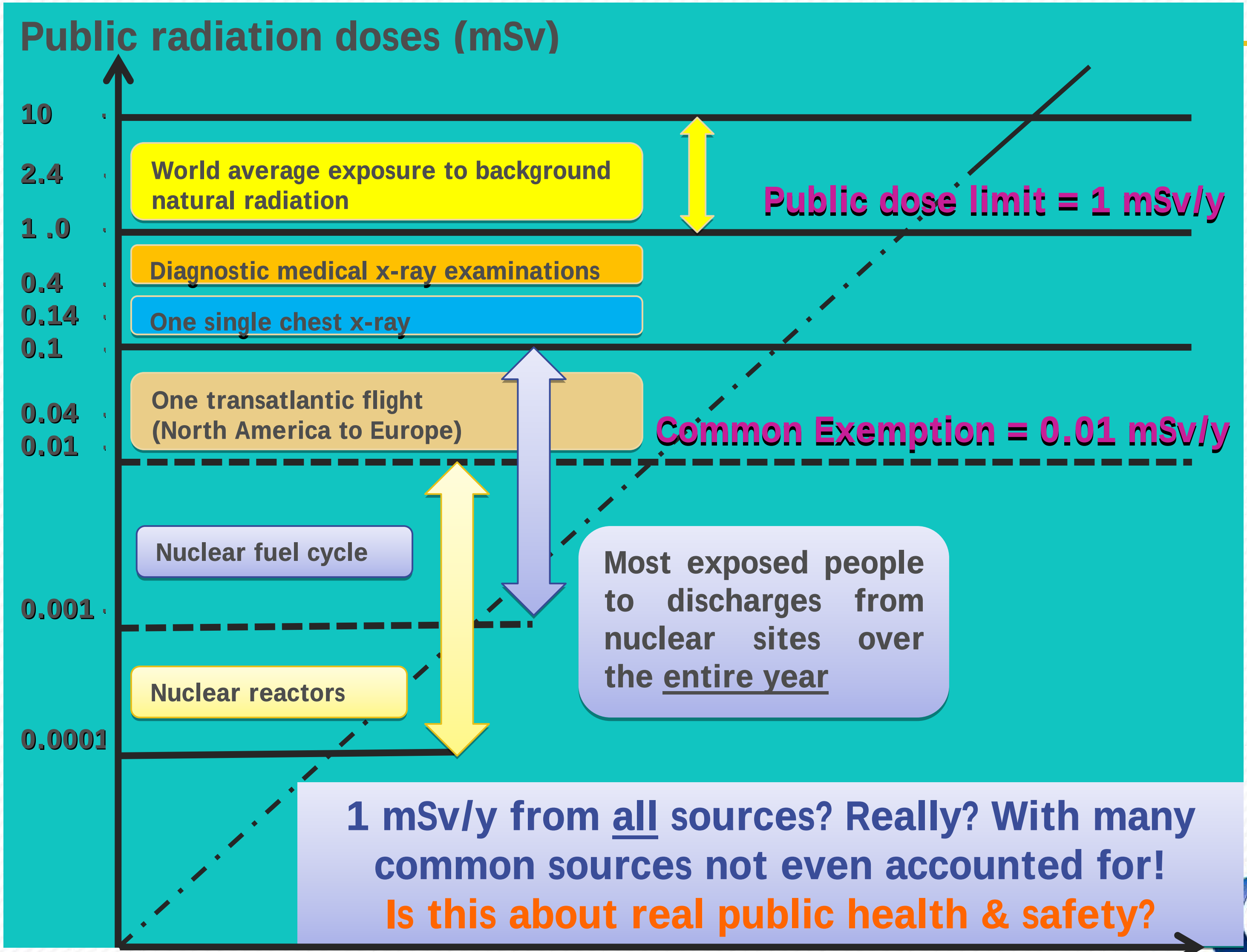
3rd Broad Challenge... A case in point



"Small square": where it counts the most for the public!

3rd Broad Challenge…

Imbalanced RP policies for controlling common public exposures



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4th Broad Challenge

Reposition well recognized and improved safe nuclear technologies as the main driver

…for the deployment of nuclear energy projects

Dissociate this drive from the ever more stringent new standards/practices ill-imposed on nuclear

- *e.g.*, **because of perception issues beyond the notion of protection!**

Tiny HSE impacts have only a minor role in the pressing world challenge on energy protection

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Summary of HSE Challenges

1. New uranium producing countries without sufficiently development regulatory regimes
2. World Challenge on Energy & Environment-Health; Tackling Energy-Protection; UN/IAEA + OECD/NEA help
3. Further convey integrated management of HSE issues via a harmonized set of revised IAEA safety standards
4. Improve RP policies for the public at low doses; Avoid RP complacency below 1 mSv/y
5. Reposition safe nuclear technologies as the main driver for the deployment of nuclear projects

Thank you for your attention

Sylvain Saint-Pierre, saintpierre@world-nuclear.org

ESSENTIAL INFRASTRUCTURE:

National Nuclear Regulation

Carl J. Paperiello, PhD, CHP
Consultant

NCRP Annual Meeting

March 2-3, 2009

REGULATION:WHY?

- Focus on Countries Without Nuclear Power
- Treaty Obligations
- Safety and Security – Domestic and Foreign
- Worldwide Impact of Serious Event

REGULATORY INFRASTRUCTURE NEEDS: WHAT?

- Law and Legal Basis
- Regulations, Guidance, Procedures
- Organization
- Human Capital

REGULATORY ORGANIZATION: WHO?

- Independence – No Conflicts of Interest
- Resources and Authority
- Management System
- Qualified Staff
- Support Organizations
- Regulatory Coordination – Multiple Regulators

TECHNICAL NEEDS: HOW?

- Radiation Protection and Industrial Safety
- Environmental Protection
- Siting – Geosciences
- Emergency Preparedness
- Fire Protection
- Physical Protection
- Safeguards
- Probabilistic Risk Assessment/Probabilistic Safety Assessment

TECHNICAL NEEDS: CONTINUED

- Transportation
- Waste Storage and Disposal
- Civil Structures
- Mechanical Systems
- Electrical Systems/Instrumentation and Control
- Chemistry – Waste Processing and Coolant
- Nuclear Fuel and Core Management
- Information Technology

REGULATORY ACTIVITIES

- Setting Standards
- Licensing – Authorizing
- Inspection – Verification
- Assessments – Applications, Inspection Results, Events
- Record Keeping
- Communication
- Enforcement

CHALLENGES TO NATIONAL REGULATION

- International Scope of Nuclear Industry
- Technical Evolution of the Nuclear Industry
- Legal and Technical Skills of the Regulator
- Effective Utilization of Consultants and Contractors

IMPORTED REGULATORY INFRASTRUCTURE: WHERE?

- Adopt Regulatory Systems and Structure of Another Country
- Adopt IAEA Standards, Guides and Infrastructure Development Programs
- Accept Foreign Licensing and Certification
- Employ Foreign Citizens as Technical Experts in Regulatory Organization

UNIFORM INTERNATIONAL STANDARDS: A QUEST

- Consistent Performance Goals – ICRP Radiation Protection Standards
- Consistent International Implementation Criteria
- Consistent Formats

EXTRAORDINARY CONCEPTS

- Contract Regulatory Activities to a More Experienced Nation – Could be a Phased Approach

- International Regulator

SUMMING UP: WHEN?

- Nations Receiving Nuclear Power Plants Need Effective Regulators
- IAEA Says Process Requires 10 - 15 y
- Uniform Regulatory Systems Would Benefit Regulators and Regulated
- Human Capital May be the Critical Path

New Nuclear Build and Evolving Radiation Protection Challenges

Dr. Ted Lazo
Deputy Head for Radiation Protection
Division of Radiation Protection and Radioactive Waste Management
OECD Nuclear Energy Agency

Future of Nuclear Power Worldwide

- Radiation protection continues to evolve, with the last 10 to 15 y having seen changes in:
  - RP science
  - RP decision making
- It also appears that the use of nuclear power for the electricity generation will increase, perhaps significantly, in the next 10 to 20 y

Safety, Health and Environment

Expanding use of Nuclear Power

Evolution of Radiological Protection

How will these trends interact?

Radiation Protection Science: Epidemiology

- Risk seems linear down to 100 mSv (LSS, Nuclear Worker Study, etc.)
- Radon seems to be a statistically significant cause of lung cancer at as low as 200 Bq m^{-3}, even for nonsmokers
- New studies from the Southern Urals may have new information on radiation-induced cardiovascular disease

Radiation Protection Science: Radiobiology

- Radiation biology at the cellular level
  - Nontargeted effects
  - Delayed effects
  - Adaptive response
- Individual sensitivity
  - Genetic susceptibility
  - Gender, age sensitivity
- Cardiovascular diseases
  - Heart disease
  - Stroke

Radiation Protection Science: Possible Implications

These new phenomena call into question our current concepts of:

- Radiation risk: include cardiovascular?
- LNT: is this sufficiently generic?
- Radiation additivity: are all response curves the same?
- Radiation health detriment to an individual: does the Sievert relate to an individual’s health risk?

Radiation Protection Decision Making: Social Evolution

- Groups and individuals want to be involved in discussions and decisions affecting public health and environmental protection
- Stakeholders question the role of science and authorities in decision making, and demand accountability
- Stakeholder involvement has affected the way that justification, optimisation and dose limitation are viewed
- Environmentalism has also continued to grow, to the point where increasingly, and at many levels, there is a link between good public health and a “healthy” environment

Radiation Protection Decision Making: Possible Implications

- It is increasingly felt that some level of control can, and should, be maintained over all radiation sources and exposure situations
- The management of risks, while fitting within a generic framework, will be largely driven by the specific circumstances under consideration
- “Standardised” values are increasingly seen as a guideline or starting point, not as an endpoint
- Stakeholder developments challenge organisational and procedural structures for decision making

Approach to New Nuclear Build in the Context of Radiation Protection Challenges

- Transparency in decisional structures and processes
- Use of state-of-the-art science
- Engagement with stakeholders

Practical Considerations for New Nuclear Power Plants

Based on current practice and past experience, new plant planning can be guided by:

- RP Benchmarks for licensing
- Designing in operational lessons learned
- Public and environmental protection aspects

