Amirkabir
University of Technology

European Summer School on Radiochemistry and Nuclear Instrumentation (low level radioactivity), 22-25 August 2017

A Standardized Individual Dose System for Epidemiology and Dose Limitation of Public and Workers by a “Universal Radiation Protection System (URPS) Hypothesis“

PART I:

Curent Radiation Protection System

(URPS)
A UNIVERSAL RADIATION PROTECTION SYSTEM

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Appreciation

- I open this talk in the name of those who did pioneering studies and efforts to formalize an International Radiation Protection Regime; what are daily being practiced in nuclear/radiation applications worldwide.
-
- I name one of them whom I had the honor to work with at the Oak Ridge National Laboratory and later at the Georgia Institute of Technology as my Ph.D. thesis advisor.

The Late
Professor Karl Ziegler Morgan who walked through the history of Health Physics; famed as Father of Health Physics

Contents

- This Lecture
- Background.
- Exposure Categories and situations.
- Real Exposure of a Workers
- Real Exposure of a Member of Public.
- Existing Exposure Situations.
- NBG Radiation Exposure (locally, nationally and Globally).
- High NBG Radiation Areas,
- Dose Band System (Sohrabi)
- Dose Band System (ICRP)
- Public and Worker Dose Limits
- LNT and Hormesis Models,
- Some Current Epidemiology Studies
- Individual Doses of Public or workers in daily life.
- Conclusions by Some Questions
- Continuation to This Lecture Part II

This Lecture

In order to discuss the topic on:

A Standardized Individual Dose System for Epidemiology and Dose Limitation of Public and Workers by "Universal Radiation Protection System Hypothesis"

present ICRP radiation protection system is discussed in detail. So this presentation consists of two parts:

- **Part I; Present ICRP Radiation Protection System**
- **PART II: "Universal Radiation Protection System Hypothesis"**

Background

- Over 100 years have passed since:
  - the first applications of ionizing radiation in medicine,
  - studies made on health effects, and
  - on philosophies, principles and mechanisms of radiation protection (RP) to protect man and environment from harmful health effects of ionizing radiation;
- I was honored in this endeavor with a high respect to learn, teach and preach what recommended by UNSCEAR, ICRP, IAEA, NCRP, ICRU, WHO, etc.
- I am also honored to share my "lessons learned and experiences gained" of over 50 years efforts in radiation protection and related dosimetry development and metrologies with you today.

Exposure Categories and Situations
(ICRP 103, 2007)

Exposure situations are used to consider how best to approach RP in different circumstances:

Categories of Exposure

- ***Occupational Exposure:*** **Exposure of workers incurred as a result of their work,** 
- ***Medical Exposure:*** **Exposure of patients as part of their diagnosis or treatment, volunteers helping in the support and comfort of patients, and volunteers in biomedical research.**
- ***Public Exposure;*** **Exposure of members of the public other than occupational and medical exposures, and not including the normal local natural background radiation**

Exposure Situations

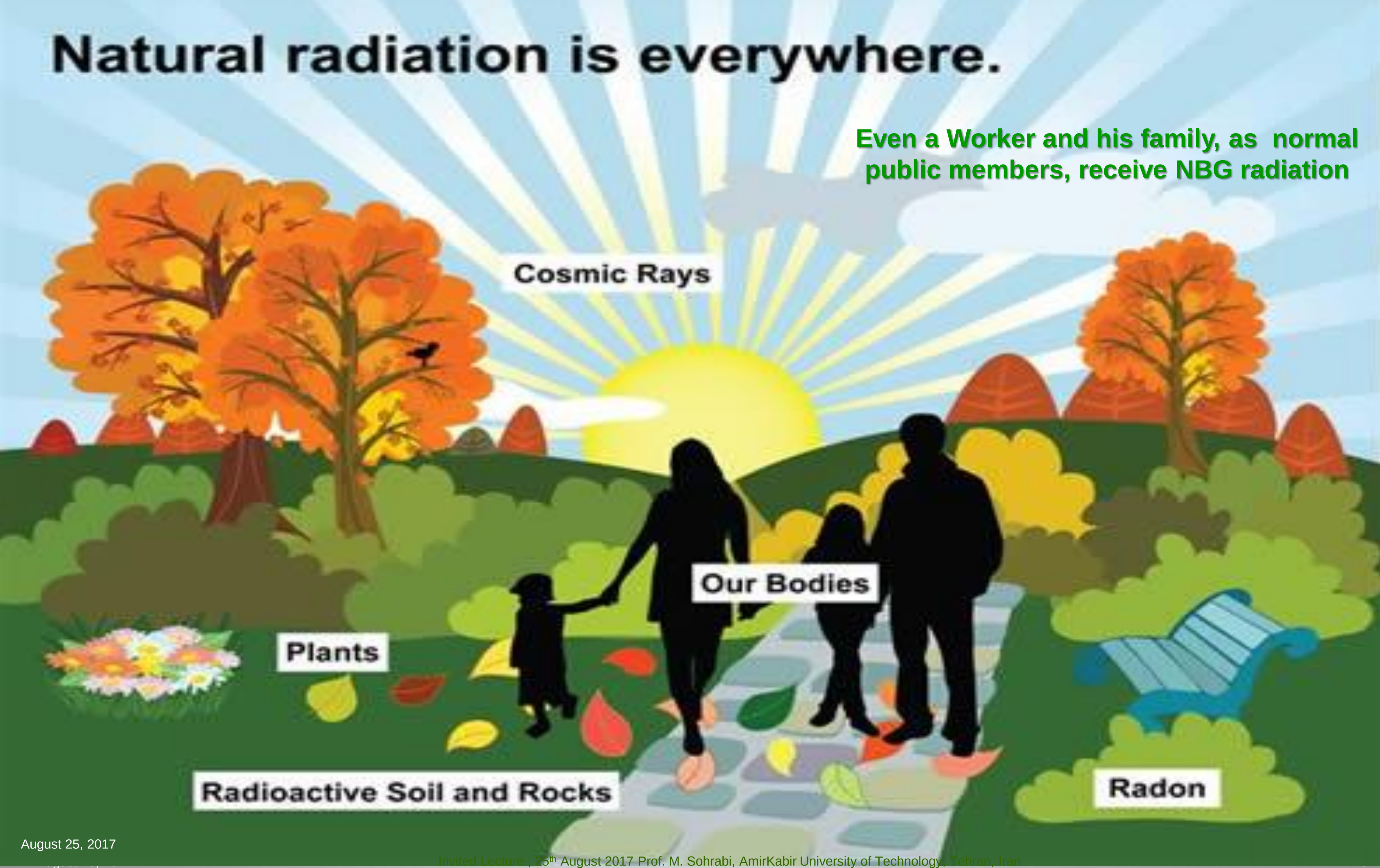
- ***Planned Exposure Situation:*** **Situations where radiological protection can be planned in advance, and exposures can be reasonably predicted**
- ***Existing Exposure Situation*****;** **Situations that already exist when a decision on control has to be taken**
- ***Emergency Exposure Situation;*** **Unexpected situations that may require urgent protective actions**

Existing Exposure Situations

"Existing exposure situation includes:

- Natural Background Radiation +
- Radiation from past practices;
  - Existing only in few countries and usually localized
  - From possible accidents

NBG exposures usually dominates and other situations are limited to few countries.



