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**New Reports of the National Council  
on Radiation Protection and  
Measurements (NCRP) on  
Uncertainties in Radiation  
Measurements, Dose Reconstruction,  
and Estimates of Health Risks**

**Thomas S. Tenforde**

*President*

**CIRMS 2006 Conference**

**National Institute of Standards & Technology**

**Gaithersburg, Maryland**

**October 23-25, 2006**



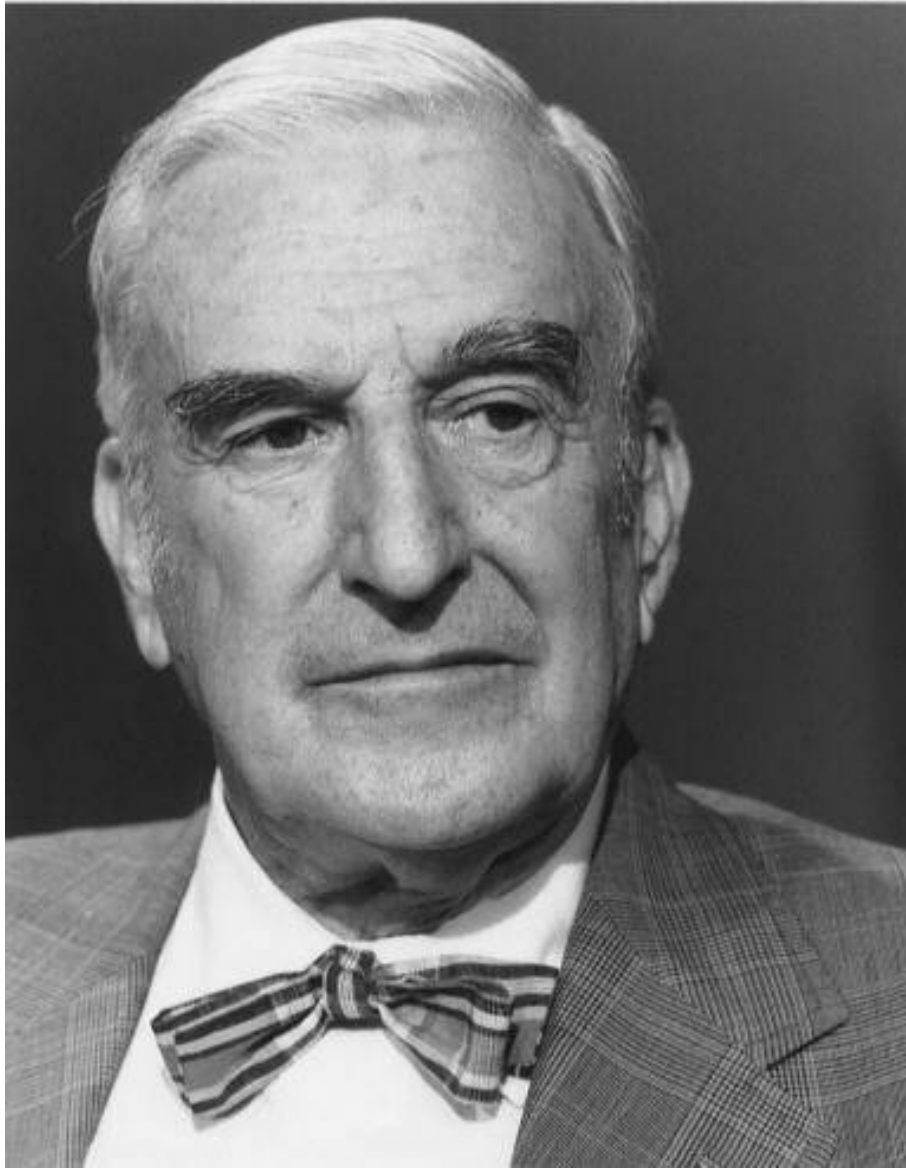
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# Topics of Discussion