Figure 1
Average Annual Collective Dose Trends for All PWRs and Advanced PWRs

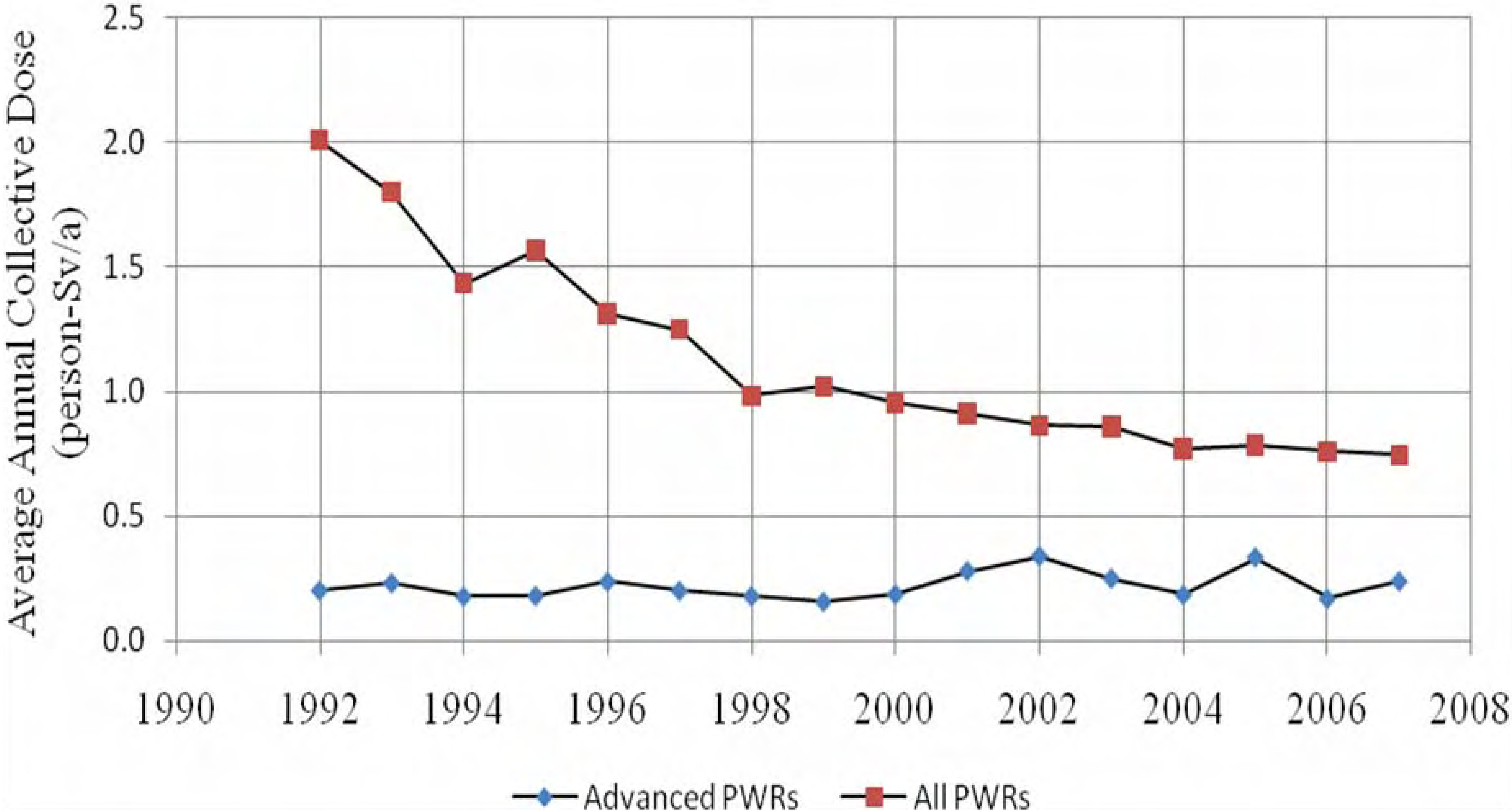


Figure 2
Average Annual Collective Dose Trends for BWRs

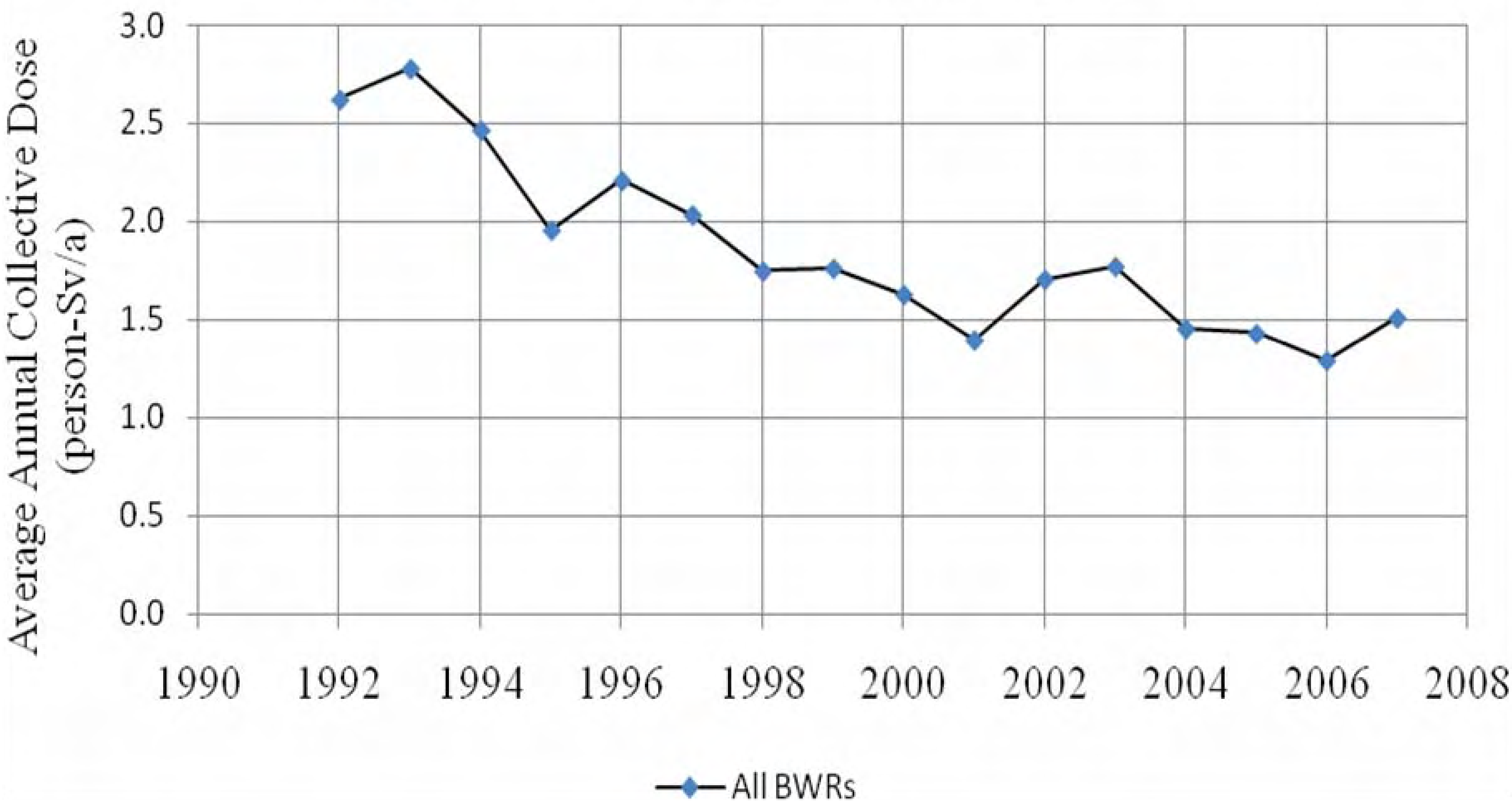
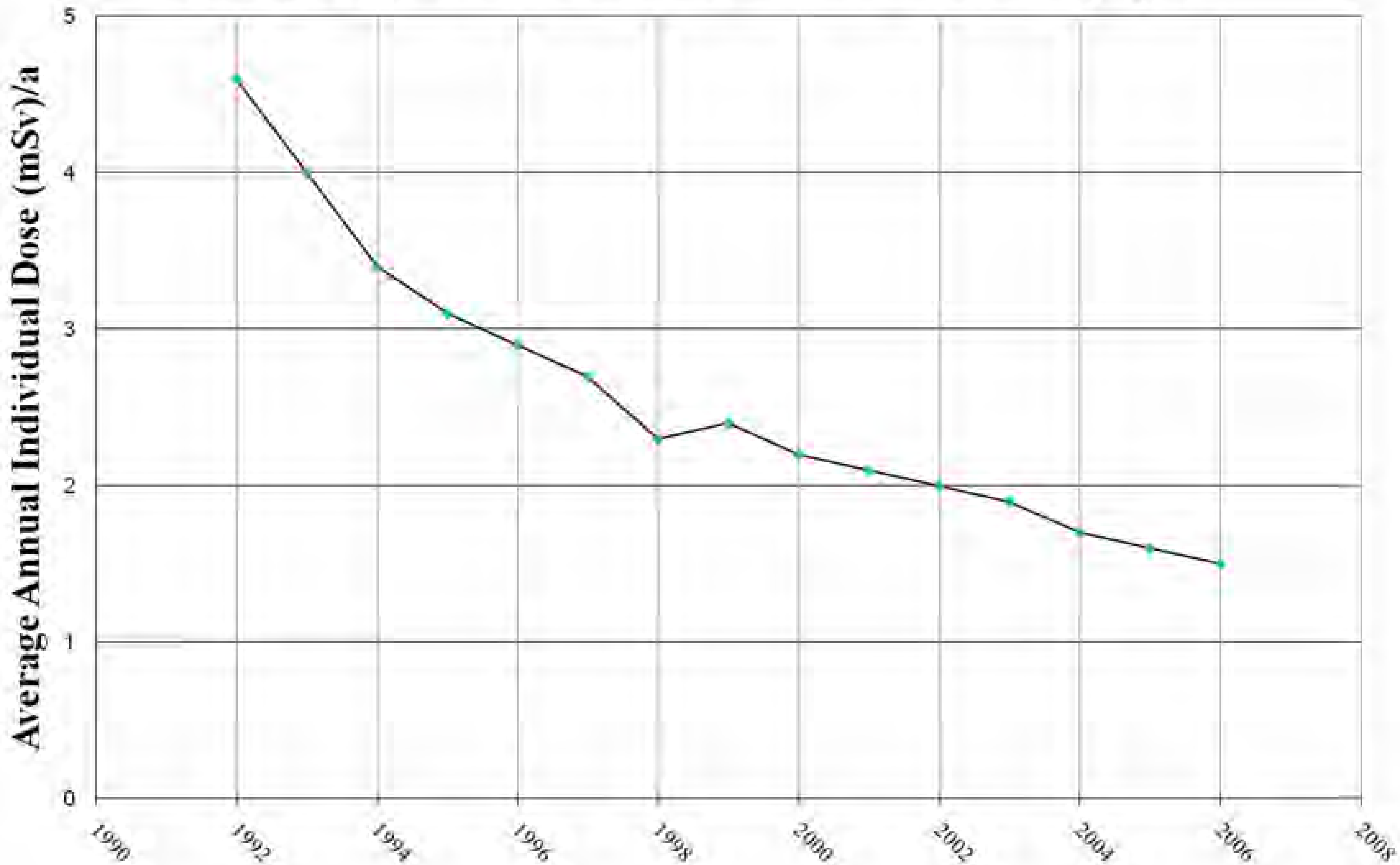


Figure 3:
Average Annual Individual Worker Dose for EDF Employees



Licensing Assessment Benchmarks

- Possible dose constraints for average worker exposures
  - On the order of 1 or 2 mSv y^{-1}
- Possible annual collective dose benchmarks for new units:
  - On the order of 0.25 person-Sv y^{-1} for PWRs
  - On the order of 1.5 person-Sv y^{-1} for BWRs

Designing in Lessons Learned: Guiding Principles for Design

- Proactive implementation of lessons learned
- Balance of risks and allocation of resources
- Effective communication in optimising design
- Recognisable, effective operational radiation protection

Designing for Public and Environmental Protection

- Best Available Techniques (BAT):
  - Common approach to management of effluents
  - Results are site-specific
  - Release level can vary by several orders of magnitude, even among "sister units"

But BAT is only part of the story

Effluent Management for Public and Environmental Protection

- Discharge limits: allowable levels of discharge (total annual and/or concentration) based on the minimum justifiable level for plant operation, and are NOT
  - Levels corresponding to the boundary between acceptable and unacceptable radiological impact
  - Levels corresponding to the dose limits or constraints contained in national or international legislation
- Headroom: based on operational fluctuations or trends that may occur in normal operation, kept to the absolute minimum strictly necessary for the normal operation of the plant

Planning Progression

- BAT is assessed and implemented at the planning stage
- Dose constraints are established considering dose limits, good practice, and possible exposure from multiple sources
- Discharge limits are then established considering good procedural implementation and operational fluctuations within the "framework" that is fixed by plant structure and BAT measures that are planned to be implemented

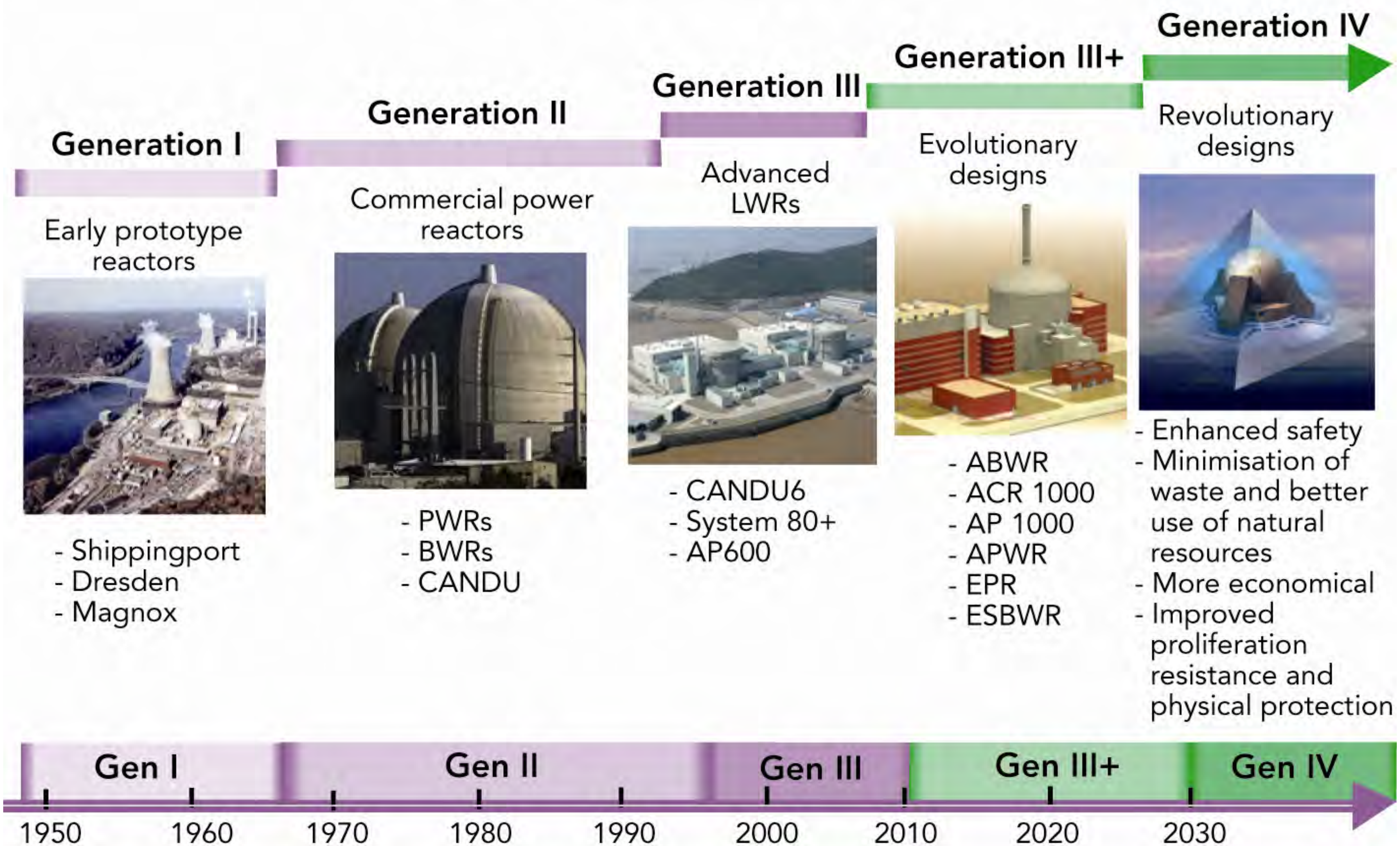
Conclusions

- The construction of nuclear power plants, whether on an existing nuclear facility site or a completely new site, has often raised issues of public concern
- Even in the current climate where nuclear energy is being seriously reconsidered in many countries at a national governmental level, and at the multinational corporate level, the construction of new units may well raise local issues and questions, and national and international opposition to nuclear power in general may become active
- In such situations, decisions acknowledged as acceptable can take some time to be reached

Conclusions

- To appropriately prepare to address questions of new nuclear build, governments should:
  - Assure that their established decisional processes clearly and unambiguously lay out rules and responsibilities,
  - Actively and effectively engage with stakeholders in gathering various values and views in preparation for taking decisions
  - Assure that state-of-the-art science is considered, and
  - Make sure that value judgements and their bases are clearly stated in making decisions
- Industry will need to assure that:
  - Proposed facilities incorporate radiological, and other, lessons learned,
  - Optimisation and work-management experience has been effectively applied to new plant designs, procedures and processes

Figure 13.1: Reactor generations



Source: adapted from NEA (2008).

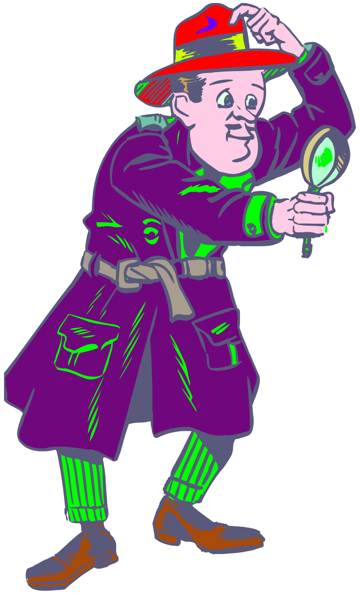
Communicating with Stakeholders about Nuclear Power Plant Radiation

Ann S. Bisconti, Ph.D.
ann@bisconti.com

NCRP Annual Meeting
March 2009

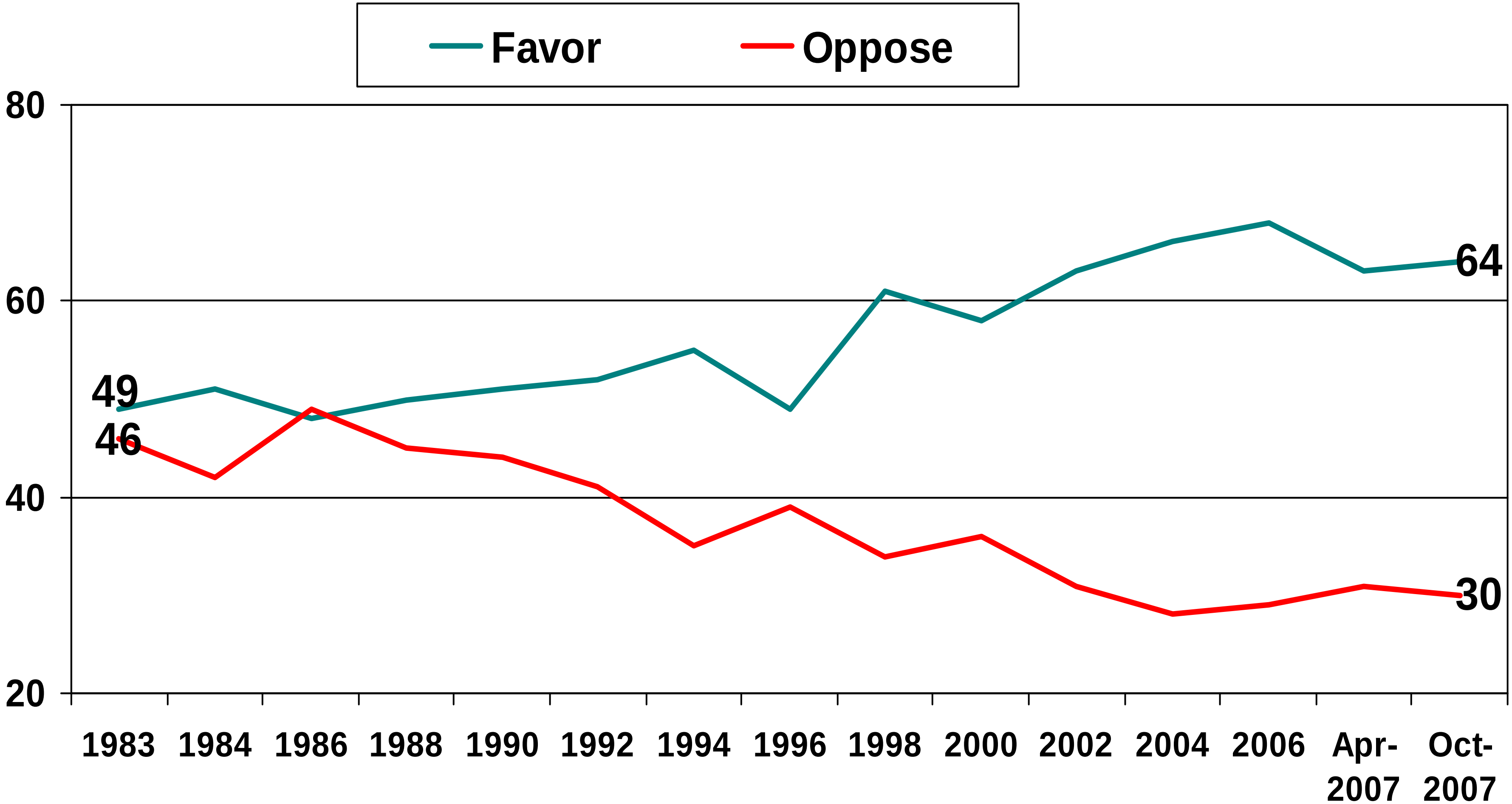
Bisconti Research, Inc.

