Plenary Session
Consistency in Radiation Protection Standards

NCRP
Scientific Authority Since 1929

NCRP and International Consistency in Radiation Protection Standards

John D Boice Jr
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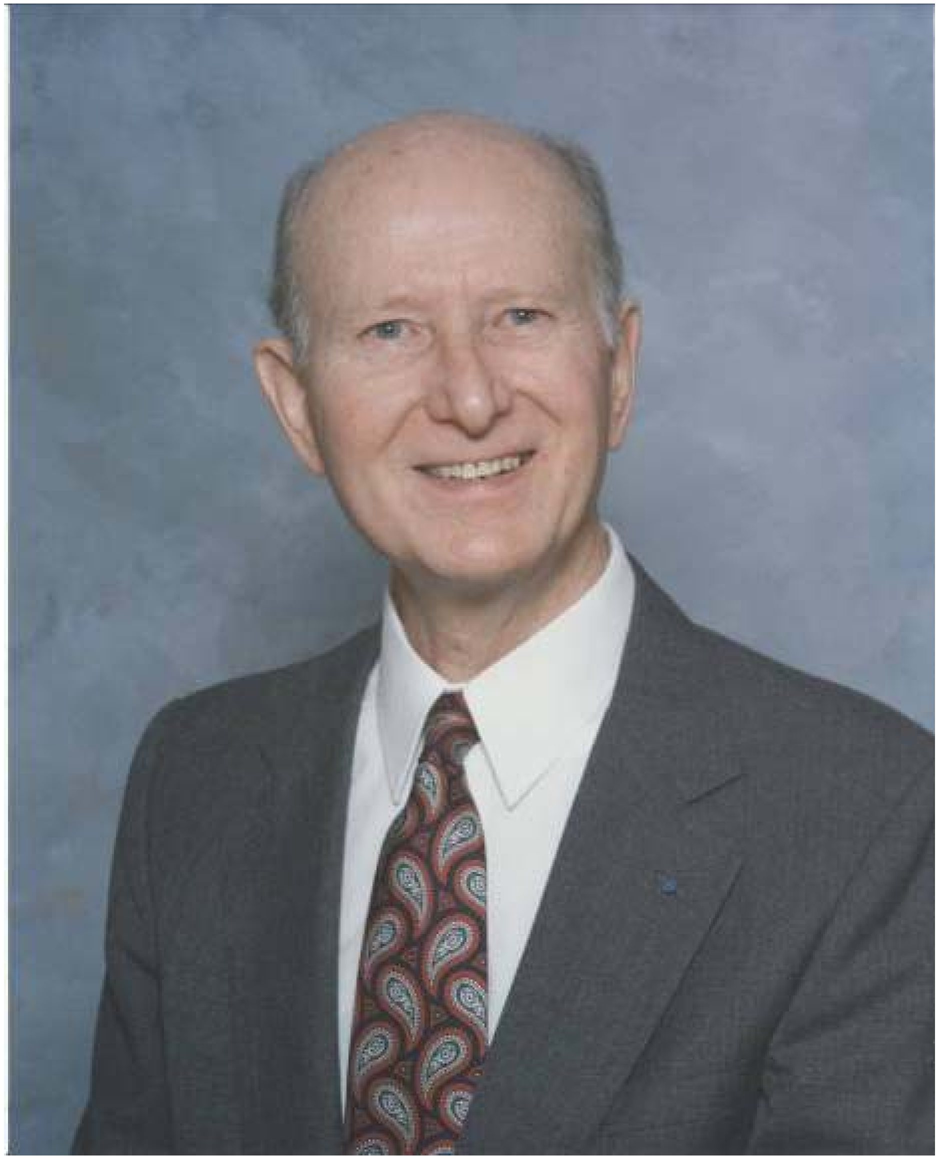
Vanderbilt University

Sacramento 2012 Health Physics Society

Health Physics Society 57th Annual Meeting
Sacramento, CA -- July 23, 2012

Vanderbilt University



Dade Moeller
1927- 2011

- Scientist
- Teacher
- Leader
- Gentleman
- Author
- Father

NERHL

- US Navy
- Georgia Tech, NC State
- USPHS: ORNL, LANL, NERHL
- Harvard School Public Health
- HPS President
- Dade Moeller & Assoc

Dade Moeller
1927- 2011

2008 NCRP Taylor Lecturer

Outline

NCRP and International Consistency in Radiation Protection Standards

- Similarities / Consistencies
- Differences
- Does it Matter?
- Issues of Importance
- Some Suggestions
- NCRP Initiatives

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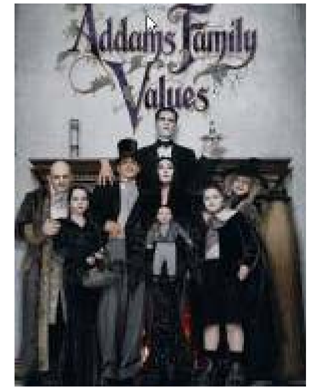
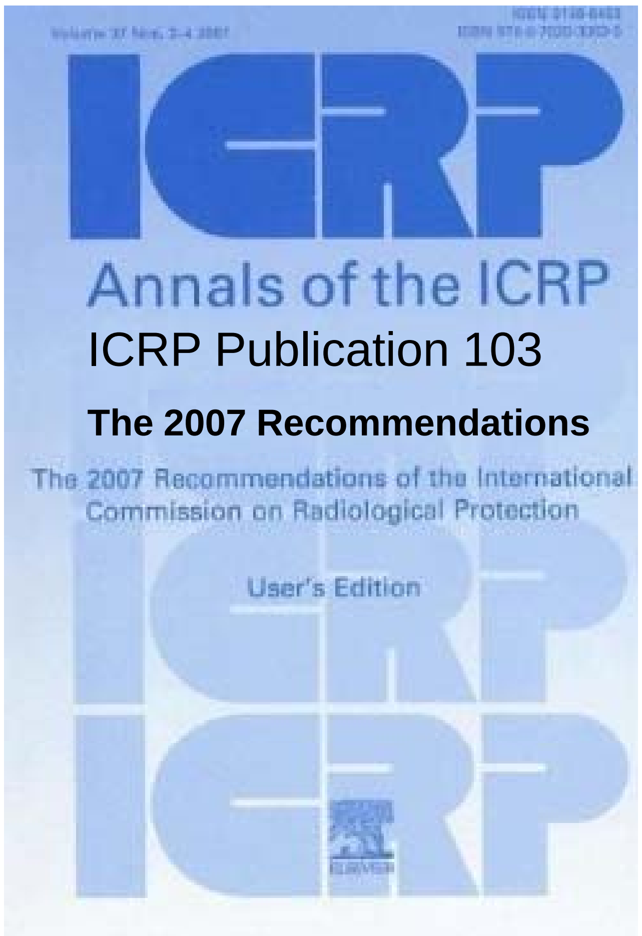
ICRP 103 (2007)



Revolution, Evolution, Evilution ?