Even a Worker and his family, as normal public members, receive NBG radiation

Public exposure to natural radiation[e]

http://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/nuclear-radiation-and-health-effects.aspx

Source of exposure		Annual effective dose (mSv) Average	Typical range
Cosmic radiation	Directly ionizing and photon component	0.28	
	Neutron component	0.10	
	Cosmogenic radionuclides	0.01	
Total cosmic and cosmogenic		*0.39*	*0.3–1.0*[e]
External terrestrial radiation	Outdoors	0.07	
	Indoors	0.41	
Total external terrestrial radiation		*0.48*	*0.3-1.0*[e]
Inhalation	Uranium and thorium series	0.006	
	Radon (Rn-222)	1.15	
	Thoron (Rn-220)	0.1	
Total inhalation exposure		*1.26*	*0.2-10*[e]
Ingestion	K-40	0.17	
	Uranium and thorium series	0.12	
Total ingestion exposure		*0.29*	*0.2-1.0*[e]
Total		**2.4**	**1.0-13**

http://www.world-nuclear.org/info/Safety-and-Security/Radiation-and-Health/Nuclear-Radiation-and-Health-Effects/#Appendix

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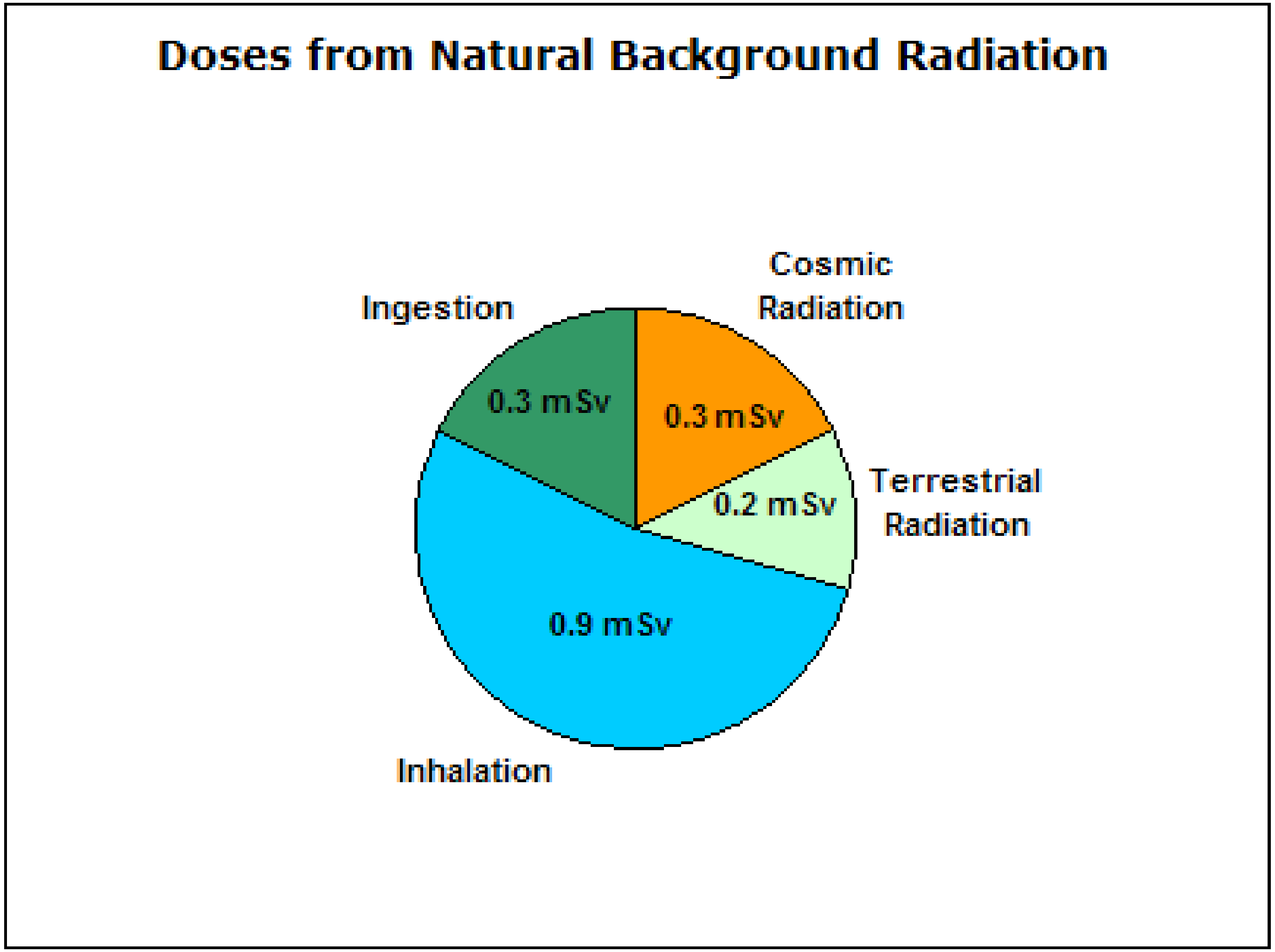
Average effective dose in Canadian cities compared to worldwide average.

http://nuclearsafety.gc.ca/eng/resources/fact-sheets/natural-background-radiation.cfm