Public Opinion and Communications Research: 25 Years



- Sponsored by Nuclear Energy Institute
- Surveys by Bisconti Research with GfK
- National random samples of 1,000 U.S. adults age 18+
- Interviewed by telephone
- Margin of error ±3 percentage points
- Latest: September 2008

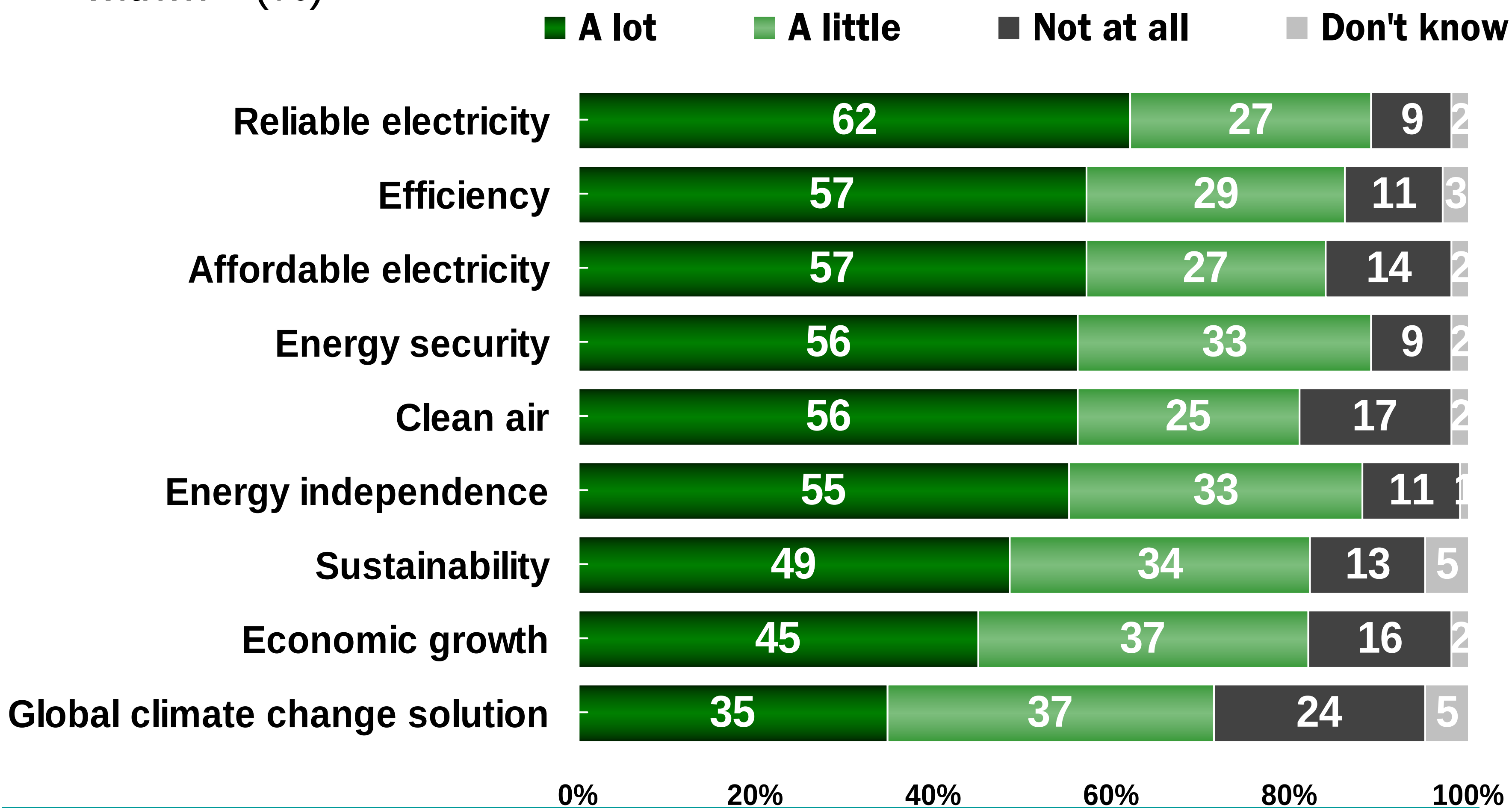
U.S. Public Increasingly Favorable to Nuclear Energy



BRi

U.S. Public Sees Benefits of Nuclear Energy

"Do you associate nuclear energy a lot, a little, or not at all with…" (%)



But Radiation Remains Underlying Public Concern

- September 2008 survey focused on:
  - Perceptions of radiation
  - Perceptions of radiation exposure from nuclear power plants and some other sources
  - Messages about radiation

Have perceptions changed over time?

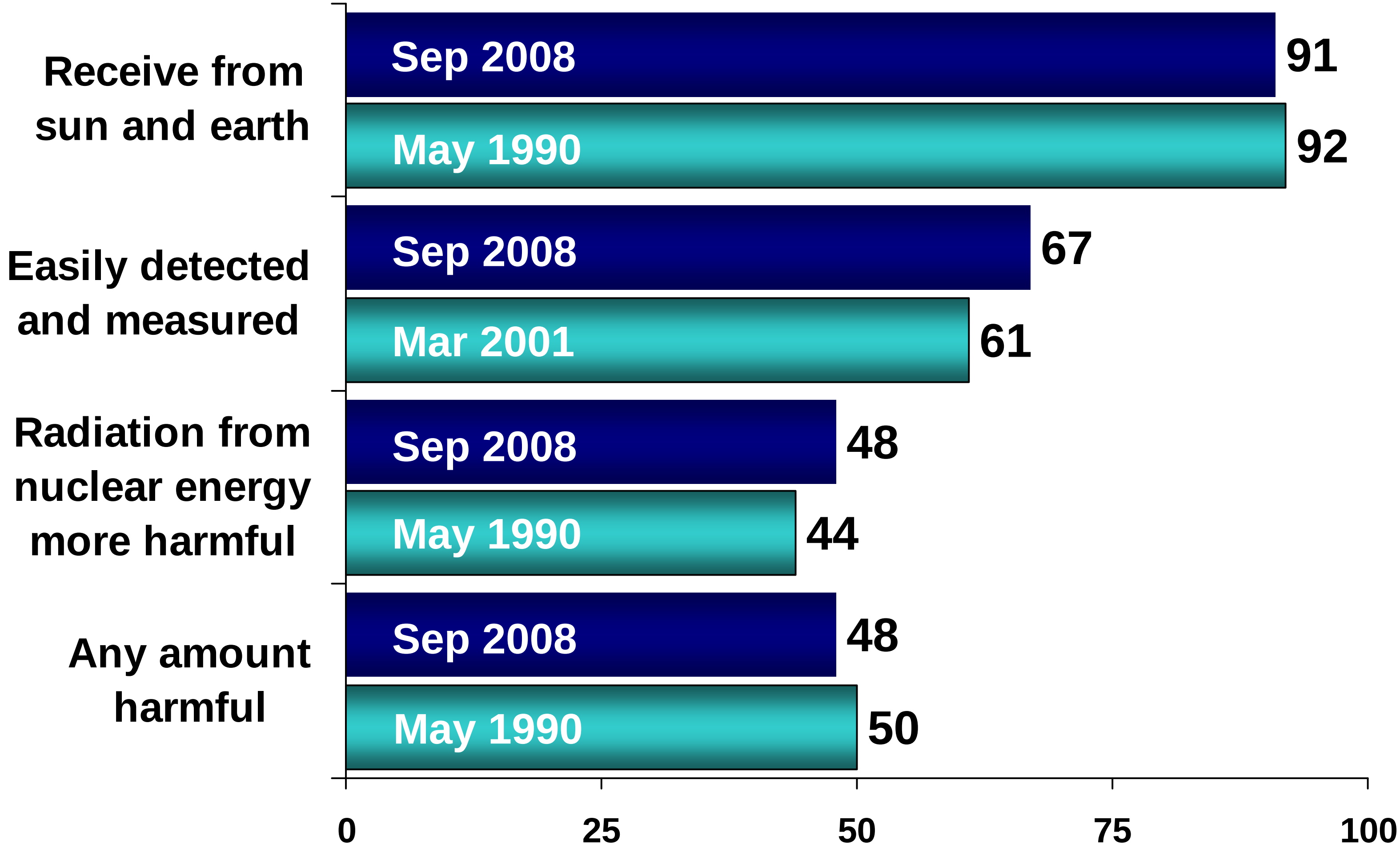
Perceptions about Radiation (%)

	True	False	DK
We all receive radiation every day from the sun and the earth	91	8	2
Radiation is easily detected and and measured	67	29	4
Radiation from nuclear energy is more harmful than the same amount of radiation from the sun	48	43	9
Any amount of radiation is harmful	48	50	2

BRi

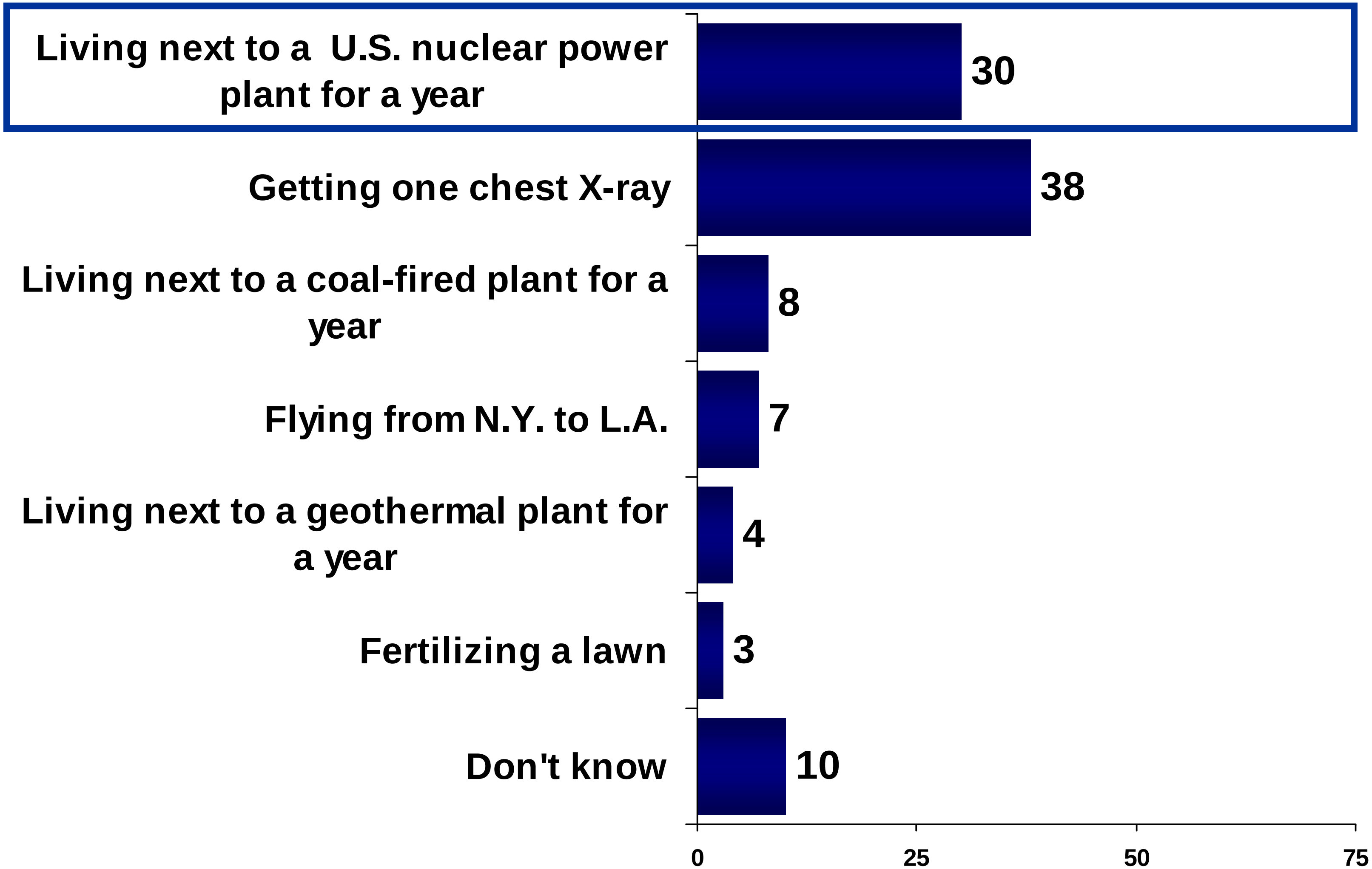
Perceptions about Radiation Unchanged

Percent Saying "True"



BRi

Perceptions: *"Which one of the following would expose a person to the most radiation?"*



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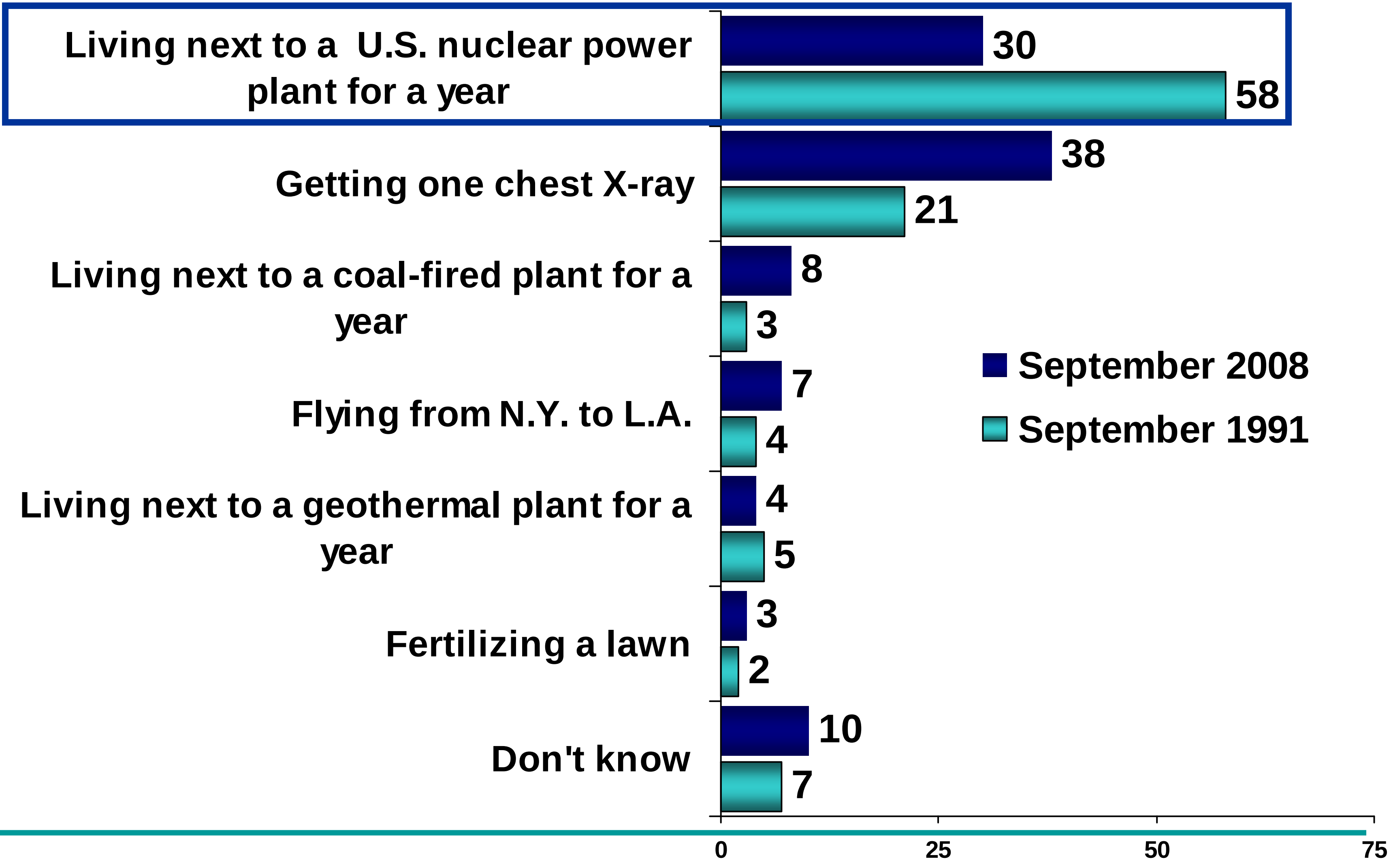
Fewer Now See Nuclear as Largest Source of Radiation