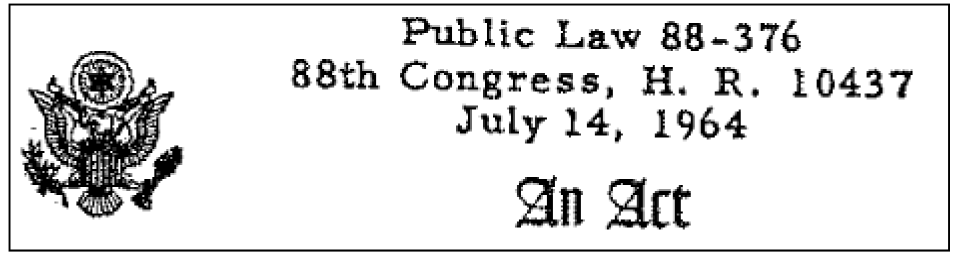
- Opportunity – Harmony, Alignment, Consistency, Consolidation, Improve, Address the New
- Awareness because of Fukushima, CT scans, terrorist concerns

United States has been an Integral Part of ICRP

1928-69	Main Commission, Chairman	Lauriston Taylor
1950-72	Main Commission, C2	Karl Z Morgan
1950-58	Main Commission, vChair	Gino Failla
1969-80	Main Commission, C1	Art Upton (ICRP 26)
1973-2001	Main Commission, vChair	Charlie Meinhold (ICRP 60)
1977-96	Main Commission, C1	Warren Sinclair (ICRP 60)
1989-2005	Main Commission, C3	Fred Mettler (ICRP 103)
1997-	Main Commission	John Boice (ICRP 103)
2004-12	Main Commission, C1	Julian Preston (ICRP 103)
2012-	Main Commission, C1	Bill Morgan

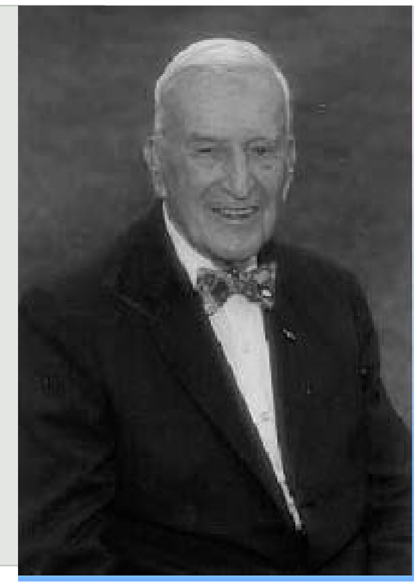
ICRP	**26**	**1977**
ICRP	**60**	**1990**
ICRP	**103**	**2007**

NCRP and ICRP


Public Law 88-376
88th Congress, H. R. 10437
July 14, 1964

An Act

- Because NCRP's Congressional Charter states that the NCRP will cooperate with ICRP, it should not be surprising that recommendations are similar, though not exactly the same.
- Differences reflect the aspects of radiation application and exposure circumstances unique to the United States.



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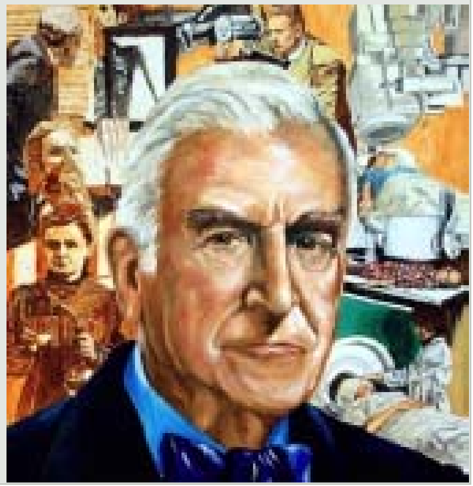
Better Alignment is Possible Because we Have the Same Goals and Principles

GOAL: Protect Workers, Public and the Environment

Fundamental Principles

- **Justify the Exposure**
- **Optimize Protection (ALARA)**
- **Dose Limits**



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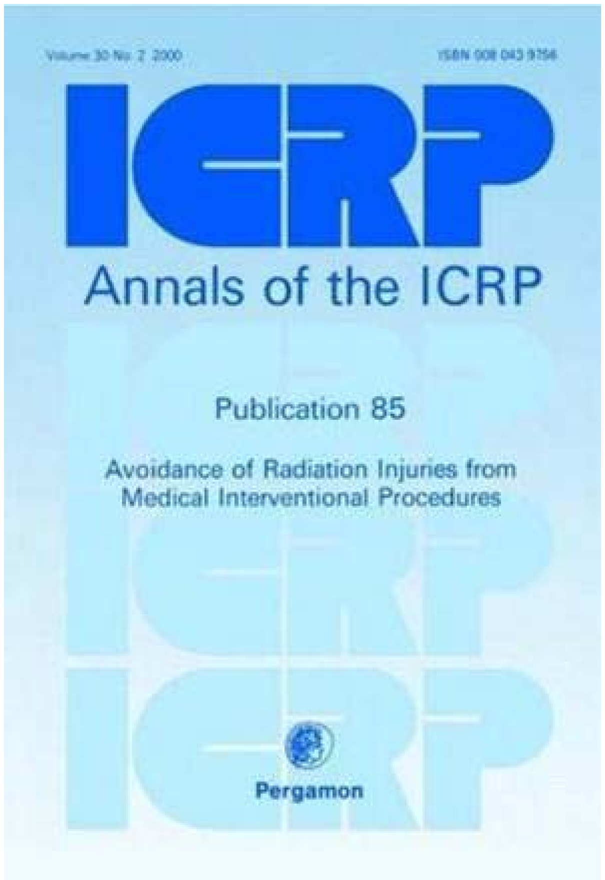
Avoid Deterministic Effects

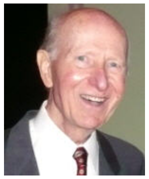


Ulcer

Hair Loss

Cataracts

Beta
burns



Dose Limits (Occupation)

	ICRP 60	ICRP 103	NCRP 116
Effective Dose			
Annual	20 mSv y^{-1} averaged 5 y, not to exceed 50 mSv in any single year	Same	50 mSv
Cumulative			10 mSv x Age (y)
Equivalent Dose			
Lens of Eye	150 mSv y^{-1}	20 mSv y^{-1} averaged 5 y, not to exceed 50 mSv in any single year *	150 mSv y^{-1}
Skin	500 mSv y^{-1}	Same	500 mSv y^{-1}
Extremities	500 mSv y^{-1}	Same	500 mSv y^{-1}

*2011 Statement

ICRP and NCRP recommendations have yet to be fully implemented in the U.S.