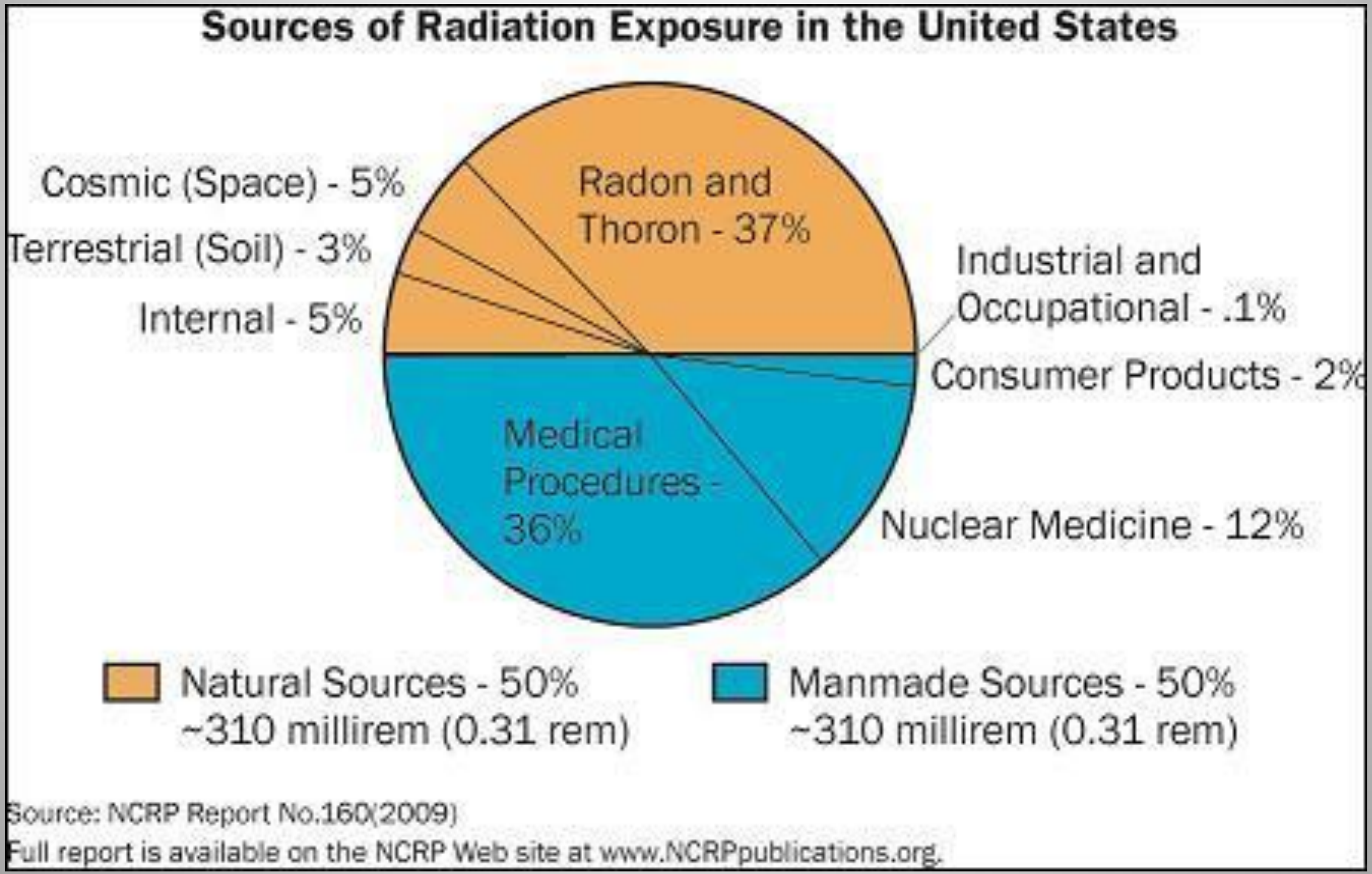
Sources and average effective dose from natural background radiation in selected canadian cities					
Canadian city	Total (mSv/y)	Cosmic radiation (mSv/y)	Terrestrial background (mSv/y)	Annual inhalation dose (mSv/y)	Radionuclides in the body (mSv/y)
CANADA	1.8	0.3	0.2	0.9	0.3
Whitehorse	1.9	0.5	0.2	0.9	0.3
Yellowknife	3.1	0.4	1.4	0.9	0.3
Victoria	1.8	0.5	0.1	0.9	0.3
Vancouver	1.3	0.5	0.1	0.4	0.3
Edmonton	2.4	0.5	0.3	1.3	0.3
Regina	3.5	0.4	0.3	2.4	0.3
Winnipeg	4.1	0.4	0.2	3.2	0.3
Toronto	1.6	0.4	0.2	0.8	0.3
Ottawa	1.8	0.4	0.2	0.9	0.3
Iqaluit	1.9	0.5	0.2	0.9	0.3
Québec City	1.6	0.4	0.2	0.7	0.3
Montreal	1.6	0.4	0.3	0.7	0.3
Fredericton	1.8	0.3	0.3	0.9	0.3
Halifax	2.5	0.3	0.3	1.5	0.3
Charlottetown	1.8	0.3	0.2	0.9	0.3
St-John's	1.6	0.4	0.2	0.7	0.3

Canada

http://nuclearsafety.gc.ca/eng/resources/fact-sheets/natural-background-radiation.cfm