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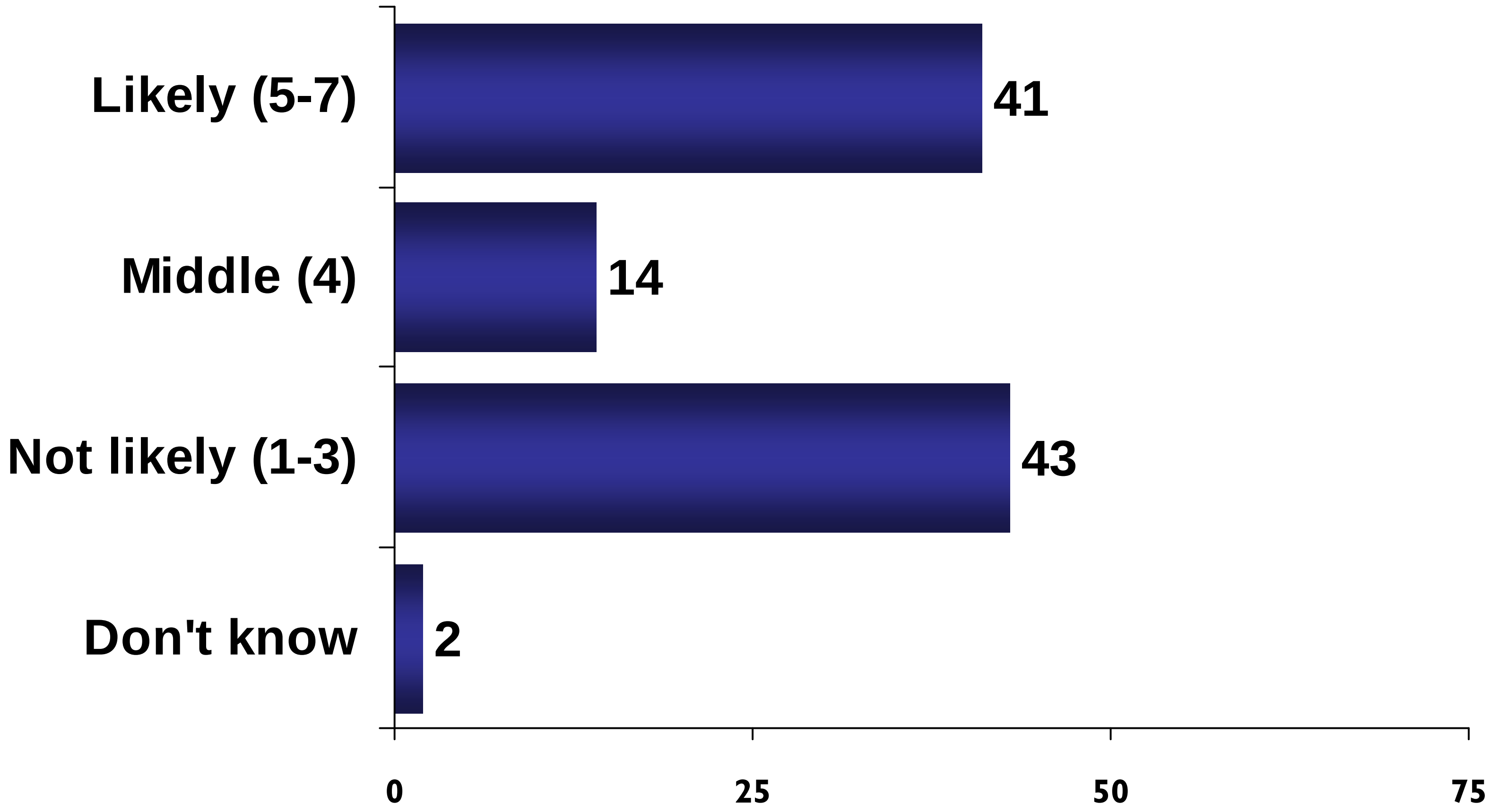
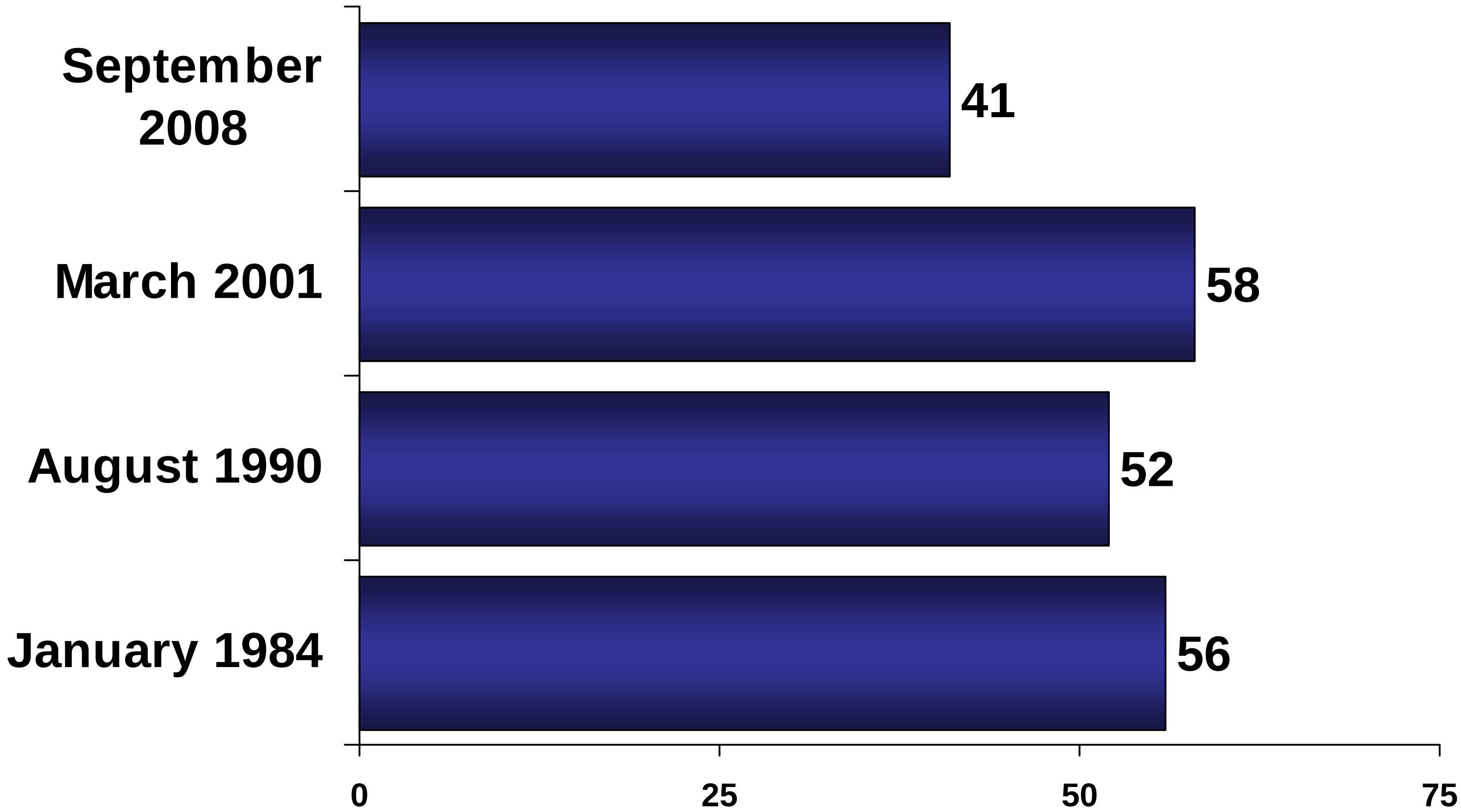
Public versus Actual Rankings of Sources of Radiation Exposure

Listed Below from Most to Least Actual Exposure	Percent of Public Ranking First	Actual Average Individual (Millirem)
Fertilizing a lawn	3	17
Getting one chest X-ray	38	10
Flying from N.Y. to L.A.	7	2
Living next to a coal plant	8	0.03
Living next to a nuclear power plant	30	0.009

Perceived Likelihood that People Living Near a Nuclear Power Plant Are Exposed to Harmful Levels of Radiation (%)



Fewer Now Think It's <u>Likely</u> that People Living Near a Nuclear Power Plant Are Exposed to Harmful Levels of Radiation



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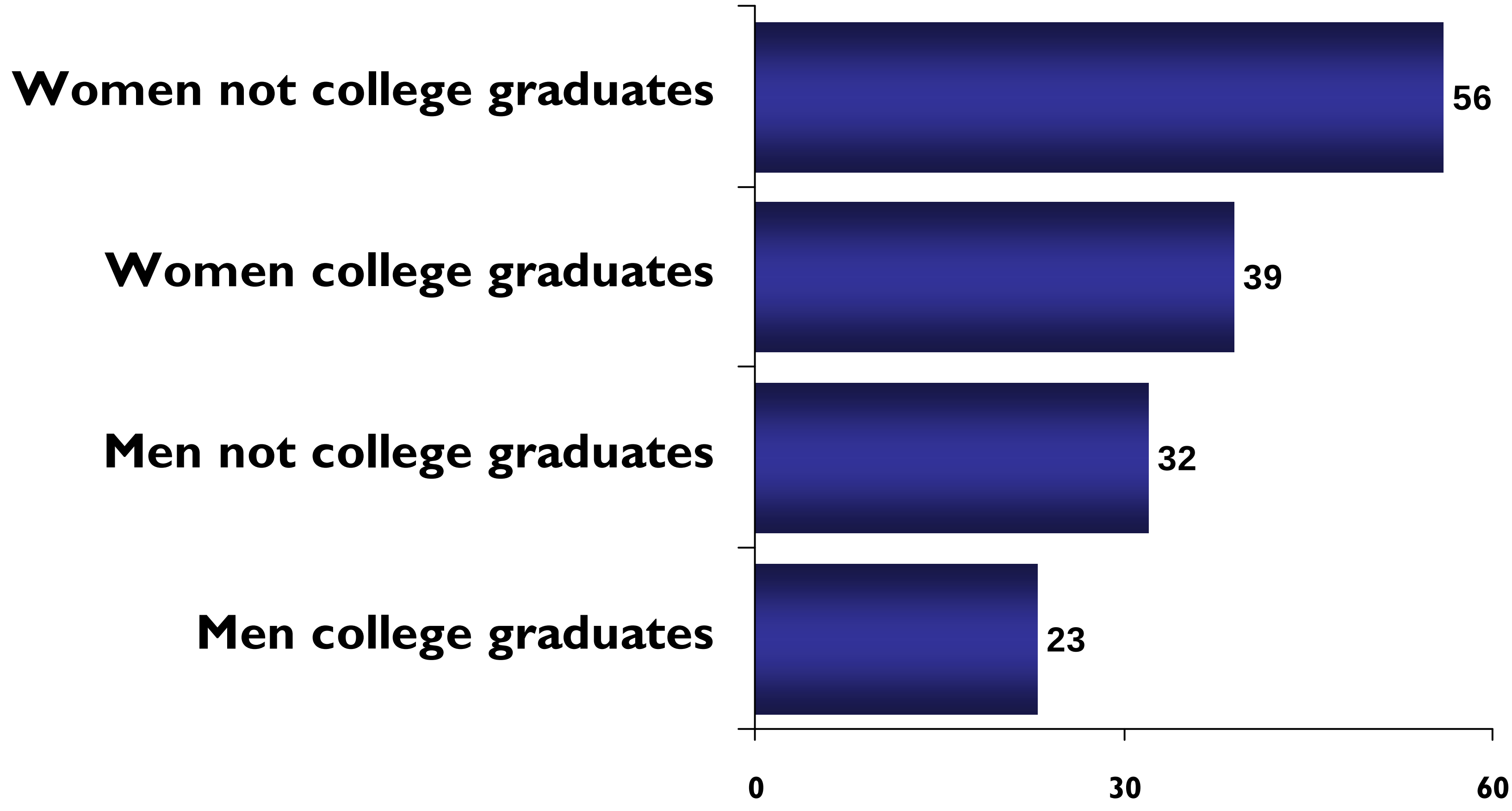
Believe it is Likely That People Living Near a Nuclear Power Plant Are Exposed To Harmful Levels of Radiation (%)



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Messages about Radiation from Nuclear Power Plants: Top Four

	Emotional: % Reassuring	Rational: % Excellent or Good Point
Radiation contained, controlled, monitored	83	72
Nuclear technologies used to benefit society in thousands of ways	81	68
Radiation standards by EPA enforced by NRC	77	67
Nuclear energy industry takes care to properly use radiation and to keep radiation levels even much lower than permitted by federal regulation	77	60

BRi

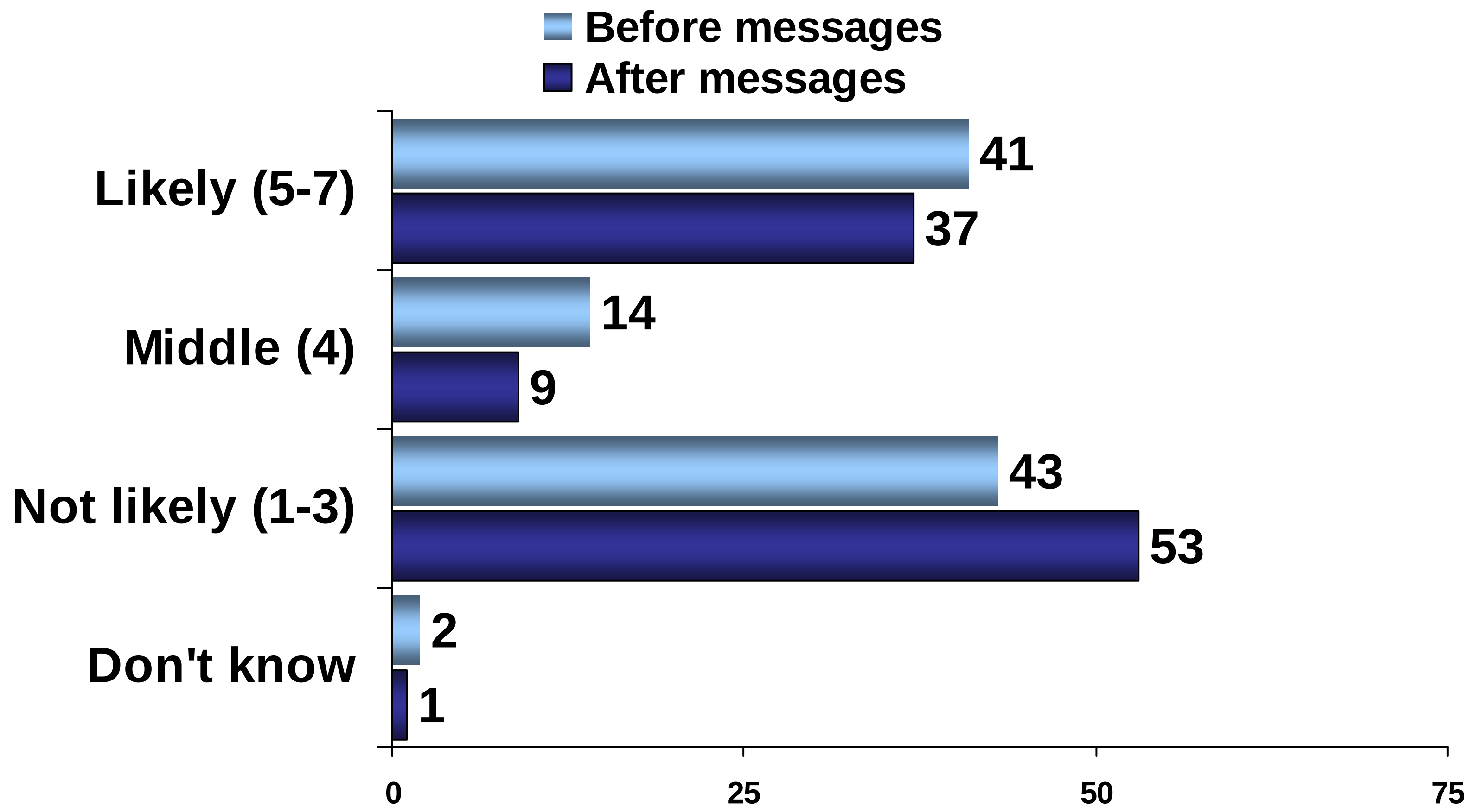
Messages about Radiation from Nuclear Power Plants: Not as Effective

	Emotional: % Reassuring	Rational: % Excellent or Good Point
■ National Cancer Institute study: no evidence of increase in cancer among people living near nuclear energy plants	69	54
■ More radiation in one round-trip flight from New York to Los Angeles	57	46
■ More radiation living next to a coal or gas power plant	57	44

Analogies to Show That the Amount of Radiation From Nuclear Power Plants is Small (% Excellent or Good)

Nature	60
X rays	58
Consumer products	53
Coal-fired power plant	51
Flight from N.Y. to L.A.	48
Granite buildings	48

Pre-Post Messages: Perceived Likelihood that People Living Near a Nuclear Power Plant Are Exposed to Harmful Levels of Radiation (%)



BRi

Conclusions

- Perceptions of radiation tracked over time did not change, but perceptions of radiation exposure from nuclear power plants did change—and they became more favorable/accurate. Why?
  - Need for nuclear energy → favorable to nuclear

Conclusions

- Messages have some impact:
  - Best messages convey radiation as familiar and controlled; risk comparisons are less effective.
  - Best messages are effective for both emotional and rational appeals.
  - For more impact, credible spokespersons may be needed.