Consistent but Different

GOAL: Limit Cumulative Exposures of Workers

- Recommendations of the NCRP and ICRP are based on radiation effects on human populations.
- **ICRP** recommends a dose limit of 100 mSv in 5 years (not to exceed 50 mSv in a single year) – essentially, 20 mSv yr-1
- **NCRP** recommends an annual limit of 50 mSv yr^{-1} and that cumulative dose should not exceed **age times 10 mSv**.
- The **NRC** standard is currently 50 mSv yr^{-1}. Routine practice of maintaining ALARA did not support additional reduction in the dose limits at the time with 97% workers receiving < 20 mSv yr^{-1}
- The goal is to translate the need to limit cumulative exposure (for which ICRP and NCRP are in general alignment) within the regulatory framework (for which recommendations seem to differ).

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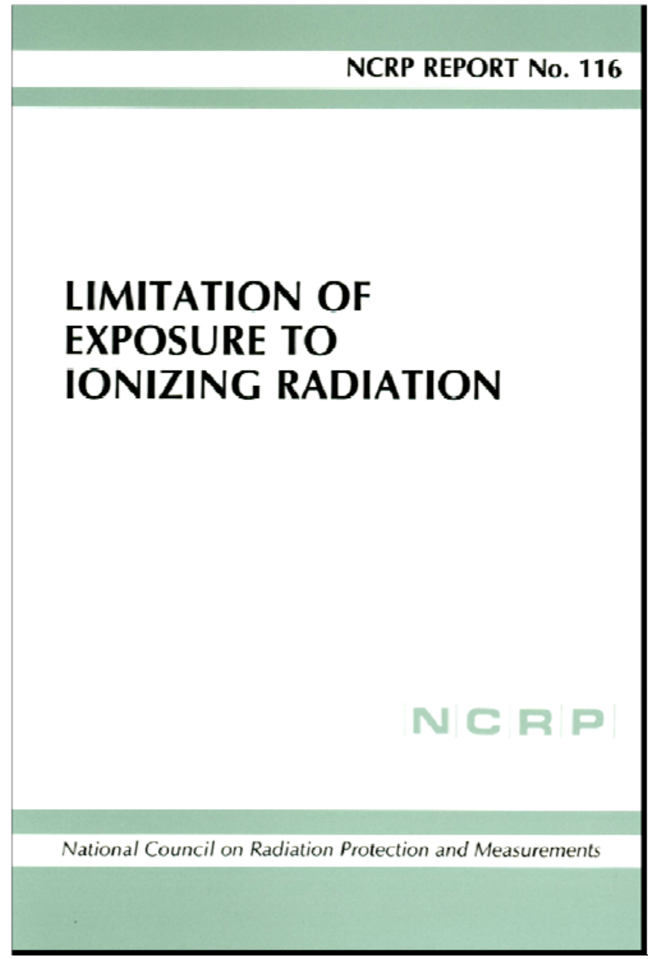
Deviations – Not Necessarily Inconsistencies

- NCRP has outlined its position with regard to international and U.S. standards and regulations in NCRP Report 116.
- Deviations from ICRP recommendations exist because of the desire for **greater flexibility** in the United States.
- Differences in the regulatory approaches include the need for substantial **stakeholder** involvement in the United States
- A more extensive process for making changes (and evaluating **impact**).



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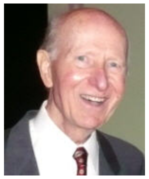
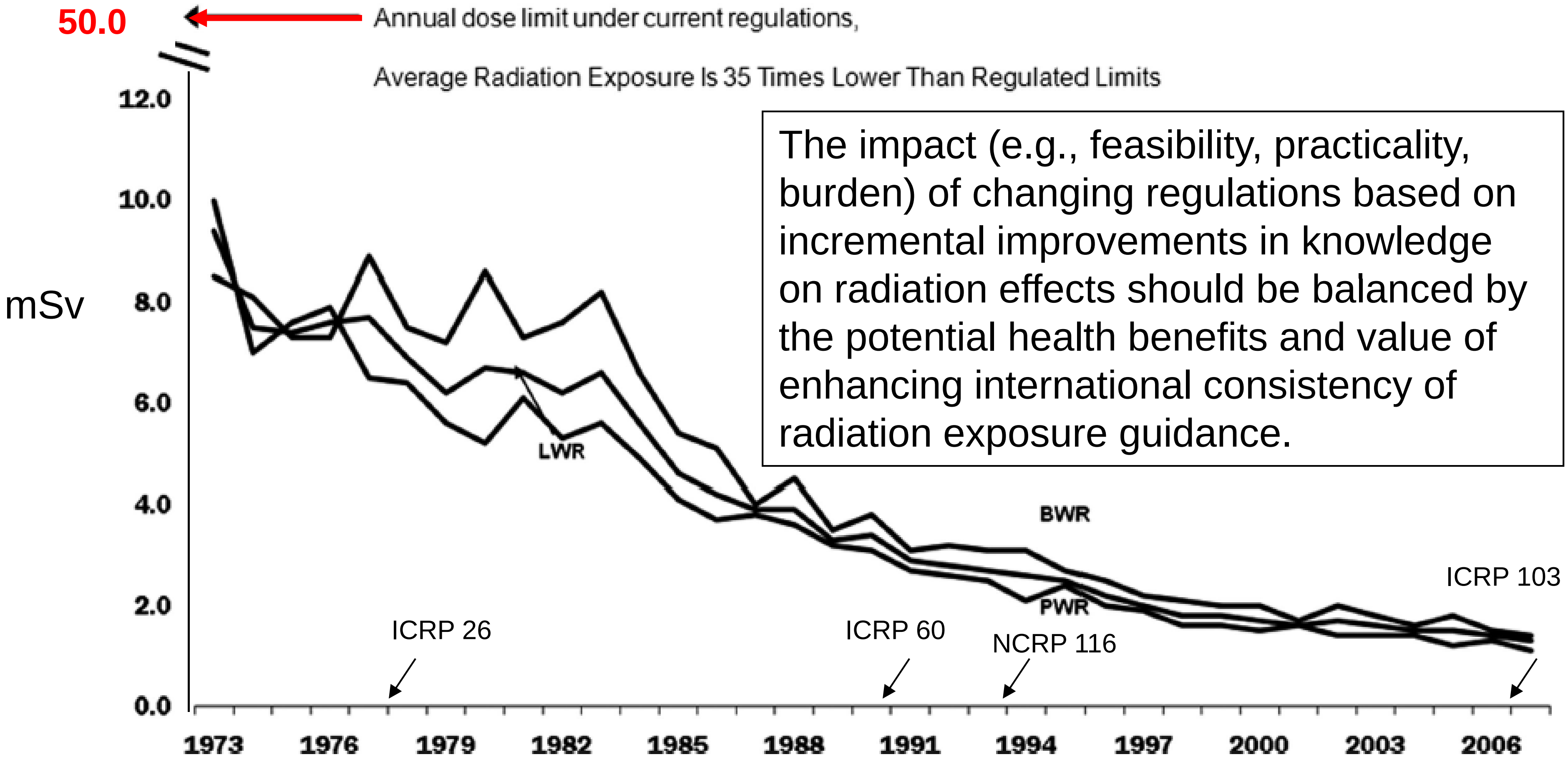


Impact – In a Culture of Safety



The impact (e.g., feasibility, practicality, burden) of changing regulations based on incremental improvements in knowledge on radiation effects should be balanced by the potential health benefits and value of enhancing international consistency of radiation exposure guidance.