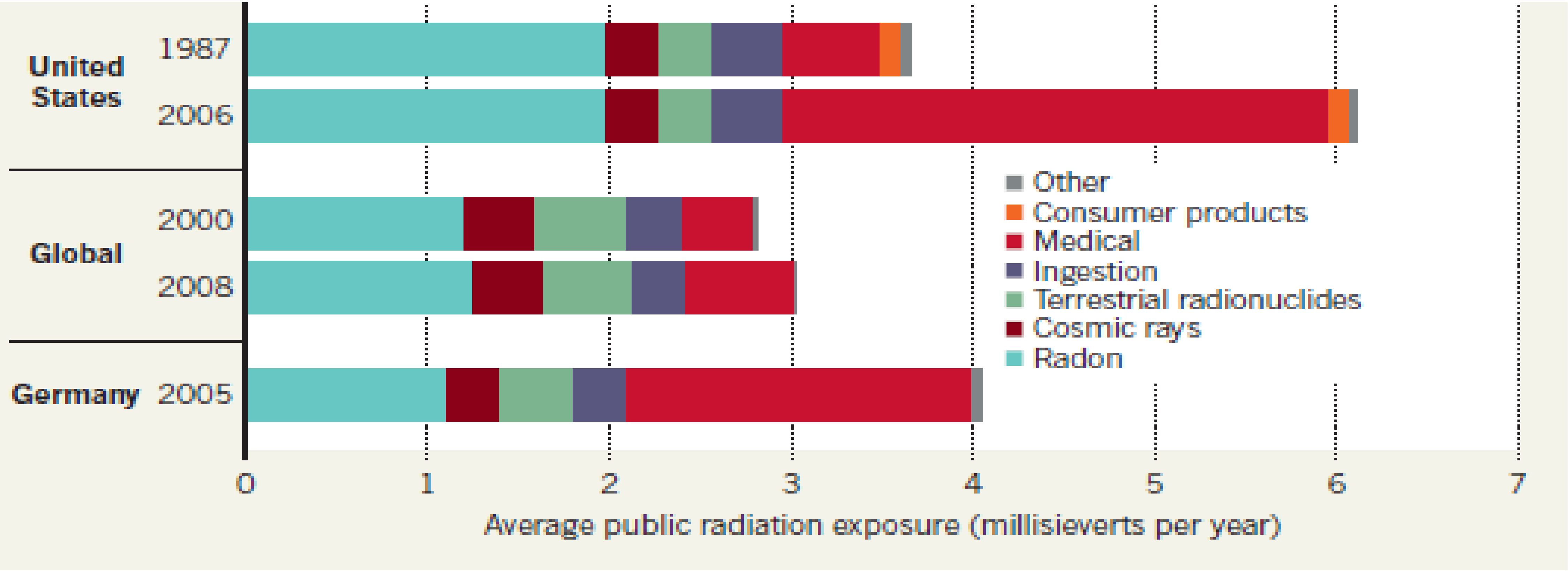


Sources of Radiation Exposure in USA



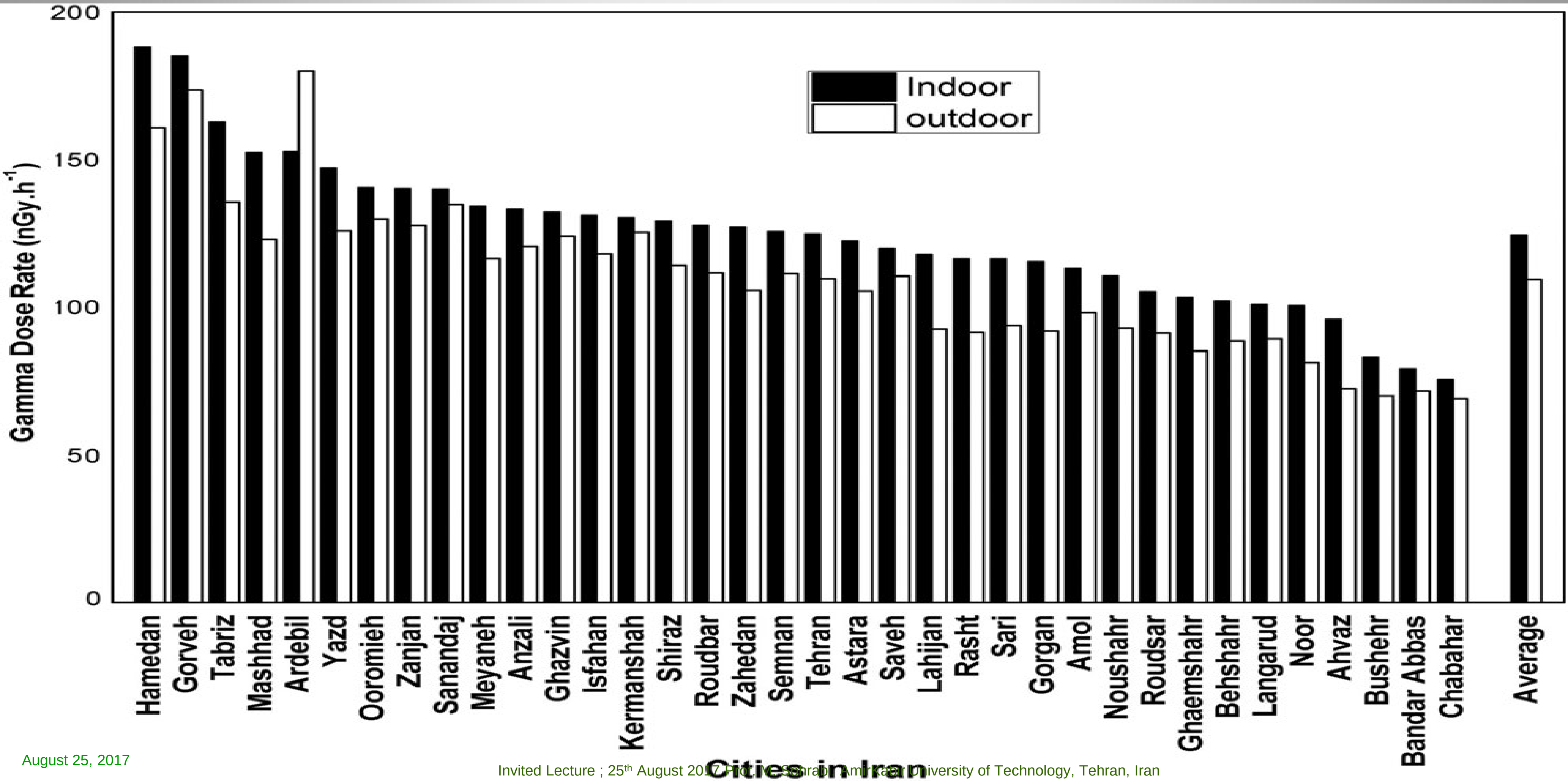
Average Public Radiation Exposure
USA, Global, Germany