Role of the International Radiation Protection Association

Kenneth R. Kase, President

Phil Metcalf, Immediate Past-President

2009 Annual Meeting

National Council on Radiation Protection & Measurements

Outline

- Brief history
- Purpose
- Recent accomplishments
- Current initiatives
- Future

The Beginning

- In 1963 then President of the US Health Physics Society WT Ham charged KZ Morgan to investigate with senior colleagues around the world any interest in setting up an International Society.
- The first "IRPA meeting" was held 30 Nov to 3 Dec 1964 in Paris with 45 delegates from 15 countries. At this meeting the proposed IRPA statutes, including the name of the Association, were adopted and a Provisional Executive Council was elected.

IRPA and Its Purpose

AN ASSOCIATION OF PROFESSIONAL SOCIETIES

- Provide for communication and advancement of radiation protection worldwide.
  - Support international dialog and scientific meetings.
  - Encourage international radiation protection publications
- Promote and assist the establishment of radiation protection societies
- Participate in the establishment and review of universally acceptable radiation protection standards and recommendations
- Foster scientific and professional enhancement

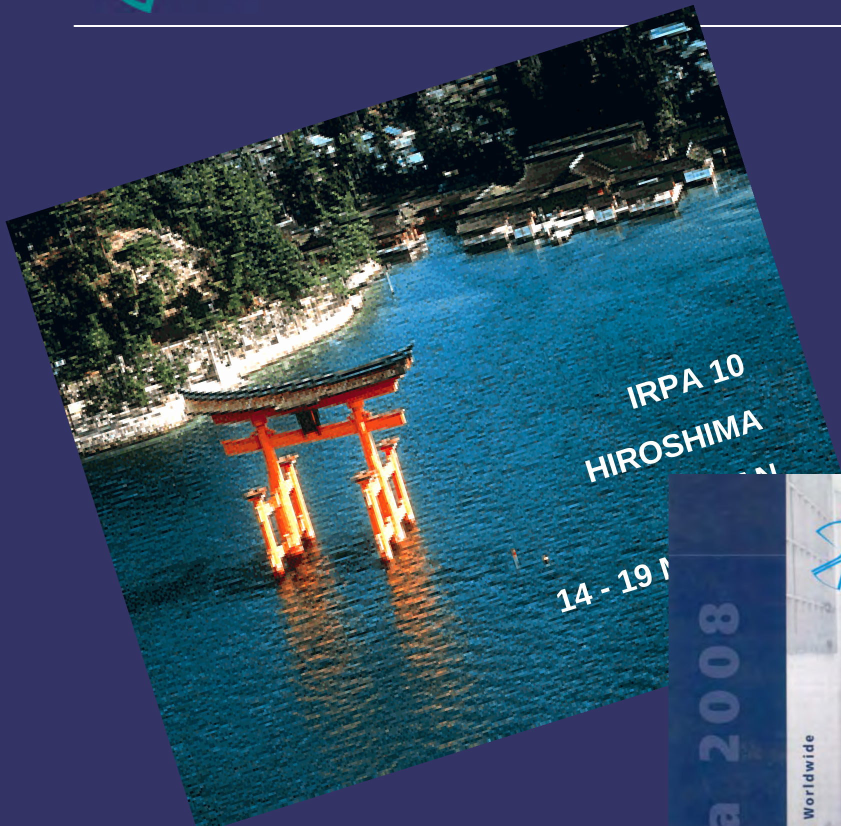
Purpose

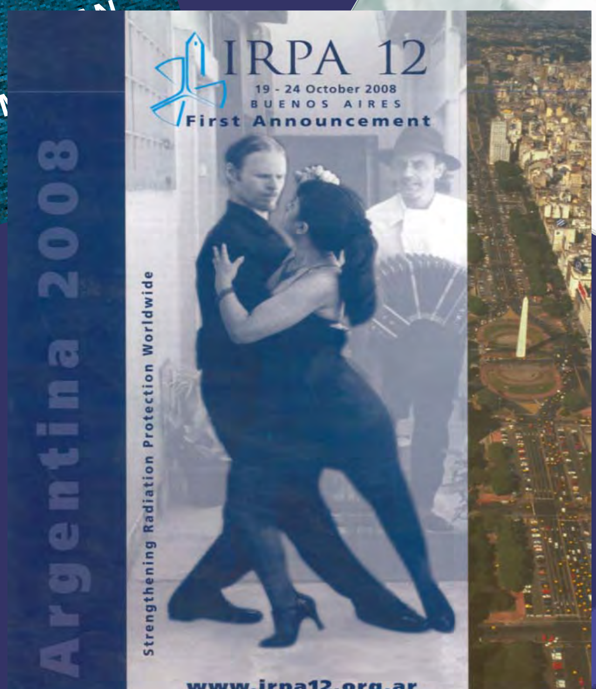
- Provide for <u>communication</u> and <u>advancement</u> of radiation protection throughout the world
  - This includes branches of knowledge as science, medicine, engineering, technology, public policy and law, to provide for the protection of humans and the environment from the hazards caused by radiation, and thereby to facilitate the safe use of medical, scientific, and industrial radiological practices for the benefit of humankind.

Purpose

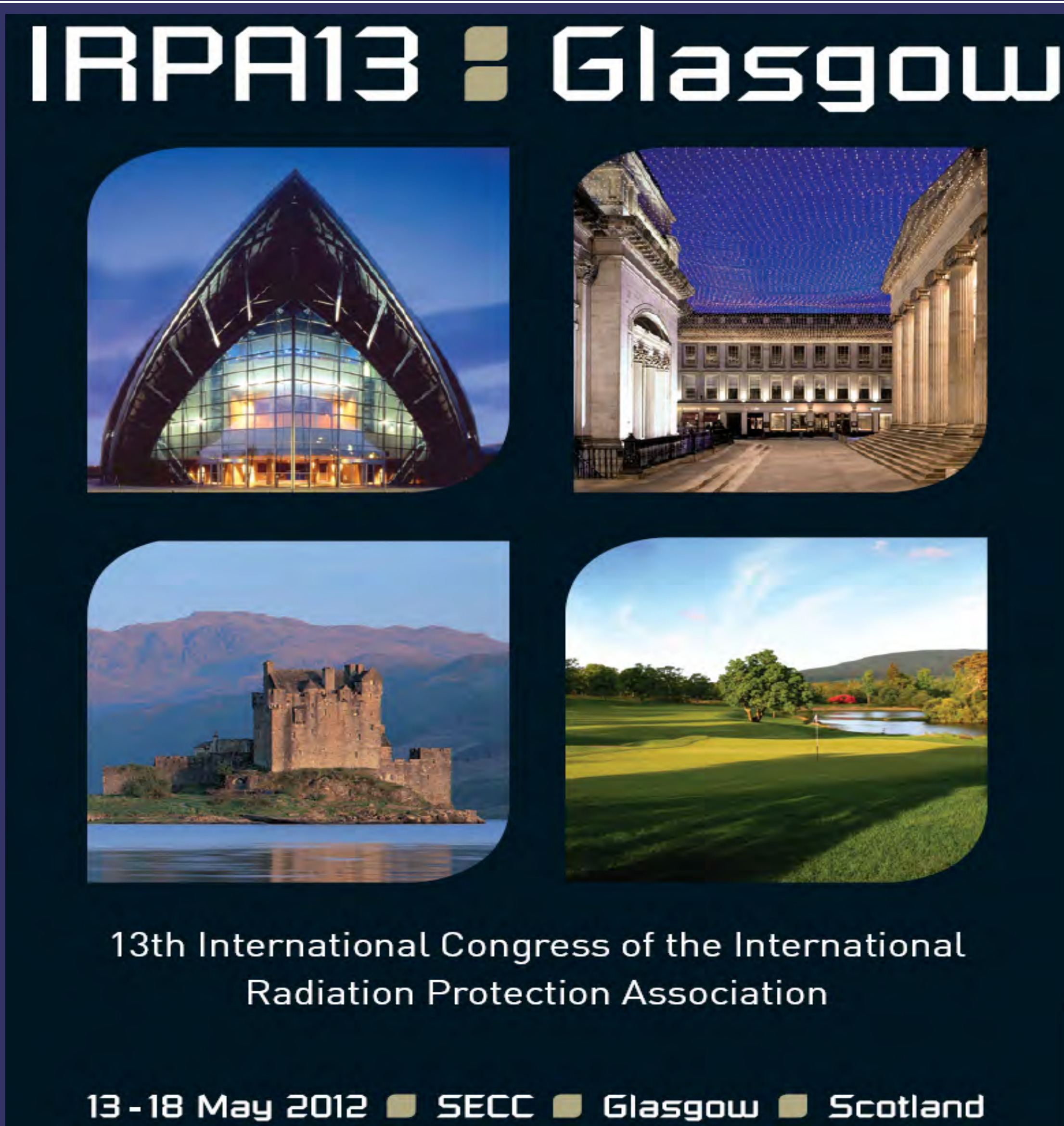
- Provide for <u>communication</u> and <u>advancement</u> of radiation protection throughout the world
  - International Congresses
    - First in Rome in 1966
    - Held every 3 to 4 y
  - Regional Congresses
    - Held in years between International Congresses

Recent International Congresses





IRPA 13: Living with Radiation – Engaging with Society



Glasgow

United Kingdom

13 - 18 May 2012

Regional Congresses

- ❑ Portsmouth (UK) 1994
- ❑ Portoroz (Slovenia) 1995
- ❑ Cusco (Peru) 1995
- ❑ Tel Aviv (Israel) 1997
- ❑ Barcelona (Spain) 1998
- ❑ Havana (Cuba) 1998
- ❑ Budapest (Hungary) 1999
- ❑ Recife (Brazil) 2001
- ❑ Dubrovnik (Croatia) 2001
- ❑ Florence (Italy) 2002
- ❑ Seoul (Korea) 2002
- ❑ Johannesburg (South Africa) 2003
- ❑ Paris (France) 2006
- ❑ Acupulco (Mexico) 2006
- ❑ Bejing (China) 2006
- ❑ Ismailia (Egypt) 2007
- ❑ Brasov (Romania) 2007

Future Regional Congresses

- Tokyo, Japan, 24-28 May 2010
- Helsinki, Finland, 14-18 June 2010
- Nairobi, Kenya, 19-24 September 2010
- Medellin, Columbia, October 2010

IRPA Publications and Services

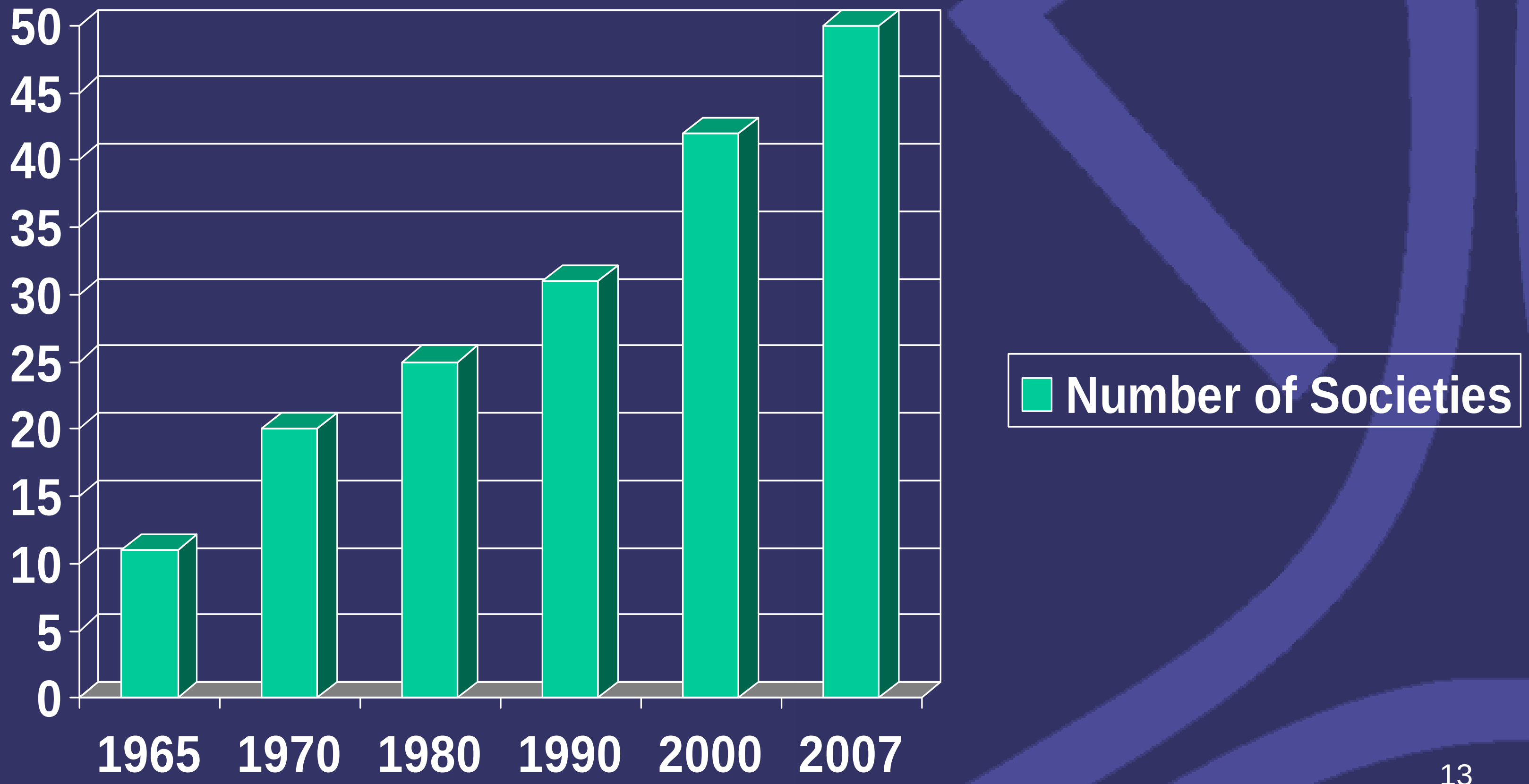
- IRPA homepage on the web
  http://www.irpa.net

