

**Perspectives of the National Council  
on Radiation Protection and  
Measurements on Important Issues  
in Understanding the Biological  
Effects of Low Radiation Doses**

*Thomas S. Tenforde*  
*President*

**Nuclear Regulatory Commission Working Group  
on the Effects of Low Radiation Doses:  
Science and Policy**

**North Bethesda, MD**

**April 8-9, 2008**



**N  
C  
R  
P**

# Topics of Discussion



**N  
|  
C  
|  
R  
|  
P  
|  
M**

- **Rationale for low-dose radiation studies**
- **Role of NCRP**
- **Key issues to be addressed**
- **NCRP activities and path forward**
- **Summary and concluding remarks**

# Key Issues in Understanding Low-Dose Radiation Effects



**P  
R  
O  
N**

- **Current knowledge is largely based on high-dose laboratory and human exposure data**
- **Epidemiological data on low-dose exposures is very limited**
- **Radiation exposure of humans under occupational conditions is generally low**
- **Regulations on public and occupational exposures are based primarily on extrapolation of high-dose exposure information**
- **A need exists to close the gap in scientific knowledge on low-dose *versus* high-dose effects, and evaluate the implications for radiation exposure practices and policies**

# Role of NCRP

- Under its 1964 Congressional Charter NCRP is mandated to analyze and recommend radiation exposure limitations
- *NCRP Cornerstones of national role in radiation health protection:*

**1) Provide information and recommendations in the public interest about:**

**a) protection against radiation; and**

**b) radiation measurements, quantities and units.**

**2) Develop basic concepts of radiation protection.**

**3) Facilitate effective use of combined resources of organizations concerned with radiation protection.**

**4) Cooperate with national and international governmental and private organizations.**



**N  
|  
C  
|  
R  
|  
P  
|  
N  
|**

# Perspectives on Key Research Needs on Low-Dose Radiation Effects

## Molecular, Cellular and Tissue Studies – 1



**NCRP**

- **Relationship between microscopic energy transfer and deposition and characteristics of damage at molecular level, including differing effects of low- and high-LET radiation and influence of radiation dose rate**
- **Molecular damage mechanisms at cellular and tissue levels**
- **Repair mechanisms for radiation damage to DNA, chromosomes, and regulatory factors in cells**
- **Influence of nontargeted radiation effects on cellular and tissue responses, including bystander effects, genomic instability and adaptive responses**

## Molecular, Cellular and Tissue Studies – 2



**N  
C  
R  
P**

- **Genetic and epigenetic consequences of unrepaired and misrepaired cellular damage**
- **Damage, repair and misrepair consequences at stromal and integrated tissue levels**
- **Modifying factors in radiation damage and repair at molecular, cellular and tissue levels, including repair enzymes, reactive oxygen species, components of the extracellular matrix, and humoral modifiers such as antioxidants, hormones and growth factors**

# **Perspective on Key Research Needs on Low-Dose Radiation Effects Laboratory Animal Studies – 1**



**NCRP**

- **Analysis of frequency of various types of toxic effects such as cancer induction, and relationship to tissue radiation sensitivity and damage mechanisms studied *in vitro***
- **Genetic mechanisms in relation to radiation sensitivity and harmful outcomes of exposure**
- **Investigation of biological markers of radiation damage and recovery**

## Laboratory Animal Studies – 2



- **Evaluation of radiation injury and recovery after exposures to radiation of differing qualities (low- and high-LET) and dose rates**
- **Analysis of radiation damage pathways and application of systems biology approaches to understanding interrelationships of damage and recovery mechanisms at the cellular, tissue and organ levels**

# Perspectives on Key Research Needs on Low-Dose Radiation Effects Human Health Studies – 1



**N  
I  
C  
R  
P**

- **Extrapolation of radiation exposure outcomes observed in laboratory animals to projection of risks in humans at tissue, organ and whole-body levels**
- **Interpretation of adverse health outcomes in humans based on results from *in vitro* and *in vivo* laboratory-based studies, including biological markers of radiation damage**
- **Evaluation of modifying factors influencing radiation damage, repair and ultimate health outcomes**