Alison Abbott; Nature July 15 2015



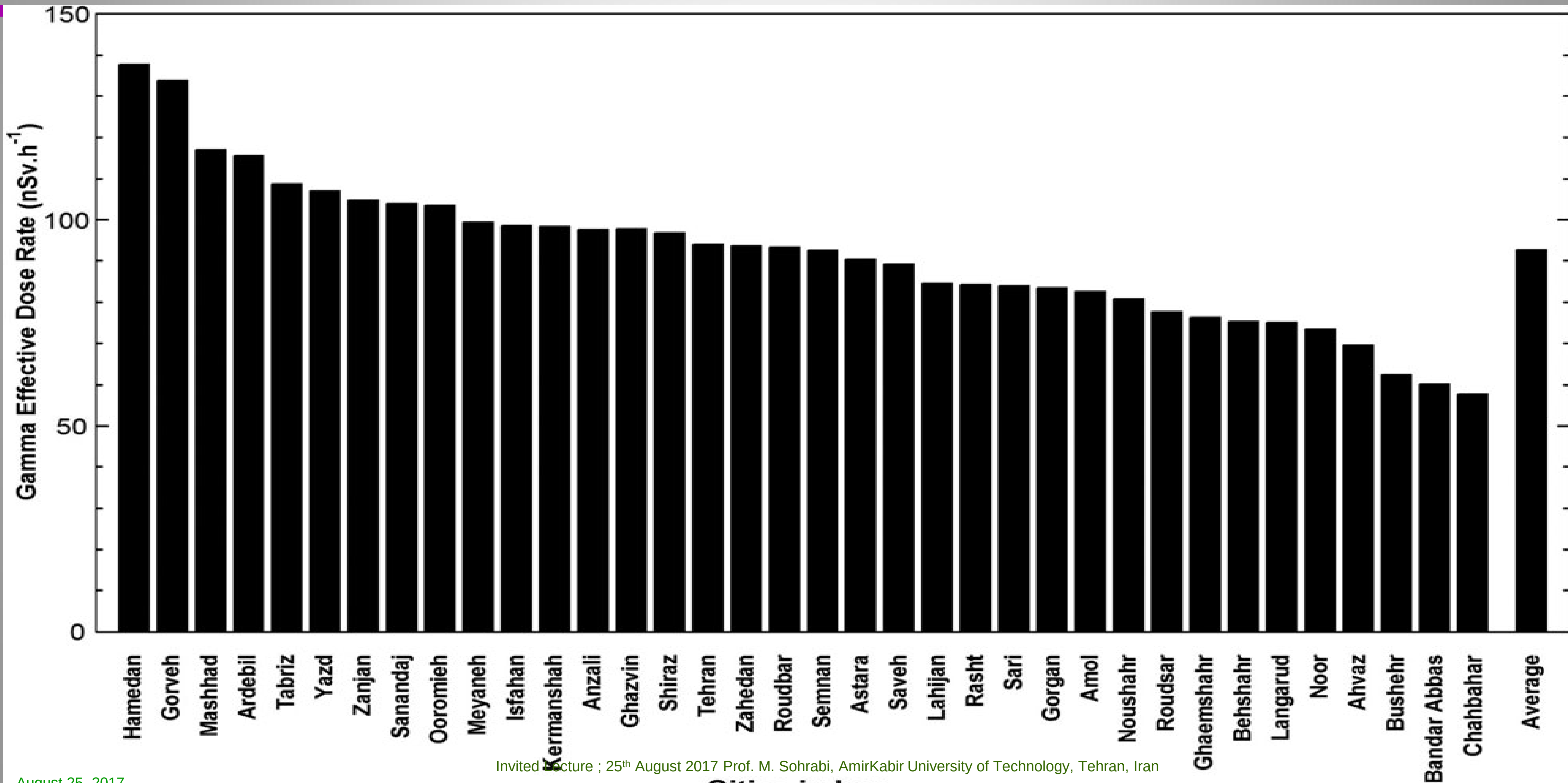
Gamma Effective Dose in Different Cities in Iran

Sohrabi et al. Radiation Protection Dosimetry (2015)



Gamma Effective Dose in Iran

Sohrabi et al. Radiation Protection Dosimetry (2015), pp. 1–9



NBG Exposure in France

- NBG Dose is about 2–3 mSv per year (cosmic rays and radon).
- The International Agency for Research on Cancer (IARC) in Lyon, France, examined causes of death in the workers (one-fifth had died by the time of the study) and correlated this with exposure records, some of which went back 60 years.
- A worker on average received just 1.1 mSv per year above NBG radiation.
- The study confirmed that the risk of leukaemia does rise proportionately with higher doses, but also showed that this linear relationship is present at extremely low levels of radiation.

Chain of Int Confs. on HLBNR Areas

- We made attempts though a chain of Int. Confs on "High Levels of Natural Radiation and Radon Areas" to find more information to estimate health risks of low doses of ionizing radiation from natural background (NBG) radiation.
- Chain of Conference Brazil (1967), India (1981), Iran (1990), China (1996), Germany (2000), Osaka (2004), India (2010), Czech Republic (2014), Next 2018 (??) to be arranged

  (may be Strasbourg if volunteer)
- In order to respond to many fundamental questions in RP practices with a hope to better protect workers, public and the environment.

In this endeavor, the time is ripe for some new thoughts from "lessons learned and experiences gained" for a global standardized RP approach to also consider NBG radiation as major sources of public and workers' exposure, also as member of public.

HLBNR Areas in Brazil

Main areas are Poc¸os de Caldas, Arax`a, and Tapira, comprising zone of volcanic alkaline intrusive in the Minas Gerais State, as well as Guarapari, located in Espirito Santo State on Atlantic Coast.

Six thousand persons reside in HBNR area in Poc¸os de Caldas, 1300 in Arax`a, and 12 000 in Guarapari.

Level of exposure since earliest publications has changed significantly due to urbanisation and public moving away from HBNRAs.

Annual effective doses (external and internal exposures) are now < 7 mSv.

Recent studies performed at Poc¸os de Caldas & Guarapari found radiation level in Guarapari as normal (near average global levels) except at hot spots on the beaches and in the fishing village of Meaipe.

At Poc¸os de Caldas, only rural areas could be considered as HNBR areas, and radiation level in urban areas can be considered as normal.

HLBNR Areas in India

Kerala is a densely populated, monazite-bearing coastal region in southwest India.