- **NCRP's historical role in radiation measurements and dosimetry**
- **Primary goal of new NCRP reports related to radiation dose reconstruction**
- **Uncertainties in external and internal radiation measurements and dosimetry**
- **Fundamental basis of procedures in radiation dose reconstruction**
- **Uncertainties in radiation risk estimates and probability of disease causation**
- **Long-term benefits of improved uncertainty analysis and dose reconstruction procedures**



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**Lauriston Sale Taylor**  
**June 1, 1902 – Nov. 26, 2004**

## **Early History --**

**1929: U.S. Advisory  
Committee on X-ray  
and Radium Protection**

**1946: U.S. National  
Committee on  
Radiation Protection**

**1964: National  
Council on Radiation  
Protection and  
Measurements (NCRP)  
chartered by U.S.  
Congress**



# NCRP's Historical Role in Radiation Measurements and Dosimetry

*Under 1964 Congressional Charter, a primary mandate was to:*

- Provide information and recommendations in the public interest about:
  - a) protection against radiation, and
  - (b) radiation measurements, quantities and units**
- NCRP and its predecessor organizations have published 85 documents on topics related to radiation measurements and dosimetry (see <http://NCRPonline.org> and <http://NCRPpublications.org>)



# **New NCRP Report Activities Related to Radiation Dosimetry**

- **In 2004 NCRP signed contract with Defense Threat Reduction Agency (DTRA) to provide technical and administrative support to new Veterans' Advisory Board on Dose Reconstruction (VBDR), the formation of which was required under Public Law 108-183 (December, 2003)**
- **VBDR's charter is to provide oversight and guidance to DTRA and Department of Veterans Affairs (VA) in dose reconstruction and claims adjudication procedures for atomic veterans**
- **NCRP's technical support includes preparation of new reports on uncertainties in measurement and dosimetry of external and internal radiation and on fundamental principles of dose reconstruction**





# Primary NCRP Goal in Uncertainty Analysis and Radiation Dose Reconstruction



- *Establish stronger scientific foundation for radiation dose reconstruction, including uncertainty analysis, for application in many exposure scenarios:*
  - Atomic veterans [occupied Hiroshima & Nagasaki after A bombs or participated in atmospheric nuclear weapons tests (1945-1962)]
  - Energy workers and members of other contractor organizations involved in production of nuclear weapons during Cold War era
  - Exposure of workers and general public from fallout or release of uncontrolled radiation and radioactive materials (Goiania incident, Chernobyl accident, *etc.*)
  - Prospective dose assessment for epidemiological studies (*e.g.*, on medically exposed populations)



# New NCRP Reports in Progress

- ***Scientific Committee 6-1*** (Chair: Harold Beck; 13 members) – “Uncertainties in the Measurement and Dosimetry of External Radiation” [Status: report drafted in preparation for Council review]
- ***Scientific Committee 6-3*** (Chair: André Bouville; 14 members) – “Uncertainties in Internal Radiation Dosimetry” [Status: report in mid-drafting stage]
- ***Scientific Committee 6-4*** (Chair: Bruce A. Napier; 12 members) – “Fundamental Principles of Radiation Dose Reconstruction” [Status: report is in early drafting stage]





# ***SC 6-1: Uncertainties in Measurements and Dosimetry of External Radiation***

- **Focus of report is on:**
  - Measurement techniques and associated uncertainties
  - Uncertainties in estimating organ doses
- **Topics discussed in depth include:**
  - Uncertainties in data obtained from personal dosimeters and area monitors for gamma, beta, neutron, and charged-particle radiation fields
  - Probability distributions for characterizing uncertainty of radiation measurements
  - Concepts and factors contributing to uncertainty in conversion of measurements to estimates of organ radiation doses, including methods for combining uncertainties associated with measurements and models to obtain total uncertainty in dose estimates





## ***SC 6-1: Uncertainties in Measurements and Dosimetry of External Radiation (con't.)***

- **Examples of uncertainty analysis for external radiation exposures:**
  - Atomic veteran exposure
  - Energy worker exposure
  - Exposure of radiological technologists
  - Accidental exposure to neutrons at an accelerator facility
  - Multi-site leukemia case-control study
  - Techa River cohort exposure