- IRPA congress proceedings

- Reduced rates for ‘**Health Physics,**’ ‘**Radiation Protection Dosimetry,**’ and ‘**Journal of Radiation Protection**’

Purpose

- Promote and assist the establishment of radiation protection societies



Membership

- 48 national or regional associate societies
- 61 countries
- Around 17,000 individual members

Regional Distribution

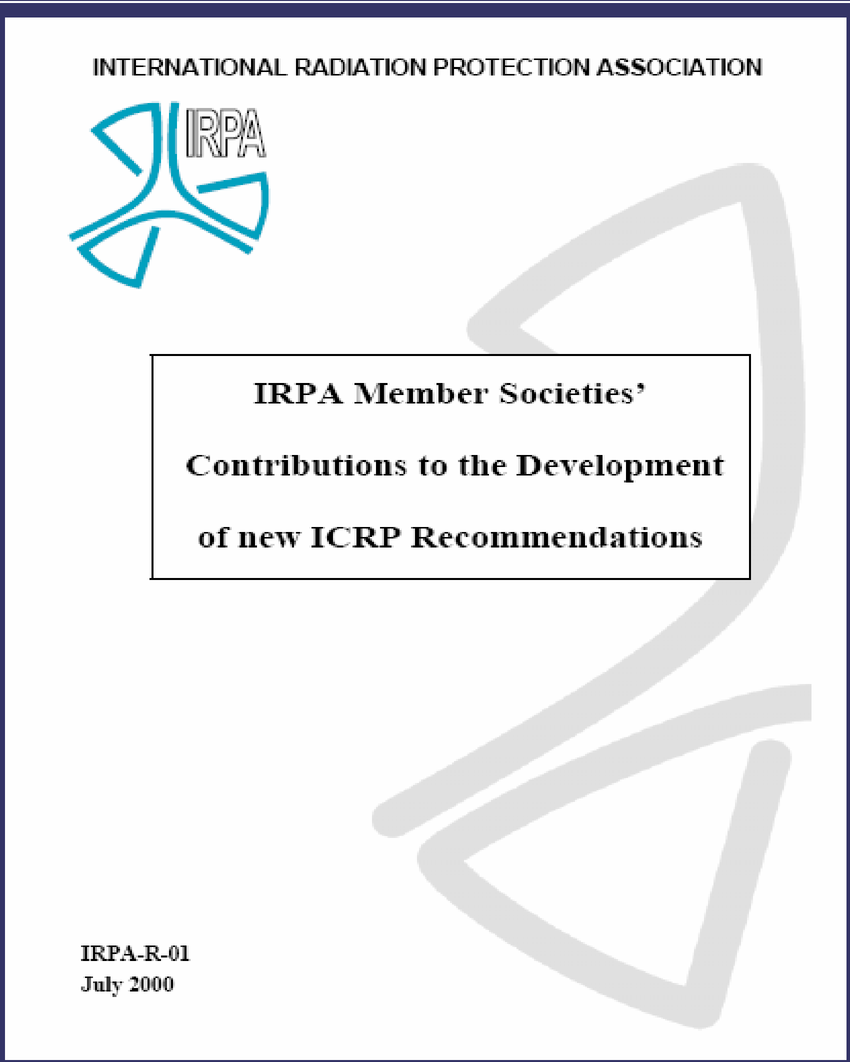
Purpose

Participate in the establishment and review of universally acceptable radiation protection standards and recommendations

International Organizations

- IAEA
- UNSCEAR
- WHO
- ILO
- IACORS
- NEA
- ICRP
- ICRU
- ICNIRP
- EC
- PAHO
- CRCPD

Radiation Protection Standards and Recommendations


INTERNATIONAL RADIATION PROTECTION ASSOCIATION

IRPA

IRPA Member Societies' Contributions to the Development of new ICRP Recommendations

IRPA-R-01
July 2000

- ❑ Feedback to ICRP on development of recommendations
- ❑ Feedback to IAEA on BSS revision

Purpose

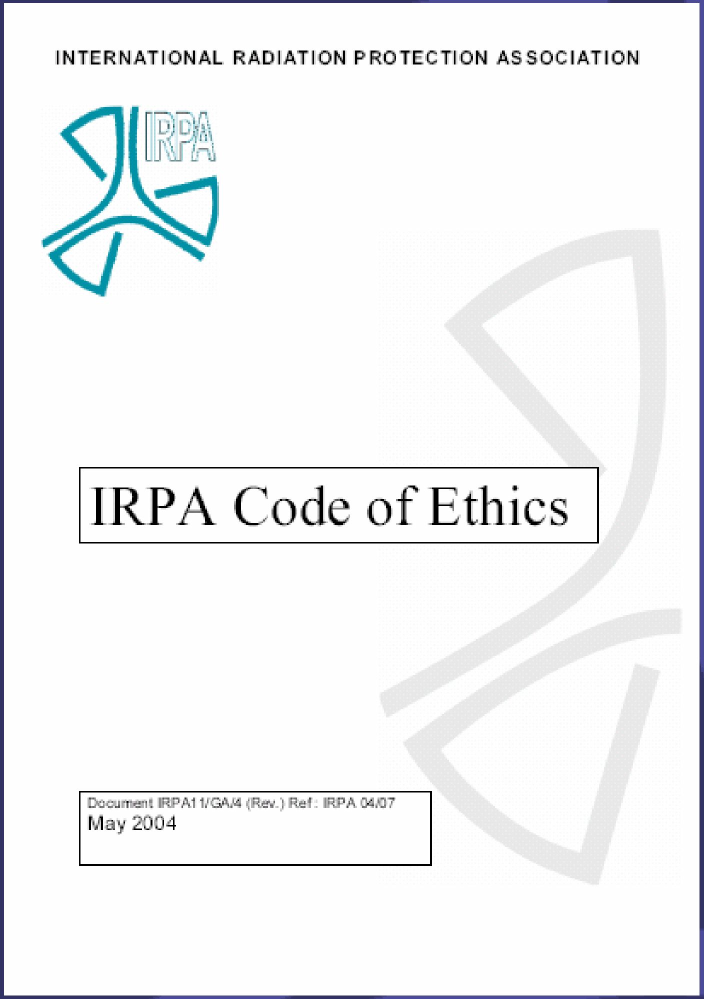
- Foster scientific and professional enhancement
  - Harmonization of education & training
  - Continuing education
  - Ethics
  - Professional recognition
  - Guidance documents

Foster Scientific Enhancement

- Harmonization of education & training
  - Participate in IAEA Steering Committee on Education and Training
  - Participate in European Commission Working Party on Education and Training
- Continuing education
  - Developing an IRPA training package based on the refresher courses at recent Regional Congresses and IRPA 12 to be posted on the website
  - Continue to support refresher courses at all forthcoming Congresses

Foster Professional Enhancement

- Ethics
  - Developed over several years with Associate Societies
  - Adopted in 2004 at the Madrid Congress as guidance for Associate Societies
  - Now all new Associate Societies are required to adopt a code of ethics based on the IRPA Code


INTERNATIONAL RADIATION PROTECTION ASSOCIATION

IRPA

IRPA Code of Ethics

Document IRPA11/GA/4 (Rev.) Ref: IRPA 04/07
May 2004

Foster Professional Enhancement

- Professional recognition
  - In November 2008, the ILO published the new draft International Standard Classification of Occupations.

    Radiation Protection Expert included under

    Environmental and Occupational Health and Hygiene Professionals.
- Definition of radiation protection expert
  - IRPA proposed a definition to the IAEA for use in the BSS

Foster Professional Enhancement

- Guidance documents
  - Guiding Principles for Stakeholder Engagement

    Adopted for further discussion on implementation at national society meetings and the regional congresses
  - Guidance for improving the radiation protection culture. Working group was established at the 2008 Congress in Buenos Aires.
    - Standards for teaching,
    - Basic tools,
    - Qualifications of the radiation protection expert, and
    - Forming professional associations.

Executive Council (2008 – 2012)

- Kenneth R. Kase (US), President
- Renate Czarwinski (Germany), Vice-President
- Roger Coates (UK), Vice-President for Congress Affairs
- Jacques Lochard (France), Executive Officer
- Richard Toohey (US), Treasurer
- Richard Griffith (US), Publications Director
- Eduardo Gallego (Spain)
- Alfred Hefner (Austria)
- Jong Kyung Kim (Korea)
- Gary Kramer (Canada)
- Bernard Le Guen (France)
- Sisko Salomaa (Finland)

Nuclear Power Expansion – Challenges and Opportunities

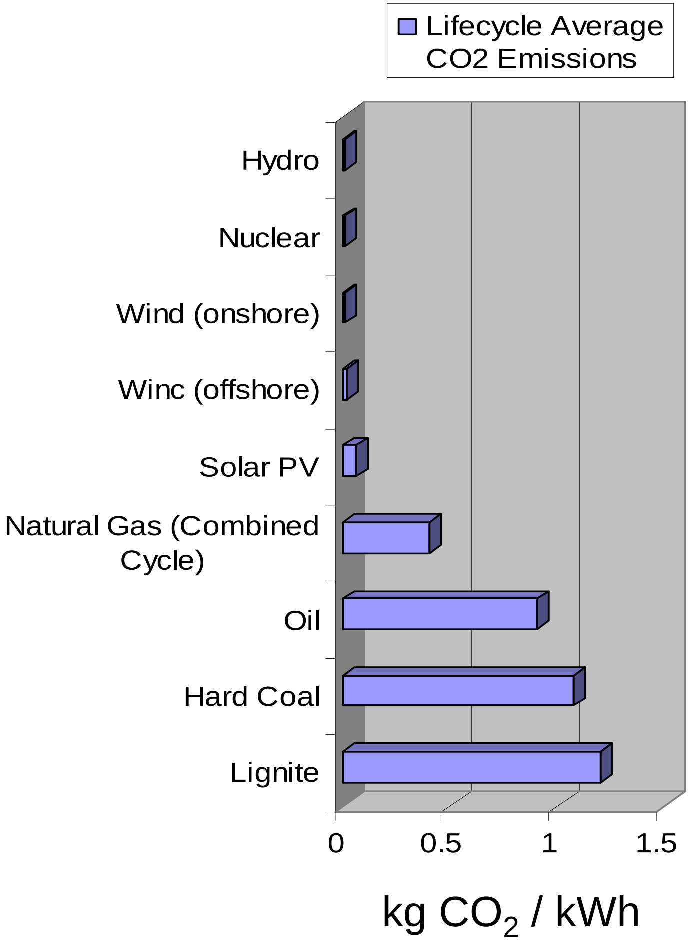
Paul Lisowski
Deputy Assistant Secretary
Office of Fuel Cycle Management
Office of Nuclear Energy
U.S. Department of Energy

Overview

- **Nuclear Energy Expansion**
- **Challenges**
  - Safety
  - Capital investment
  - Adequate infrastructure for safe, secure new deployment
  - Used fuel management
  - Proliferation
- **Opportunities**
  - Global cooperation
  - Impact climate change

Increasing Energy Demand

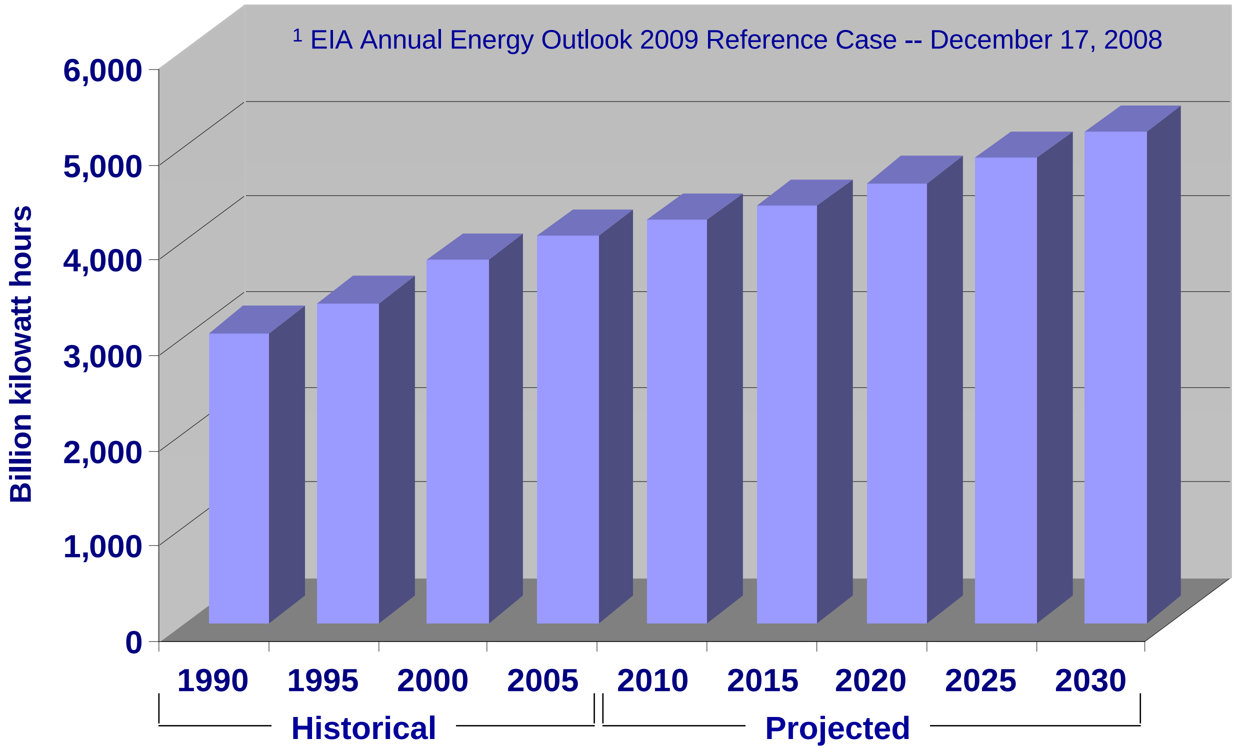
- **The world needs more energy, drivers are:**
  - Population growth
  - Economic growth
  - Energy security
- **Electricity is a particularly important energy source for developing countries**
- **Impacting climate change requires non-CO_2 emitting sources of baseload electricity**
  - Nuclear is 72% of the non-emitting U.S. electricity supply
  - Hydro unlikely to expand
  - Wind, and solar are important but are not baseload sources



Dones et al. *Life Cycle Inventories of Energy Systems …* (2004)
See Nuclear Energy Outlook 2008 p151