- **Radiation exposure in these areas is mainly due to the presence of thorium and its decay products in the surface soil.**
- **Its 360 000 inhabitants, who generally have low migration rates, receive annually, on average, external whole-body doses of about 4.5 mGy from gamma-rays plus an internal dose of 2.4 mSv (effective dose) from exposure to radon.**
- **The typical high end of the dose range is about 10 mGy from gamma-rays plus 6 mSv from radon, though a considerable range of 1 to about 45 mSv y^{-1} has also been reported.**

HLBNR Areas in Iran

- Ramsar is a northern coastal city in Iran with over 50 sulfurous hot springs that contain enhanced ^{226}Ra concentrations.
- The water has ^{226}Ra concentrations of up to 146 kBq m^{-3} and it flows into the surrounding areas, adding more radioactive residues to the existing radioactivity in the environment.
- Ramsar has a population of 60–70 000, though only about 1000 people reside in the HNBR areas.
- The annual effective doses received by the inhabitants from external exposures (indoors and outdoors) range between 0.7 to 131 mSv.y^{-1} with a mean of 6 mSv, and the internal dose due to ^{222}Rn ranges from about 2.5 to 72 mSv.y^{-1}.
- Areas also exist in Mahalat area of Iran

HBNRAs in China

- **HNBR area of Yangjiang County (Guangdong province) in south of China consists of Dong-anling and Tongyou regions separated by a short distance.**
- **The HNBR area covers an area of 540 km^2. More than 125 000 people, primarily farmers, live in the two regions.**
- **Residents whose families lived in those areas for six or more generations comprise 90% of the population.**
- **Fine particles of monazite are washed down the mountains by rain to the surrounding basin regions, giving rise to the HNBR areas.**
- **The level of natural radiation is due to radionuclides such as ^{232}Th and ^{238}U in the surface soil and in the building materials of houses. The average effective dose is 6.4 mSv.y^{-1}, with an external dose of 1–3 mSv (average 2.1 mSv) and an internal dose of 4.3 mSv.y^{-1},**
- **about 3 times higher than that of control areas.**

Dose Band System (DBS) Based on Natural Background (NBG) Radiation

Over 3 decades ago, a Dose Band System (DBS) was proposed by this author for the first time, in several articles, proposing the following five actions;

- **classified NBR areas by a DBS to prevent any NBG area to be called high or very high NBR area,**
- **applied the dose limits recommended by ICRP (60, 1991) in the DBS to correlate a synergy between exposure of workers and public in existing exposure situations,**
- **proposed remediation action in each band as regulatory mechanism for decision making for prolonged exposure situations,**
- **included, for the first time, the concept of NBR dose into the DBS by setting the upper limit of the lowest band of the DBS as 5 mSv.y-1 (about two times the UNSCEAR's global mean NBG dose of 2.4 mSv.y^{-1}, as a base line) with no regulatory control needed.**

References to the DBS

- M. Sohrabi, World High Level Natural Radiation and/or Radon-Prone Areas with Special Regard to Dwellings, In: Procs. 4th Int. Conf. on High Levels of Natural Radiation, Beijing, China, October 21-25 (1996), Elsevier, Tokyo, 57-68 (1997).
- M. Sohrabi, High Radon Levels in Nature and in Dwellings: Remedial Actions, Chapter of A Book on Radon Entitled "Radon Measurements by Etched Track Detectors; Applications in Radiation Protection, Earth Sciences and the Environment, R. Ilic and S. A. Durrani (Eds.), World Scientific Publisher, Singapore, pp. 225-242 (1997).
- M. Sohrabi , The State-of-the-Art on Worldwide Studies in Some Environments with Elevated Naturally Occurring Radioactive Materials (NORM). J. Applied Radiation and Isotopes, 49 (3), pp. 169-188 (1998).
- M. Sohrabi, World high background natural radiation areas: Need to protect public from radiation exposure, Radiation Measurements (2012), doi:10.1016/j.radmeas.2012.03.011.
- J. Hendry, S.L. Simon, A. Wojcik, M. Sohrabi, W. Burkart, E. Cardis, D. Laurier, M. Tirmarche, I. Hayata, Human exposure to high natural background radiation: what can it teach us about radiation risks? J. of Radiol. Prot. 29, A29-A42 (2009).

for Remediation and Reg. Control (RC) (Sohrabi,1996, 1997, 1998, Hendry et al., 1999)

annual dose $mSv.y^{-1}$

VHLNBRA > 50 $mSv.y^{-1}$ ⇒

Subject to RC, evaluation and urgent RC with the assistance of the Government, when justified

Very High Level

50

High Level

HLNBRA > 20 to ≤ 50 $mSv.y^{-1}$ ⇒

Subject to RC within 1 year

20

Medium Level

MLNBRA > 5 to ≤ 20 $mSv.y^{-1}$ ⇒

Subject to no RC within 5 years

5

Low or Normal Level

LLNBRA ≤ e.g. 5 = 2x2.4 $mSv.y^{-1}$ ⇒

Subject to no RC

DBS; ICRP 82, 2000

The DBS concept and methodology proposed above was also adopted by ICRP 82 (2000) with some alterations, as follow;

- **new doses were assigned for each band of the DBS, and**
- **a 1 $mSv.y^{-1}$ reference level (from gamma radiation of a dominant type of commodity amenable to control by intervention — such as some building materials — which could in some circumstances be a significant cause of prolonged exposure…. on top of the UNSCEAR's global mean NBD of 2.4 $mSv.y^{-1}$.**

annual dose (mSv.y^{-1})

Generic reference level for interventions almost always justifiable ⇒ ~100 VERY HIGH

Generic reference level for interventions not likely to be justifiable⇒ ~ 10 TYPICALLY HIGH

UNSCEAR Mean NBG Dose⇒ ~ 2.4 AVERAGE

ICRP 82,2000 ~ 1 MINIMUM

DBS; ICRP 82, 2000

Considering the DBD based on NBG radiation in the RP system by ICRP 82 (2000) has limitations when 1 mSv.y^{-1} is added on top of the UNSCEAR's 2.4 mSv.y^{-1} global mean NBD for two purposes;

- **Dose Limit of 1 mSv.y^{-1} for public exposure due to planned exposure situations (practices),**

- **Reference Level of 1 mSv.y^{-1} as additional annual dose (from gamma radiation of a dominant type of commodity amenable to control by intervention.**

Is 2.4 mSv.y^{-1} Global Mean NBG Justified as a Base Dose?