**ORNL**



# SC 6-3: Uncertainties in Internal Radiation Dosimetry

- **Focus of report is on:**
  - Intake pathway analysis (ingestion, inhalation, dermal absorption, wounds)
  - Uncertainties associated with modeling uptake, retention and biodistribution of radionuclides
  - Uncertainties in estimation of organ doses for past exposures and in prospective dosimetry
- **Topics discussed in depth include:**
  - Measurement uncertainties in biodosimetry and environmental monitoring
  - Uncertainties in models used to predict radionuclide biodistribution and retention
  - Uncertainties in dose estimation, including Monte Carlo and Bayesian methods





## ***SC 6-3: Uncertainties in Internal Radiation Dosimetry (con't.)***

- **Examples of uncertainty analysis for internal radiation exposures:**
  - Atomic veterans
  - Energy workers (including Pu inhalation)
  - Medical exposures (including thyroid ablation with  $^{131}\text{I}$ ,  $^{18}\text{F}$ -FDG,  $^{90}\text{Y}$ -Zevalin)
  - Environmental exposures (including radon,  $^{90}\text{Sr}$ ,  $^{131}\text{I}$  from Chernobyl accident)
  - Occupational and public exposures from reactor sources
  - Potential nuclear and radiological terrorism incidents

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# ***SC 6-4: Fundamental Principles of Radiation Dose Reconstruction***

**Focus of report will be on an in-depth presentation of optimal methods for performing the six basic elements of dose reconstruction:**

- Characterization of exposure scenarios  
(including data collection and organization)**
- Identification of exposure pathways**
- Development and implementation of methods for estimating dose**
- Evaluation of uncertainties in estimating dose**
- Interpretation and presentation of results**
- Quality assurance and control in all elements of dose reconstruction program (including documentation)**





## ***SC 6-4: Fundamental Principles of Radiation Dose Reconstruction (con't.)***

**Areas of focus in the report with numerous examples of retrospective and prospective dose reconstruction:**

- **Uncertainties in exposure scenario characterization, pathway analysis, and dose assessment (measurements and models)**
- **Dose reconstruction procedures and optimization in exposure scenarios of contemporary interest:**
  - **Medical**
  - **Occupational**
  - **Environmental**
  - **Accidents and incidents involving workplace and/or public exposures**

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# **New NCRP Report Activity Expected to be Initiated in FY 2007<sup>1</sup>**



**NCRP plans to establish Scientific Committee 1-16 in 2007 (Chair: R. Julian Preston) to prepare a report on “*Uncertainties in Radiation Risk Estimation and Probability of Disease Causation*”**

**Topics to be analyzed and discussed in depth include:**

- Overall uncertainties in absorbed dose assessment from external and internal sources (building on reports of SC 6-1 and SC 6-3)**
- Uncertainties in radiation and tissue weighting factors used in effective dose calculations**
- Uncertainties in estimation of radiation-related health risks (including cancer, non-cancer effects, severe genetic defects) and effects of variables such as age at exposure, time since exposure, gender, and dose and dose-rate effectiveness factors**

<sup>1</sup> Support anticipated from Department of Labor and National Institute for Occupational Safety and Health



## **New NCRP Report Activity Expected to be Initiated in FY 2007 (con't.)**

**Topics to be analyzed and discussed in depth (con't):**

- **Incorporation of uncertainty analysis in estimation of Probability of Disease Causation (PC, or Assigned Share)**
  - **Review Interactive Radio-Epidemiological Program (IREP) used to estimate PC**
  - **Analyze inherent uncertainties in estimating PC**
  - **Recommend improvements in current procedures for estimating PC, including effects of uncertainty analysis for IREP parameters and input dose estimates**

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# **End Goals of NCRP's New Report Activities on Radiation Dosimetry and Disease Causation**

- **Improve scientific basis for estimating uncertainties in radiation measurements, dosimetry, dose reconstruction processes, and estimation of radiation health risks**
- **Improve accuracy and efficiency of dose reconstruction procedures**
- **Achieve greater credibility of dose reconstruction programs – both prospective programs (for epidemiology applications) and retrospective programs (for claims adjudication and compensation programs)**