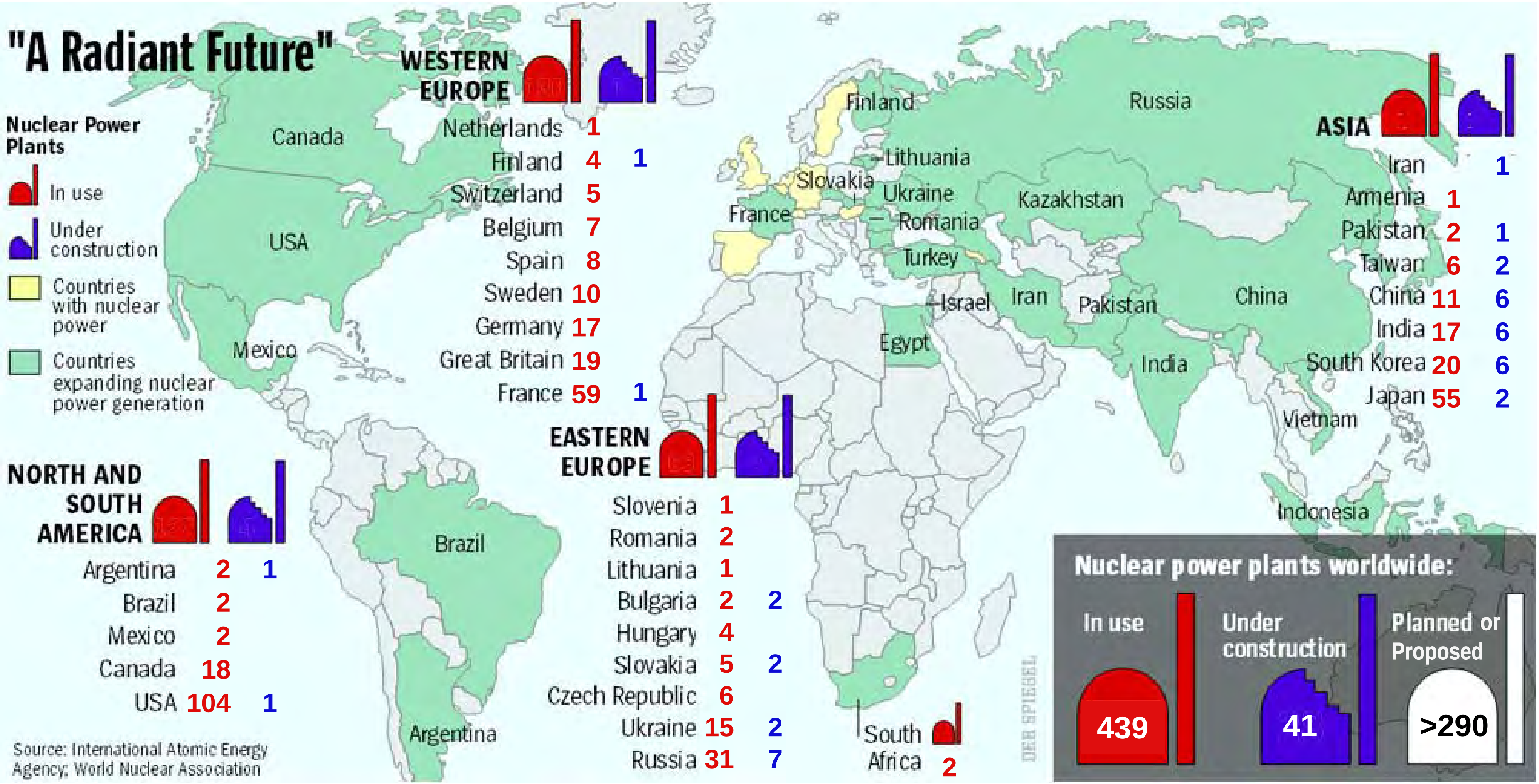
Electricity Demand Growth

- By 2030, domestic electricity demand[1] is projected to grow by ~24%
- During that time, global demand is expected to nearly grow by twice that and demand by India and China will nearly double[2]



[2] World Energy Outlook 2008 – Global Energy Trends to 2050

International Expansion of Nuclear Power



http://www.spiegel.de/international/spiegel/0,1518,460011,00.html (updated WNA 2/10/2009)

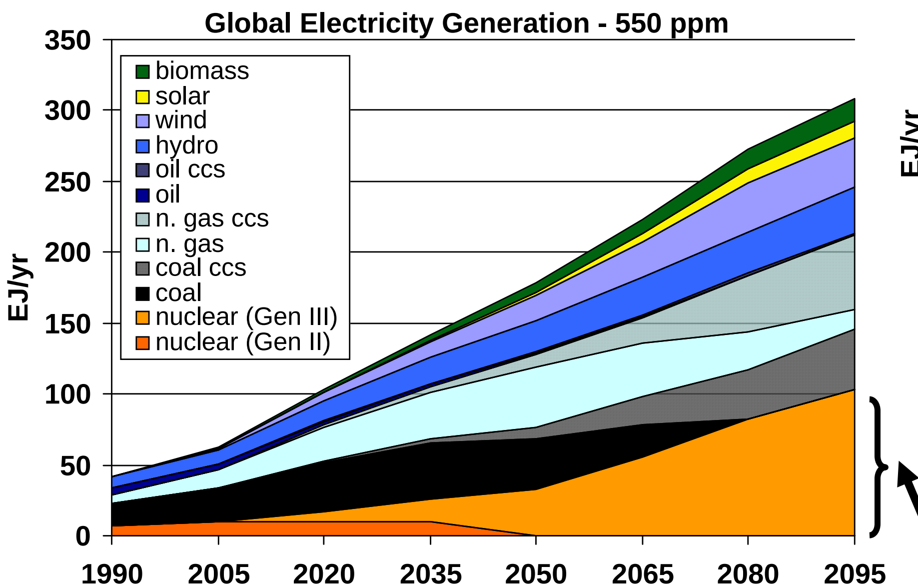
Systems Analysis Gives a Picture of How Different Technologies Contribute to Mitigate Climate Change

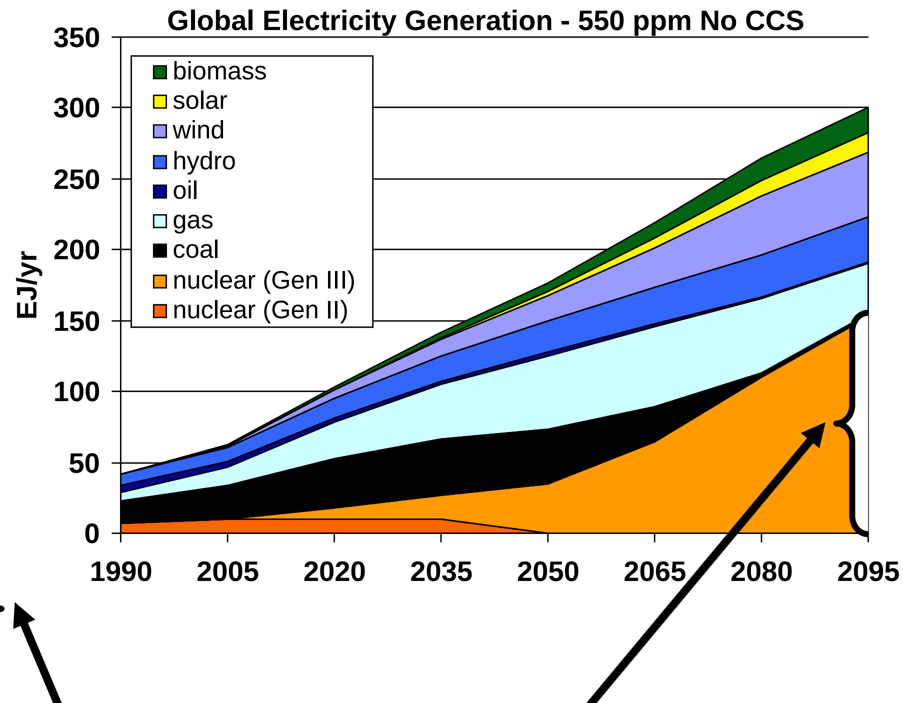
- The ObjECTS-MiniCAM was developed and employed by the Global Energy Technology Strategy Program
  - Battelle/Pacific Northwest National Lab
  - Joint Global Climate Change Research Initiative
  - University of Maryland
- Integrated Assessment Model simulating the relationship of key systems pertaining to climate change
  - Internal Carbon Cycle, Atmospheric Chemistry, Radiative Forcing, & Climate Simulation
  - Fully Integrated Agriculture and Land Use Model
  - Energy-Agriculture-Economy Market Equilibrium
- Model used to support IPCC and US Climate Change Technology Program
- CO_2 emissions limitation is affected assuming a global carbon tax, applied to all sources of emissions

The Joint Global Change Research Institute
A collaboration of the Pacific Northwest National Laboratory and the University of Maryland

Nuclear Power is an Important Part of Stabilizing CO_2

- Example: Stabilize at 550 ppm – apply carbon tax to all sources of carbon
- Carbon Sequestration from Coal Included, or not



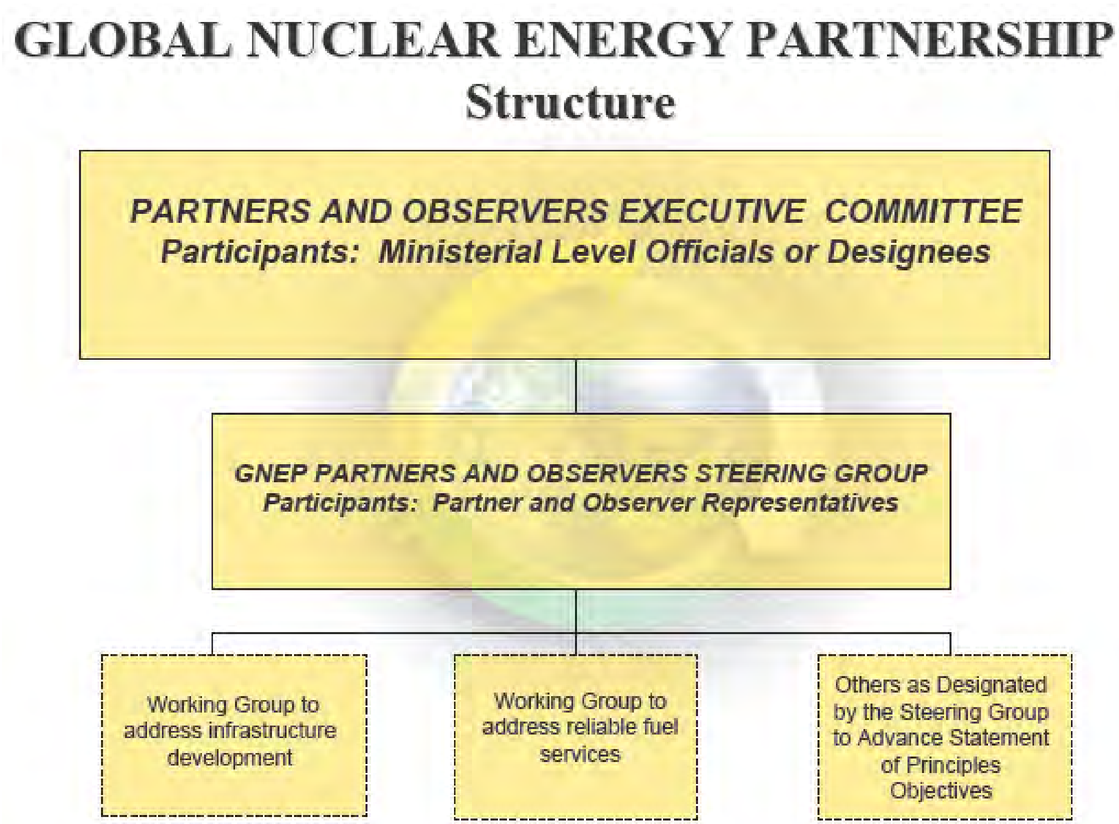


~6,000 GW Reactors Worldwide

~4,000 GW Reactors in Worldwide

Reference:
The Potential of Nuclear Energy for Addressing Climate Change, February 2008
GNEP-SYSA-PMO-MI-DV-2008-000179

A Framework to Address Some of the Challenges Associated with Global Expansion is in Place



In October 2008, France served as Host and Chair of the 2nd Executive Committee Ministerial Meeting.

The Partnership expanded from 21 to 25 full Partner nations.

China is the 2009 GNEP Ministerial Chair.

Deploying Nuclear Power for the First Time Involves Many Steps After a Decision to Proceed

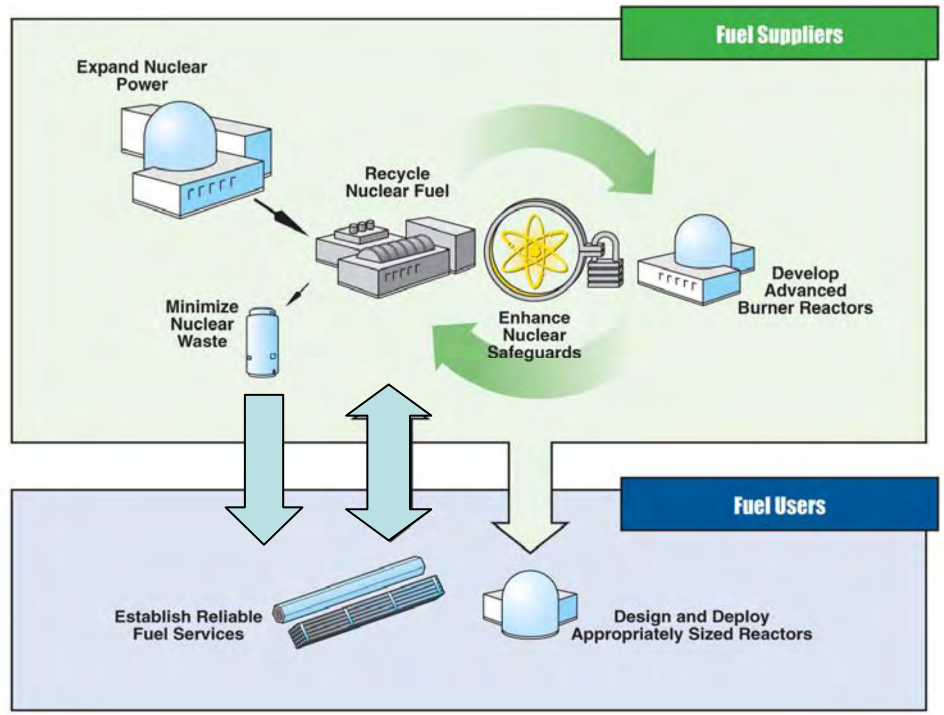
- Constructing, commissioning and operating
- Providing for Site and Industrial Planning
- Gaining Stakeholder Support
- Establishing a Means for Human Resource Development
- Having an Adequate Electrical Grid
- Obtaining Funding and Financing
- Meeting Safeguards Expectations
- Approving Nuclear Legislation
- Building a Management Organization
- Building a Nuclear Safety Regulatory Framework
- Building a Nuclear Safety Regulatory Framework
- Establishing a National Policy

Activity

Time

As Nuclear Energy Expands Worldwide, Management of Both Ends of the Fuel Cycle Become More Important

- **Fuel Supply:** Operate reactors and fuel cycle facilities, including fast reactors to transmute the actinides from used fuel into less toxic materials
- **Fuel Users:** Operate reactors, lease and return fuel
- **IAEA:** Provide safeguards and fuel assurances, backed up with a reserve of nuclear fuel for states that do not pursue enrichment and reprocessing



Global Nuclear Partnership Working Group Results

Systematic comprehensive approach to assess issues and constraints, first with discussions on the front-end of the fuel cycle followed by the back-end.

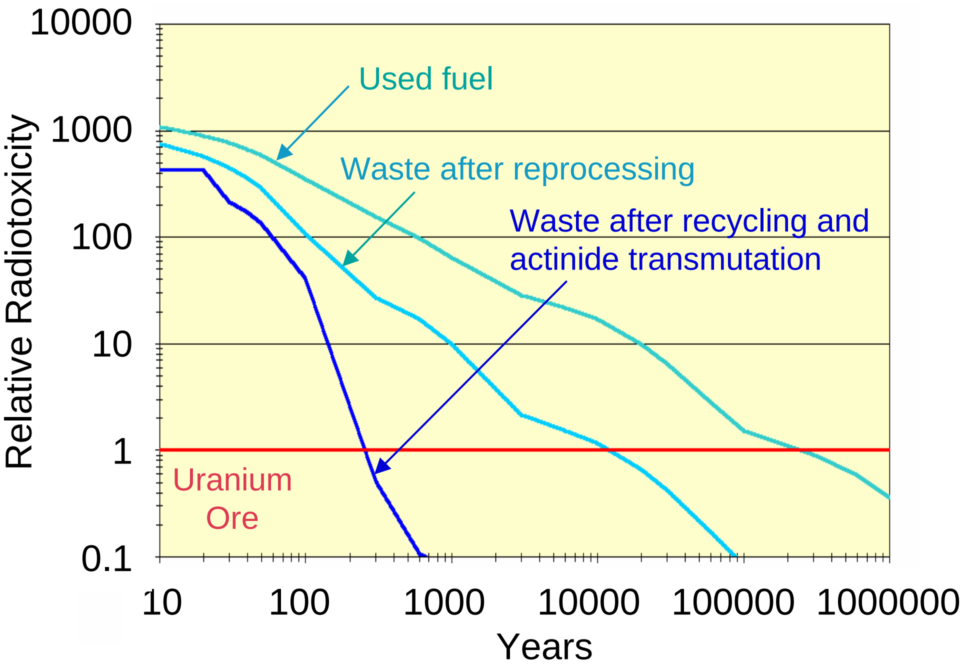
We are Structuring a Science-Based Research & Development Program to Provide the U.S. with New Options for Nuclear Waste Management

- **Requirements:**
  - High safety, security, and environmental protection standards
  - Improved waste and resource management
  - Affordable

- **The radiotoxicity relative to the original uranium ore of the waste going to geologic storage could be reduced to between 300 and 1000 years from ~300,000 years.**

- **The U.S. program will investigate and develop innovative technologies to maximize waste management and resource benefits**

- **Such alternatives may make it more likely that the U.S. can fully participate in comprehensive fuel services, leading to a "transformative means to discourage both enrichment and reprocessing worldwide"[1]**



[1] Draft Nonproliferation Impact Assessment of the Global Nuclear Energy Partnership, December 2008.