- **UNSCEAR's 2.4 mSv.y^{-1} global mean NBG dose is in fact the mean value of different national NBG doses that public receive in countries in different parts of the world.**

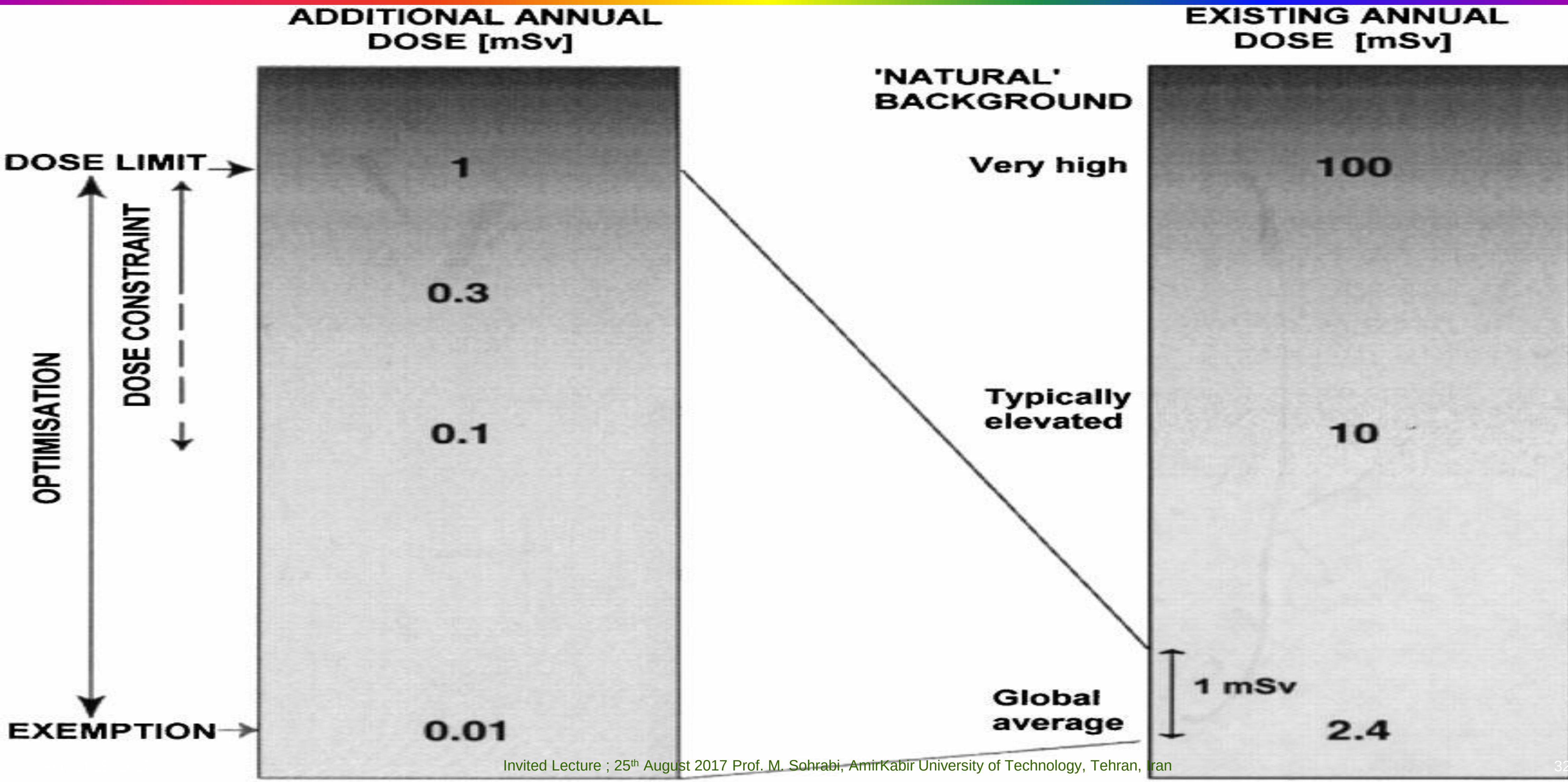
- **Mean national NBG doses range 1 to 13 mSv.y^{-1}(UNSCEAR 2000). This range of doses is in fact quite different compared to 2.4 mSv.y^{-1} on top of which 1 mSv.y^{-1} is added.**

- **So thought should be evolved on this concept to consider the real mean NRG received in each country.**

Concept	Quantity	Value (mS)
Generic reference level for interventions almost always justifiable Generic reference level for interventions not likely to be justifiable	Existing annual dose Existing annual dose	<~100 <~10
Exemption from intervention in commodities	Additional annual dose	~1
Dose limit for practices (Now Planned Exposure Situation) Dose constraint for practices Exemption for practices	[Aggregated] Additional annual dose Additional annual dose (for the prolonged component)a Additional annual dose	1 <~1 &~0.3 (~0.1) ~0.01

ICRP 82, 2000

DBS; ICRP 82, 2000



Worker's Dose Limits

- **Effective Dose to a worker from Occupational Exposure:**

20 mSv per year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv.

After a woman worker declares a pregnancy, the dose to the embryo/fetus should not exceed about 1 mSv during the remainder of the pregnancy

Occupational Exposure of Workers
(from man-made sources)

Occupational exposure in daily work in different applications:

- Medical
- Industrial
- Nuclear Power
- Agriculture
- Research & Development
- Education
- Military
- Etc.

Real Worker's Exposure; from work and also as a Member of Public (Integrated Dose)

Natural **(As Public)**
- Cosmic rays
- Terrestrial
  - External (Gamma)
  - Internal (Radon, and others)

\+

Man-made **(As Public)**
- Medical
- Nuclear Power
- Military
- Accidents

\+

Occupational **(As Worker)**
- Man-made

  or
- TENORM
- Accidents

Exposure of a Member of Public in Daily Life

Man-made

(As Public)