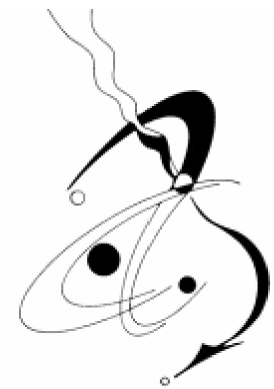
Average measurable dose per worker 1973-2006, mSv.

Source Nuclear Regulatory Commission – Occupation radiation exposure at commercial nuclear power reactors and other facilities, 2006. (from Blevins & Anderson H Physics 100:35, 2001)

ICRP and NCRP "Recommend" Several US Agencies Regulate

The position in the United States is somewhat complicated because various agencies are involved with radiation protection regulation and guidance:

- U.S. Nuclear Regulatory Commission
- U.S. Environmental Protection Agency
- U.S. Department of Energy
- Occupational Safety and Health Administration.



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Why Change ?

- New scientific data have been published since ICRP 60 and NCRP 116.
- The estimates of cancer risk attributable to radiation exposure have not changed greatly in the past 17 years
- The estimated risk of heritable effects is currently lower than before.
- The new data provide a firmer basis on which to model risks and assess detriment.

ICRP Publication 103

Table 1. Detriment-adjusted nominal risk coefficients (10^{-2} Sv^{-1}) for stochastic effects after exposure to radiation at low dose rate.

Exposed population	Cancer		Heritable effects		Total	
	Present[1]	*Publ. 60*	Present[1]	*Publ. 60*	Present[1]	*Publ. 60*
Whole	5.5	6.0	0.2	1.3	5.7	7.3
Adult	4.1	4.8	0.1	0.8	4.2	5.6

An Opportunity to Align and to Compliment and to Consolidate

- New data on the biological effects of ionizing radiation include new information on cataracts, heart disease and non-cancer
- New technologies – Medical Imaging, modular reactors, airport screening
- Awareness of population exposures (indoor radon; flight crews; CT scans)
- Concern over nuclear incidents, accidents, terrorist actions
- Recognition that the world has changed – there is a safety culture

New Knowledge - Cataracts

Dose limits for the eye is an important issue raised based on new data on health effects. It is encouraging that ICRP Recommendations 103 has generated debate and discussions within the United States.

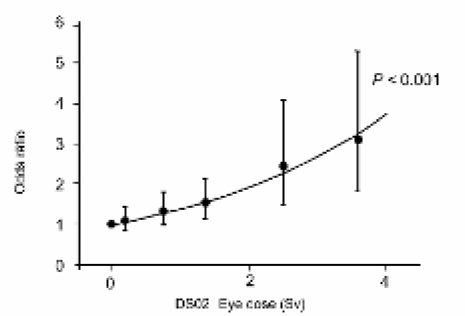
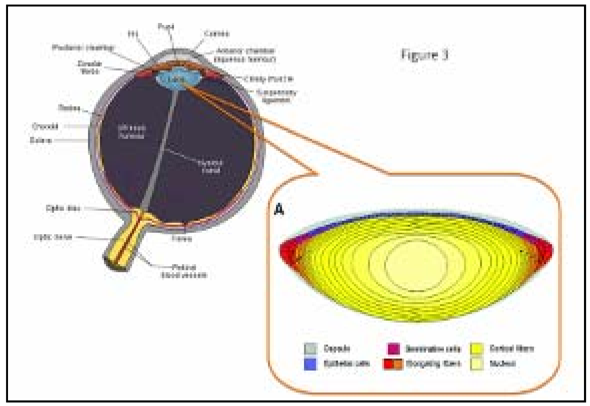


Figure 5. Dose responses for postoperative cataract. Prevalence study in 2000–2002. *(Neriishi K et al. Radiat Res 168:404, 2007)*



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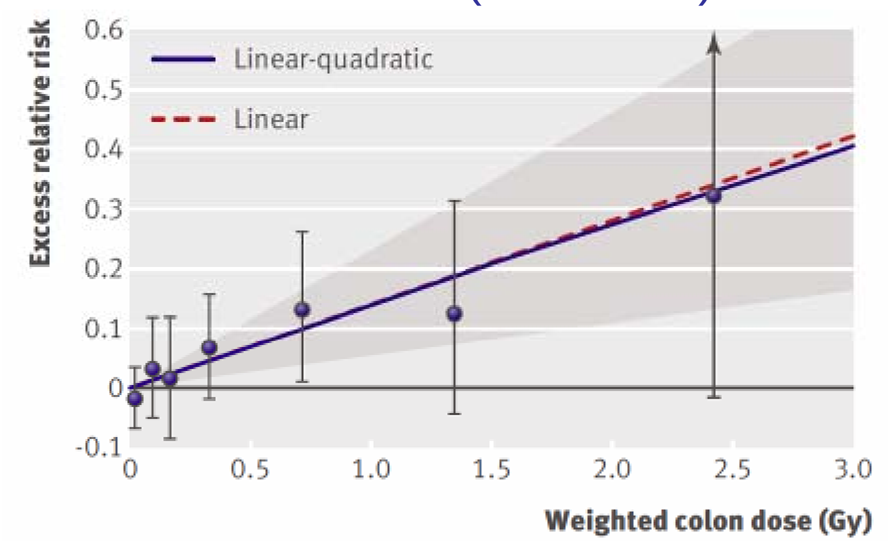
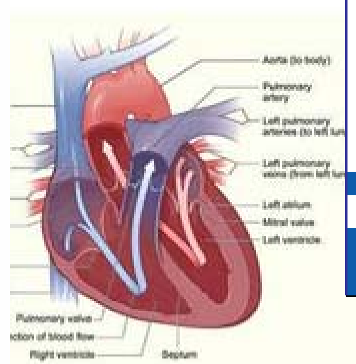
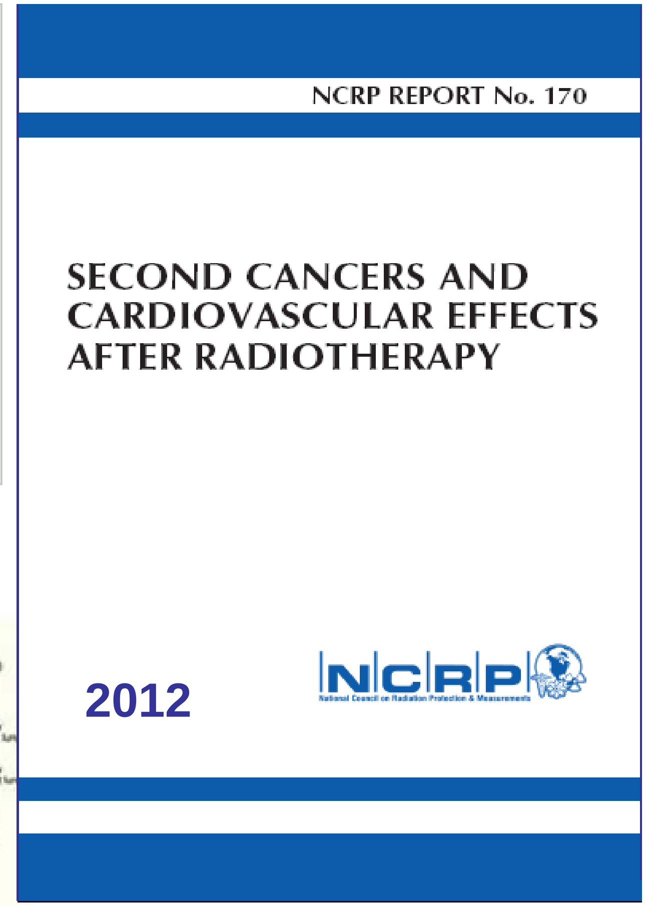
New Knowledge – Heart Disease