Conclusion

- **The global expansion of nuclear energy is underway and can be enormously beneficial**
- **We must be aware of the challenges and successfully address them to fully realize those benefits**
  - Place high priority on safe, secure use of nuclear energy
  - Use nuclear energy to enhance economic development, provide energy security, and mitigate climate change
  - Enhance global cooperation to put in place assured fuel services to prevent the spread of sensitive technologies and materials
  - Provide improved ways of managing nuclear waste

The Three Most Important Actions for Growth of Nuclear Power

NCRP Annual Meeting

March 3, 2009

Wayne Johnson,
Pacific Northwest National Laboratory
Mike Lawrence,
Pacific Northwest National Laboratory

Pacific Northwest NATIONAL LABORATORY

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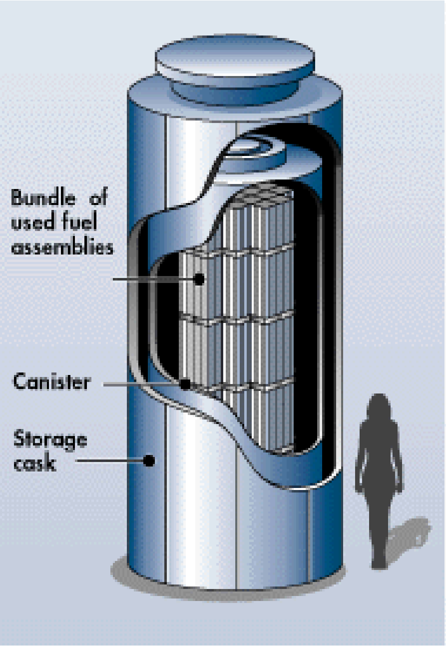
Global Context for Expansion of Nuclear Power

- In a carbon constrained world, the interdependencies among energy, the environment, the economy and security will lead to broad sweeping economic transformation in the 21st century.
- There is a growing acceptance of the role nuclear power can play in this transformation.
  - Provides near zero emission base load power
  - Improved operational performance over the past two decades
- Support for nuclear is fragile and could be hampered by even a minor accident or incident.
- In addition to ensuring safe operations, cost, waste disposal, and nonproliferation issues are commonly discussed.
- We've identified three near-term U.S. actions necessary for expanded growth of nuclear power.

Action #1 - The U.S. Government Should Fulfill its Legal Requirement to Accept Title to Used Fuel

- Amend NWPA to allow USG to take title to used fuel at shut down sites
- Pursue license application for Yucca Mountain
  - Science must drive licensing decision
- Establish nuclear waste authority with responsibility to accept, treat, and dispose of used fuel
  - Business case will establish drivers for advance fuel cycle research & development
- Establish global reliable fuel services to lease and take back nuclear fuel



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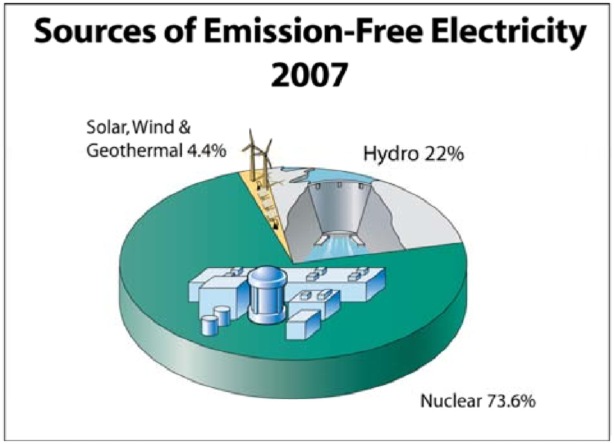
Action #2 - Limit Economic Risks for New Reactor Builds

- World-wide, nuclear power is cost-competitive with other forms of electricity generation, except where there is direct access to low-cost fossil fuels.
- The cost of carbon emissions must be accounted for in making energy tradeoffs.
- The USG should provide sufficient loan guarantees or other incentives to establish a predictable licensing process and to enable competitive financing.
- Industry should consider offering smaller, lower capital cost plants.

Action #3 - Provide National Leadership (aka "the other inconvenient truth")

- Declare presidential advocacy of nuclear energy as a component in the U.S energy and climate change strategy
- Establish clear national and international objectives
- Provide leadership for international cooperation on non-proliferation and waste management issues (see Action # 1)



http://www.nei.org/keyissues/protectingtheenvironment/

Contact Information

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  Manager of Nuclear Programs

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  Tel: 509-372-6902
  Cell: 509-392-1943
  michael.lawrence@pnl.gov

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT: STATUS CHALLENGES AND SOLUTIONS

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

2009 National Council on Radiation Protection and Measurements

TODAY'S DISCUSSION

- **Current Issues in LLW**
- **Regulatory History**
- **Challenges**
- **Paths Forward**

NUREG-1853:
ACNW LLW WHITE PAPER

- **Provides Historic Perspective on the Management of Commercial LLW**
  - Describes How NRC Staff Addressed Earlier Performance Deficiencies
  - Identifies Current Issues and Emerging Concerns
  - Summarizes Past ACNW Views on Issues Committee Has Been Asked to Review

- **White Paper Availability ...**
  - Distributed to 200+ Organizations and Entities
    - http://www.nrc.gov/reading-rm/doc-collections/nuregs

ACNW WHITE PAPER CONTENTS

- **Part I: LLW Program History**
  - Commercial LLW Management
  - NRC LLW Regulatory Framework
  - Past ACNW Observations and Recommendations

- **Part II: NRC LLW Regulatory Framework**
  - Introduction
  - Approach to Developing Part 61
  - Other NRC LLW Program Developments

WHITE PAPER CONTENTS (continued)

- **Part III: Past ACNW Advice and Recommendations**
  - General LLW Issues
  - Groundwater Monitoring Issues
  - Mixed LLW Issues
  - Onsite Storage Issues
  - Performance Assessment Issues
  - Waste Package and Waste Form Issues

ACNW MAY 2006
WORKING GROUP MEETING

- **Purposes**
  - General LLW Issues
  - Groundwater Monitoring Issues
  - Mixed LLW Issues
  - Onsite Storage Issues
  - Performance Assessment Issues
  - Waste Package and Waste Form Issues

- **Four Sessions**
  - Current LLW Program Status
  - Current Framework for Managing LLW and Operational Issues
  - Industry Roundtable
  - Stakeholder Perspectives

ACNW&M FEBRUARY 2008 WORKING GROUP MEETING

- **Growing Concern Regarding Management of LAW**
  - US EPA 2003 RCRA Advanced Notice of Rulemaking
  - National Academies 2006 Study
  - 2008 Commission Direction to ACNW&M

- **February 2008 WGM**
  - 14 Presentations
    - Current Regulatory Framework for Managing LAW
    - Practitioner Perspectives
    - Examine Alternative Management Approaches

- **Committee Letter Report in April 2008**

WGM KEY MESSAGES

- No Need to Revise NRC's LLW Regulations at this Time
- Develop Guidance Permitting Management and Disposal of Unique and Emerging Waste Streams
- Place Greater Emphasis on Radionuclide Content Rather Source or Origin
- Examine How Potential Increases in Class-B and -C LLW Storage are to be Regulated
- Evaluate Any Unintended Consequences Due to Changes in Regulations or Guidance

PATH FORWARD

- **Improved Risk-Informed Guidance for Waste Averaging**
- **Risk-Informed Performance Assessments for Storage and Disposal**
- **Risk-Informed Evaluation of the Entire Disposal System**

PATH FORWARD (continued)

- **Improved Risk-Informed Guidance for Waste Averaging**
- **Irradiated Hardware 94-Nb and 63-Ni Influences on Classification**
- **Can Averaging Over a Wider Range on Concentrations Result in Compliant Disposal?**

PATH FORWARD (continued)

- **Remember Quantity Disposed is a Better Metric of Risk than Concentration**

- **Concentration is a metric for Health Physics and Transportation**

PATH FORWARD …
10 CFR 61.58

- **Risk-Informed Accounting for:**
  - **Quantity of Materials**
  - **Waste Form**
  - **Packaging**
  - **Site Features (Natural and Engineered)**
  - **Performance of Overall Disposal System**
  - **Principle Protection Criteria Must Be Met**

PATH FORWARD …
Regulatory Initiatives

- DU from enrichment plants - SECY-08-0147 (note the improved performance assessment tools for DU)
- Concentration Averaging BTP - Sandia has begun work on updating the BTP, no results available yet
- LLW blending rules are being revisited
- LAW - Standard Review Plan will be developed
- LLW Storage

The Challenges and Opportunities of a Global Nuclear Energy Future: Key Issues at the Back End of the Nuclear Fuel Cycle

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March 3, 2009

In the Beginning…

- Nuclear weapons secrets were known by very few
- There were extremely small amounts of SNM in very few, secure places
- Required knowledge and infrastructure only available to most developed countries
- Terrorists lacked motivation to use WMD
- Terrorists weren't willing to sacrifice themselves
- Terrorists couldn't attract technically sophisticated members
- Terrorist groups would be small or discovered

The World has Changed

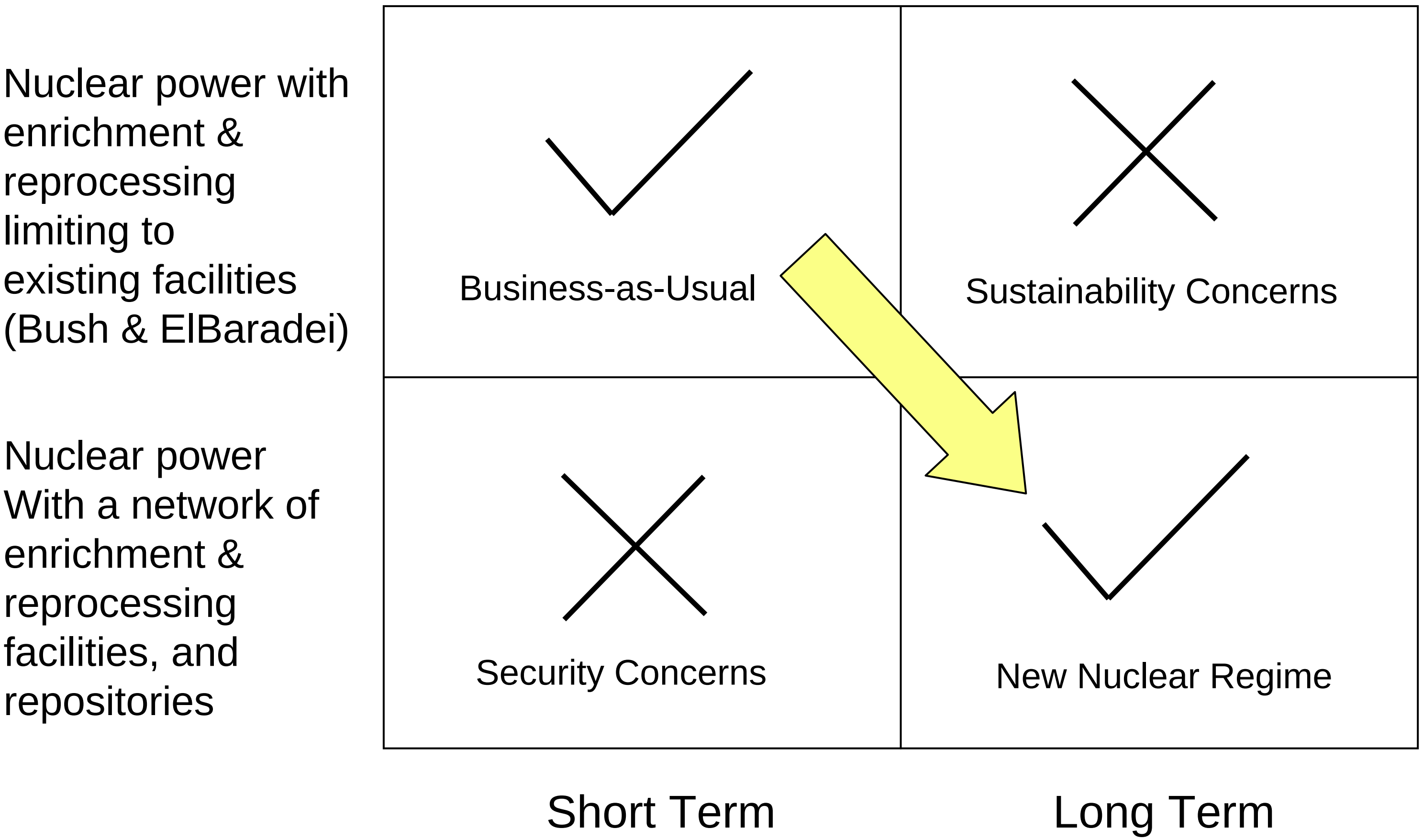
- Many nations have access to enrichment and reprocessing technologies and know-how
- A small, but crucial set of nations have moved close to weapons under guise of peaceful uses and by covert means - DPRK, Iran, India, Pakistan . . .
- Closed fuel cycle seen as “latent proliferation” concern
  - Osirak, Syria, Iran
  - Potential knock-on regional escalation?
- Pu commerce a security concern
- Threat of terrorist WMD, possibly aided by “rogue” nations
- If they have the material, is it reasonable to assume they can make a weapon?

The Situation Today

- Spread of nuclear power likely
- Spread of enrichment/reprocessing technologies
- Growth of SNF
- Excess materials/wastes from defense programs
- Research reactor fuel
- No operating HLW/SNF repositories
- Many countries planning on SNF storage/disposal

What are the concerns?
What are the opportunities?

Working toward a New Nuclear Regime (NNR)



Moving toward a network to provide fresh fuel supply assurance and spent fuel & waste management

The Intersection of Nuclear Power, Security, and Waste Management

Can we devise and move toward a

“New Nuclear Regime”

That allows the growth and spread of nuclear power while reducing security and waste management concerns?

Is it possible that we may better solve the energy, security and waste management elements as part of a whole than each one separately?

The Back-end of the Fuel Cycle
The Achilles’ heel?
Or challenges and opportunities?

Some Possible Futures

- Business as usual
- Modified business as usual
- Punctuated equilibrium/crisis management
- New nuclear regime
- ?

What are the salient features?
What are the criteria for success?
How can we move with effect?

Some Elements of a NNR

- Countries have access to nuclear power at market prices
- Nuclear fuel supplies are assured at competitive prices
- Rationale for enrichment/reprocessing eliminated for all but selected few under international control/oversight
- All excess weapons-usable material is secured, put in unattractive form, burned where sensible, and brought under international control in appropriate countries
- SNF is returned to appropriate countries for management and disposal under international control
- Any moves toward weapon development or nuclear material acquisition are surely, quickly, and clearly apparent

The Crucial Role of Waste Management

- Providing a secure home for SNF from commercial and research reactors, defense materials, etc.
- Offering a potential win/win for developed and developing countries regarding nuclear power
- Regional/international solutions driven by energy, security, and environmental considerations

Repositories and storage become instruments of security, more than utility dumping grounds

Challenges

- Can we live in a nuclear have/have not world?
- Should we provide assurances to avoid the spread of enrichment/reprocessing?
- How do we deal with concept of take-back or take-away?
- Are there appropriate metrics?
- What are the security risks, institutional and operational features for multi-party repositories?
- What are the roles of IAEA and others?

Is there a new bargain?