## Human Health Studies – 2



**ICRP**

- **Analysis of effects of radiation quality and influence of dose rate on health outcomes**
- **Dose-response modeling at tissue, organ and whole-body levels, taking into account nontargeted effects and chronic exposure to natural background radiation (to maximum extent possible)**
- **Evaluation of interventional approaches to reducing adverse health outcomes of radiation exposure**

# **Perspective on Key Research Needs on Low-Dose Radiation Effects Public Policy and Regulatory Implications – 1**



**N  
C  
R  
P**

- **Predictive risk modeling of health impacts of exposure to low doses of radiation, including consideration of radiation quality and dose rate**
- **Application of results of laboratory-based studies and extrapolation of these results to humans in establishing acceptable levels of exposure in occupational and public settings**

## Public Policy and Regulatory Implications – 2



**N  
C  
R  
P**

- **Use scientific knowledge to improve radiation protection policies and practices, including allowance for complexities associated with variable responses to low radiation doses among individuals of differing sensitivity and between different organ and tissue systems within each individual**
- **Resolve in an unambiguous manner the question of whether general conclusions can be drawn and predictive models developed for the optimization of health protection in humans chronically exposed to low doses of radiation (at or close to background levels)**

# NCRP's Role in Analyzing Effects of Low Doses of Radiation

## Published Reports Since 1990 – 1



**N  
C  
R  
P**

- **Report No. 150: *Extrapolation of Radiation-Induced Cancer Risks from Nonhuman Experimental Systems to Humans* (2005)**
- **Statement No. 10: *Recent Applications of the NCRP Public Dose Limit Recommendation for Ionizing Radiation* (2004)**
- **Report No. 136: *Evaluation of the Linear-Nonthreshold Dose-Response Model for Ionizing Radiation* (2001)**
- **Report No. 126: *Uncertainties in Fatal Cancer Risk Estimates Used in Radiation Protection* (1997)**

## Published Reports Since 1990 – 2



ICRP

- **Report No. 117**: *Research Needs for Radiation Protection (1993)*
- **Report No. 116**: *Limitation of Exposure to Ionizing Radiation (1993)*
- **Report No. 115**: *Risk Estimates for Radiation Protection (1993)*
- **Report No. 104**: *The Relative Biological Effectiveness of Radiations of Different Quality (1990)*

# NCRP's Role in Analyzing Effects of Low Doses of Radiation – 2008 Annual Meeting



**N  
C  
R  
P**

- **44<sup>th</sup> NCRP Annual Meeting on *Low Dose and Low Dose-Rate Radiation Effects and Models* (April 14-15, 2008 at Bethesda North Marriott Hotel and Conference Center)**
- **Program available at <http://NCRPonline.org>**
- **Sessions include:**
  - **Molecular, Cellular, Tissue and Animal Radiation Responses of Relevance to Radiation Protection**
  - **Human Epidemiology Studies**
  - **Low-Dose Radiation Effects, Regulatory Policy and Impacts on the Public**
- **Peer-reviewed proceedings of meeting will be published in *Health Physics***

# **NCRP's Role in Analyzing Effects of Low Doses of Radiation: The Path Forward – 1**



**N  
C  
R  
P**

- **NCRP plans to prepare a definitive report on *Biological Effects of Low Radiation Doses and Implications for Human Health and Radiation Protection***
- **Detailed outline of report and proposal to potential funding cosponsors will be prepared in 2008, with anticipated starting date of a four-year effort in 2010**

## The Path Forward – 2



- **NCRP Scientific Committee preparing the low-dose report will be large and contain scientists with expertise in all major aspects of basic radiation research, epidemiology, operational and public health radiation protection, and public policy and regulatory issues**
- **Committee discussions will include collaborative input from international organizations involved in radiation protection issues (*e.g.*, ICRP) and report will be placed in both national and international contexts**

# Summary and Concluding Remarks



**N  
C  
R  
P**

- **Understanding biological and human health effects of low radiation doses is a major scientific challenge and frontier that must be crossed**
- **As described in the recently issued NCRP Strategic Program Plan 2008-2010, the analysis of low-dose radiation effects is a major strategic area of long-term effort by NCRP**
- **NCRP welcomes input on its plans and activities from interested scientists and regulators in the U.S. and worldwide**