Although uncertainty remains, the absorbed dose threshold for circulatory disease may be as low as 0.5 Gy to the heart. Doses to patients of this magnitude could be reached during complex interventional procedures, and therefore particular emphasis should be placed on optimization in these circumstances (ICRP 2011).

Heart Disease (BMJ 2010)





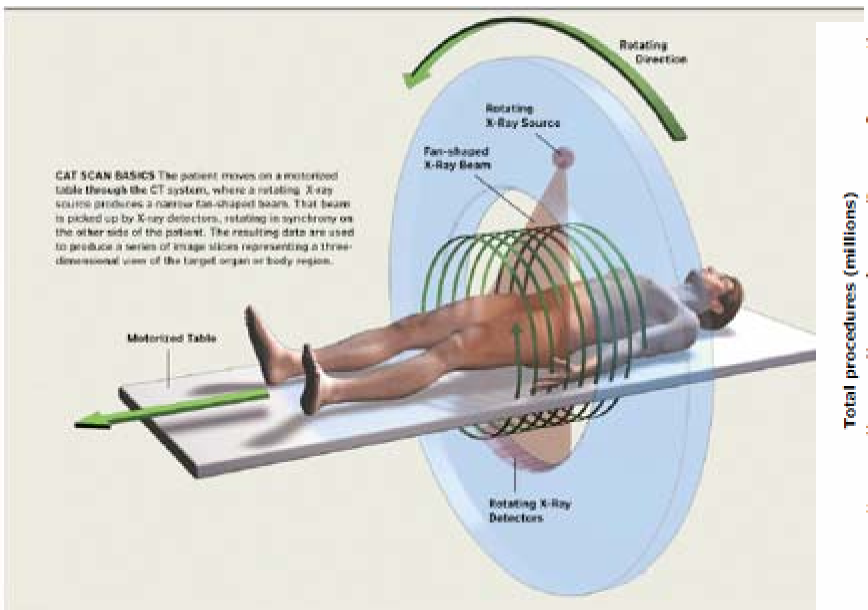

NCRP REPORT No. 170

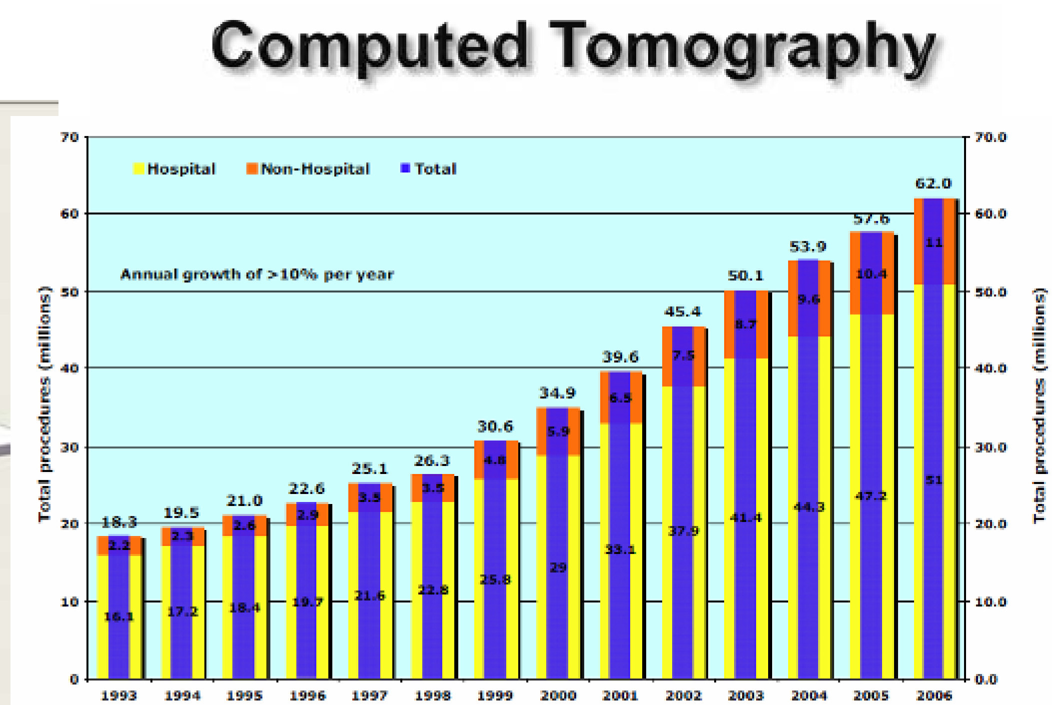
SECOND CANCERS AND CARDIOVASCULAR EFFECTS AFTER RADIOTHERAPY

2012

NCRP
National Council on Radiation Protection & Measurements

Impact – New Technologies





Calendar Year

62 Million in 2006
85 Million in 2011

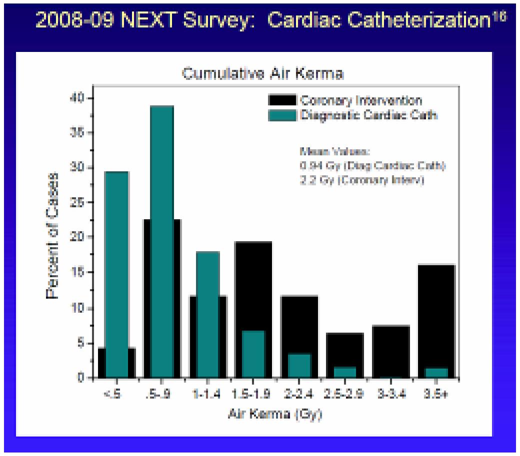
2010

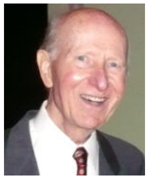
Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging

February 2010

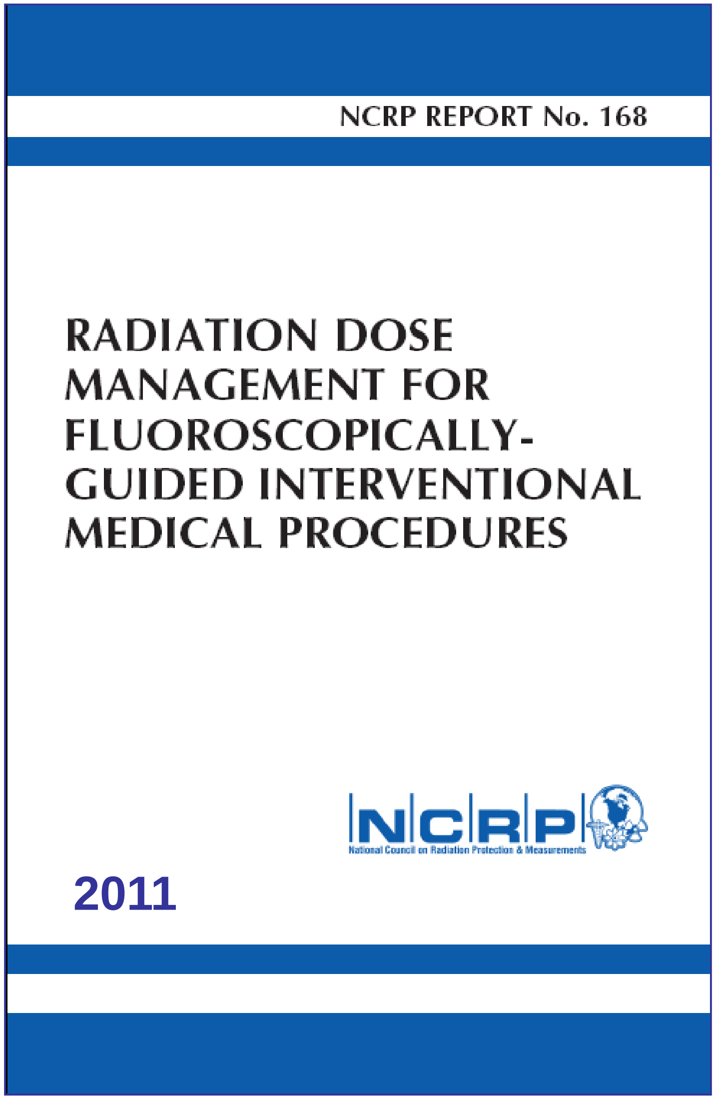
Center for Devices and Radiological Health

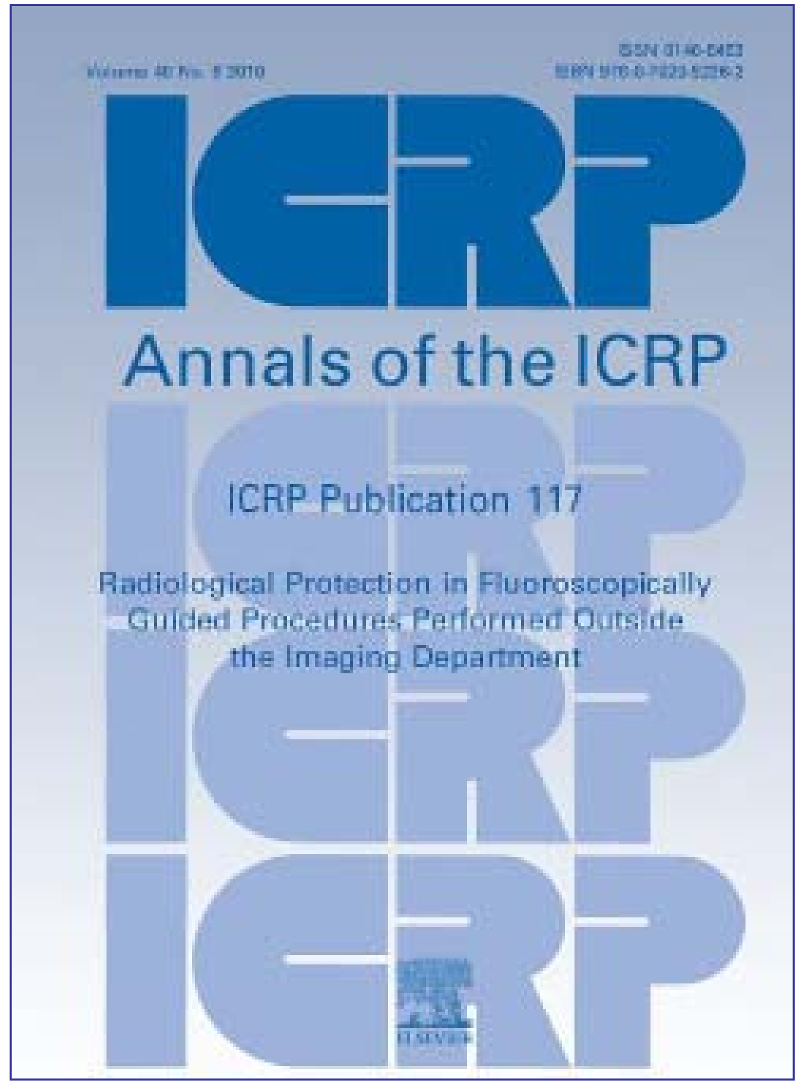
U.S. Food and Drug Administration





Exposures in Medicine





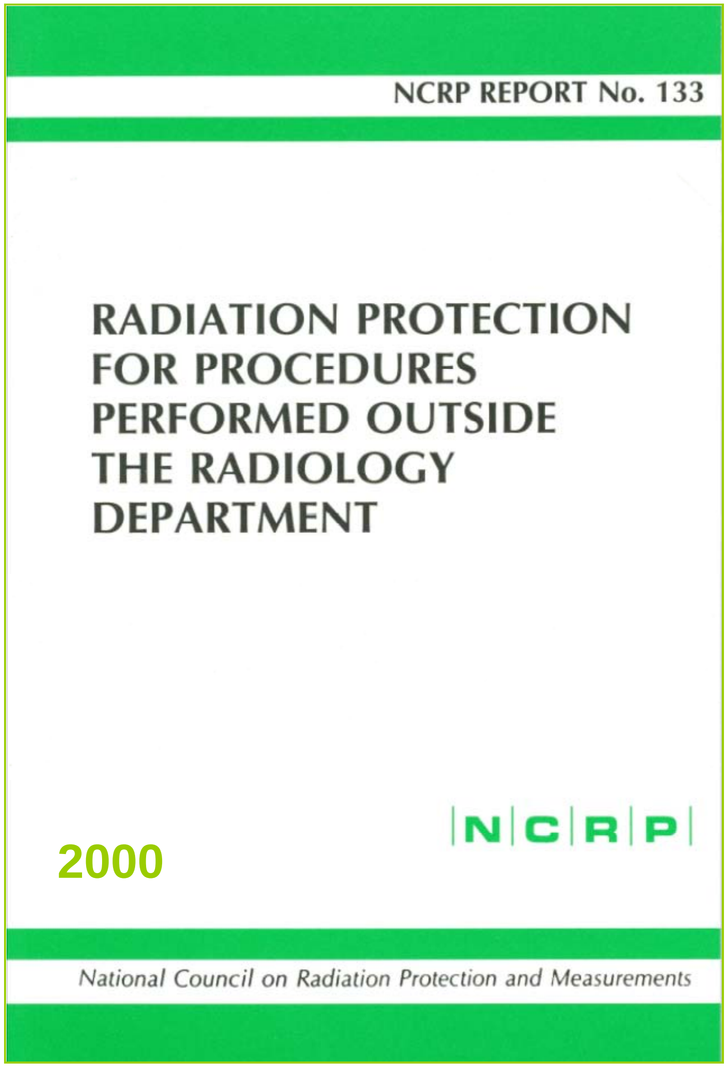
Medical Exposures Deserve Continued Attention

NCRP Report No. 172

Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States

NCRP
National Council on Radiation Protection & Measurements

Coming Soon



NCRP REPORT No. 133

RADIATION PROTECTION FOR PROCEDURES PERFORMED OUTSIDE THE RADIOLOGY DEPARTMENT

NCRP

National Council on Radiation Protection and Measurements

2000

Impact – New Technologies

NCRP COMMENTARY No. 21

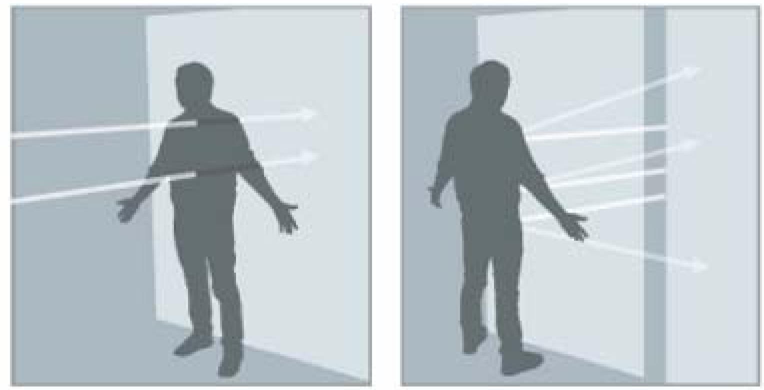
RADIATION PROTECTION IN THE APPLICATION OF ACTIVE DETECTION TECHNOLOGIES

NCRP National Council on Radiation Protection & Measurements

2011

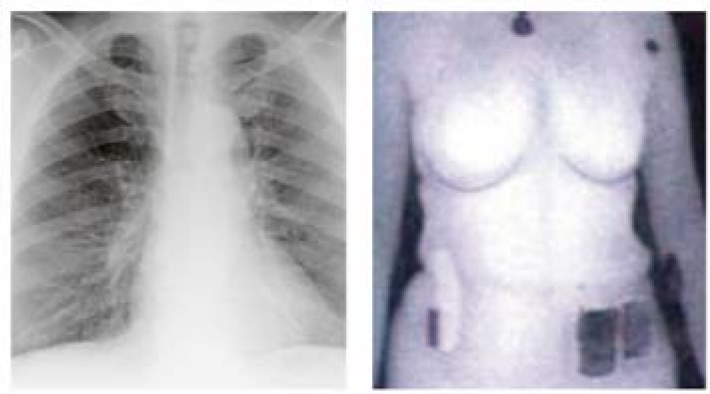
A Reflection on You

The technology of X-rays for whole-body scanning in airports involves tiny doses of radiation and technology to record how it bounces off the skin. Here's how it differs from medical X-rays.



Transmission X-rays, such as | **Backscatter X-rays,** such as

TYPICAL DOSE 4 millirems | TYPICAL DOSE: .005 millirem

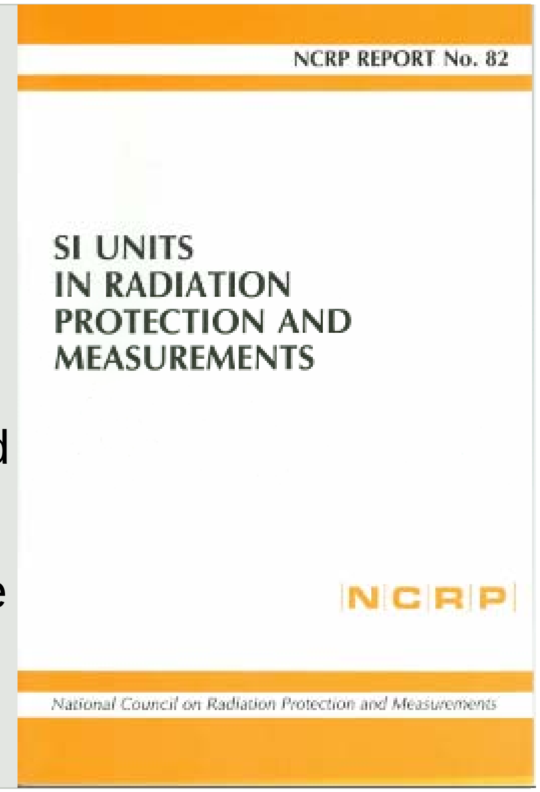


Sources: Health Physics Society; American Science and Engineering Inc.

Thoughts to Harmonize / Align

Personal suggestions would be to consider:

- (1) unification of terminology – mSv should replace rem, effective dose (or total effective dose) should replace TEDE, etc. – we need to speak the same language for scientists and the public;
- (2) leapfrog ICRP 60 and start with ICRP 103 when considering updating recommendations that are based on ICRP 26 or earlier reports;
- (3) modify the radiation weighting factors based on the latest ICRP biokinetic models and evaluations;
- (4) re-evaluate lens of the eye dose limits;



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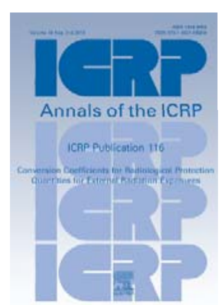
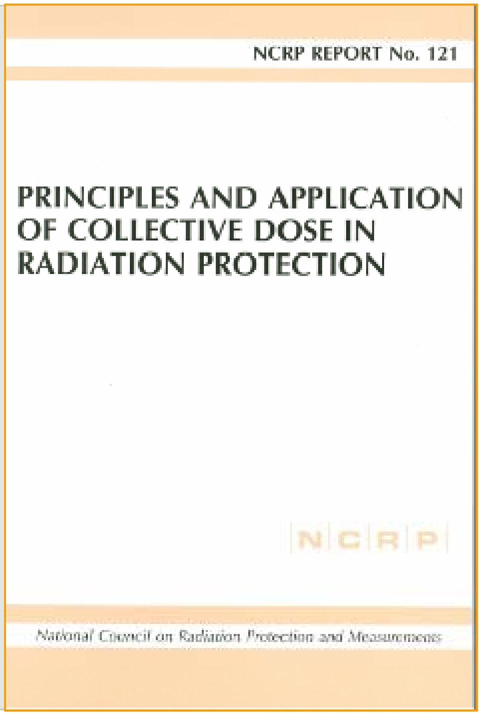


Thoughts to Harmonize/Align

- (5) collective dose should not be used to attribute hypothetical numbers of cancer deaths from tiny doses;
- (6) continued focus on need for change and implications of change (with stakeholder involvement): such as in industry (radiographers) and in medicine (interventional radiologists, cardiologists, emergency department physicians) and effects on job performance and/or patient care;
- (7) be involved, when asked to serve on ICRP or NCRP committees, make a difference.



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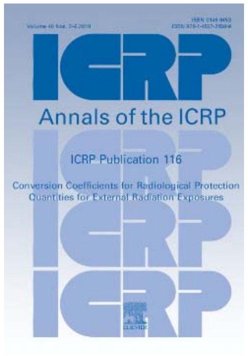
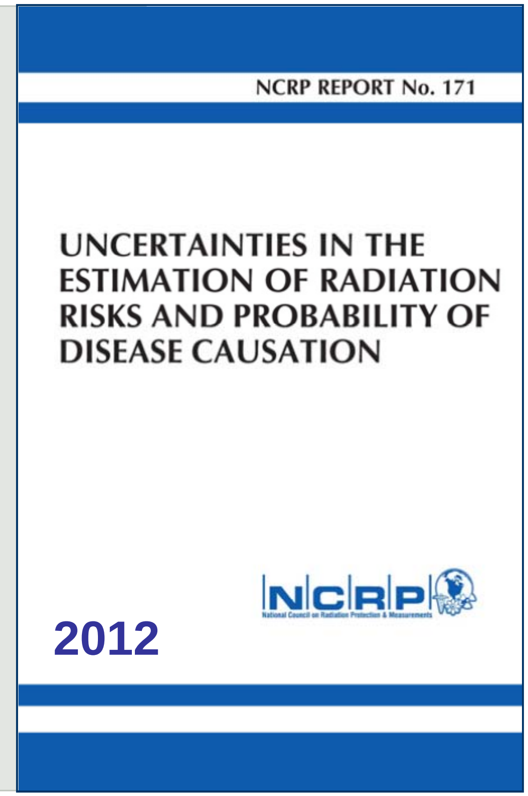


NCRP Initiatives/Contemplations

- Update NCRP 116 Recommendations
- Update NCRP 136 Evaluation of the LNT Model
- Integration of Epidemiology with New Biology for estimation of risk
- Update NCRP 126 Uncertainties in Risk Estimates used in Radiation Protection
- Guidance in Medicine such as Diagnostic Reference Levels and CT use in Emergency Departments
- Coordinate Studies on Low Dose Rate Effects



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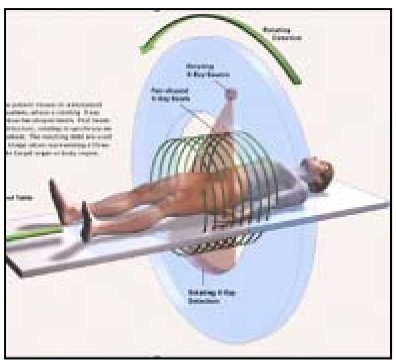
The Major Issue in Radiation Epidemiology and Radiation Protection?

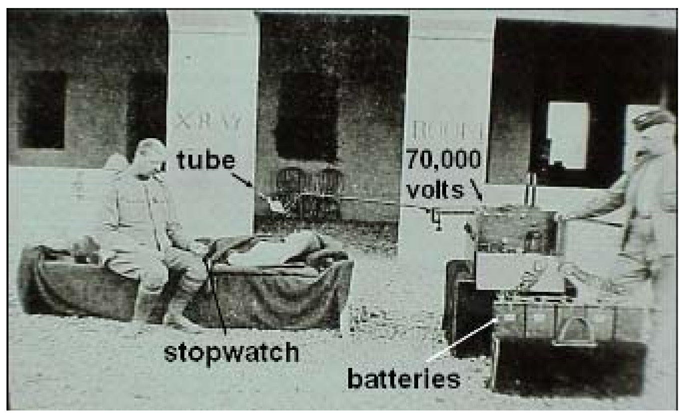
What is the level of risk when exposure received gradually over time and not briefly ?

Medicine



Accidents

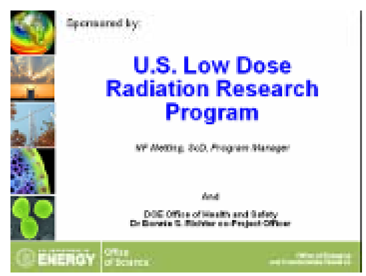
Occupation



Environment

One Million U.S. Radiation Workers and Veterans

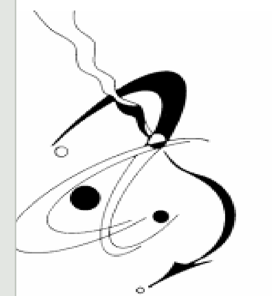
- Manhattan Project Workers
- Atomic veterans
- Nuclear utility workers
- Medical and other occupational
- Possible – Other Military



https://www.orau.gov/lowdose2011/abstracts/boice_john.pdf

Concluding Remark

- **Common philosophy**: radiation protection is based on justification, dose limitation and the application of ALARA (optimization), economic and social factors being taken into account (NCRP 1993, 1998).
- **ALARA** is "simply the continuation of good radiation-protection practices which traditionally have been effective in keeping the average individual exposures for monitored workers well below the limits" (NCRP 1993).
- As the needs for radiation protection change in the 21st century there is a need for constant improvements, constant vigilance and continued cooperation and alignment with the world. Let's "Come Together"



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NCRP 2013 Annual Meeting

Radiation Dose and Impacts on Exposed Populations

S.Y. Chen & Bruce A. Napier, *Co-chairs*

March 11-12, 2013

Bethesda, Maryland

NCRP