- Medical
- Military
- Nuclear Power
- Accidents

Natural

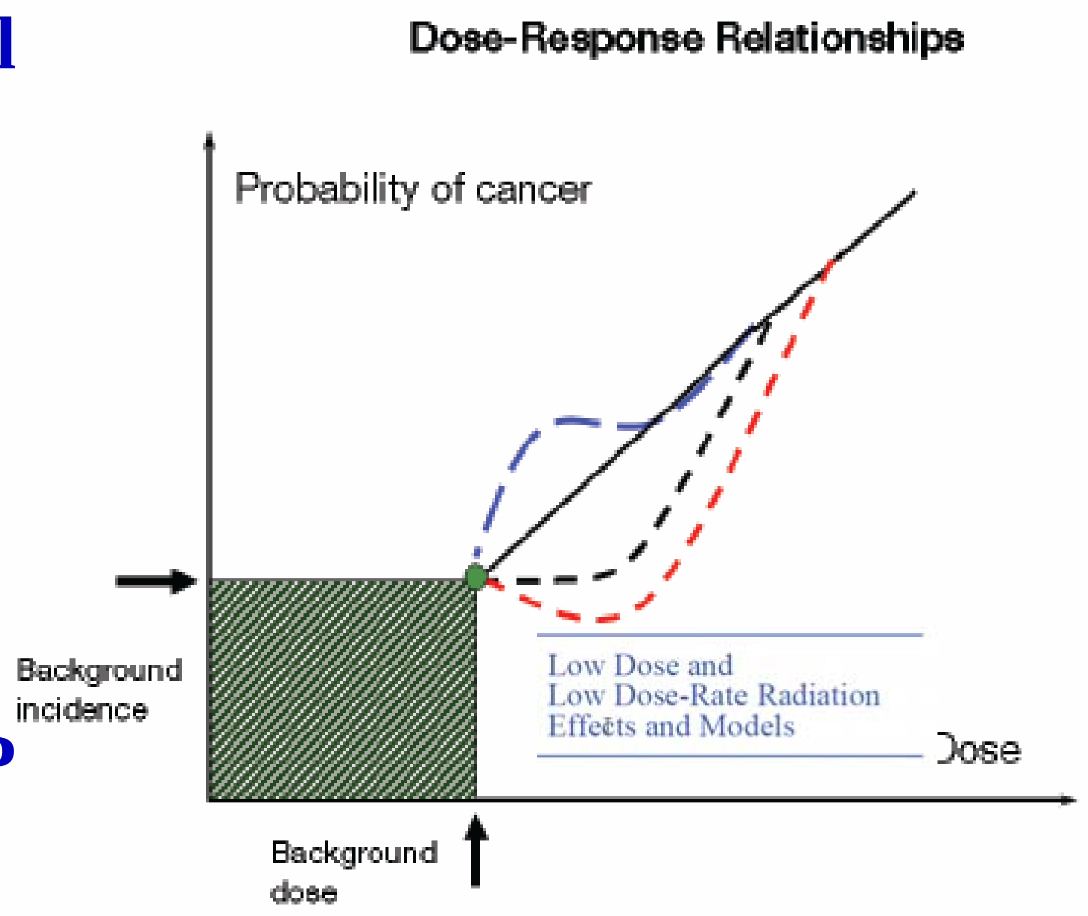
(As Public)

- Cosmic rays
- Terrestrial
  - External (e.g. Gamma)
  - Internal (Inhalation of Radon), Ingestion (Radium, etc.)

Present NBG Concept on the LNT

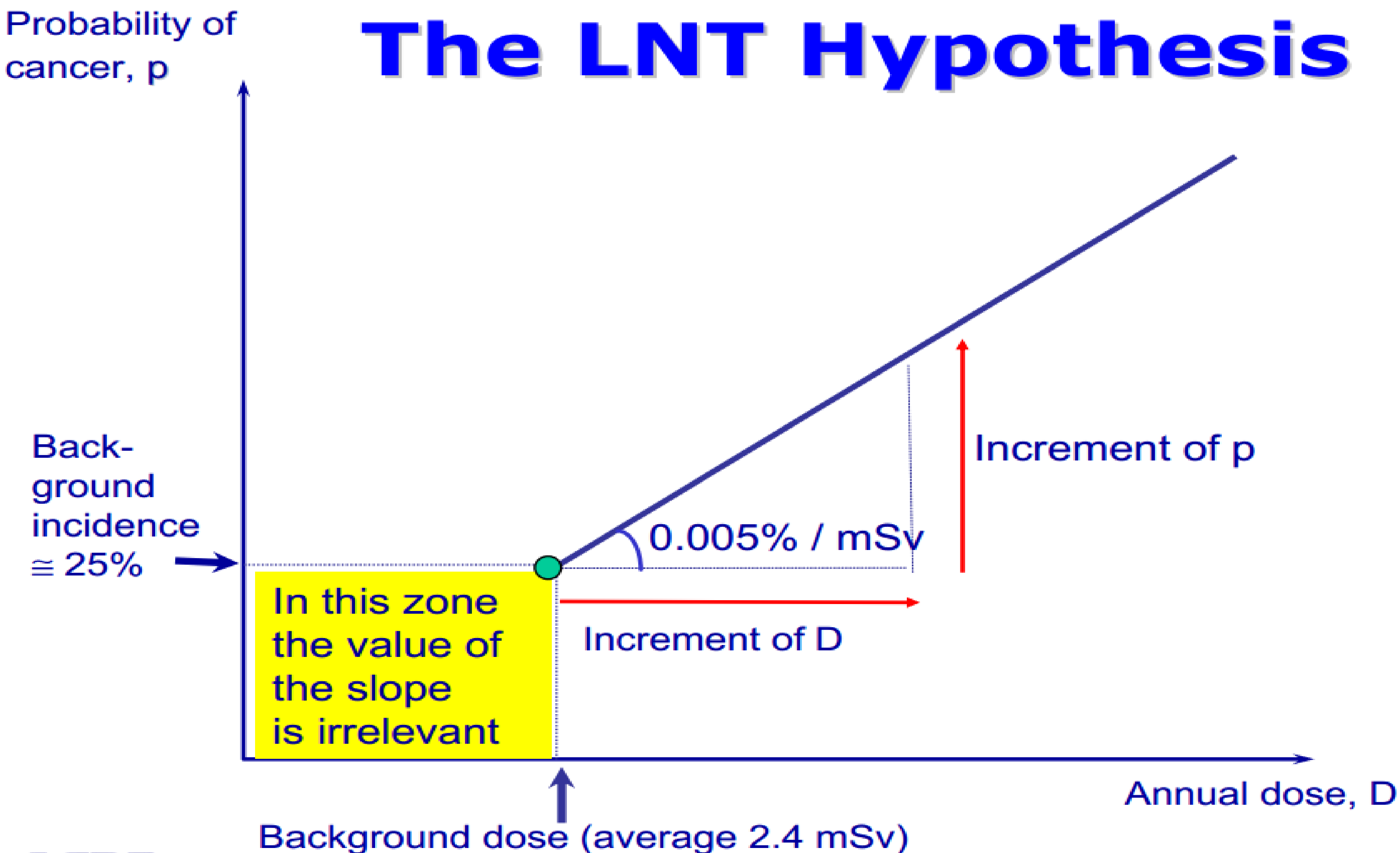
John D Boice Jr, radiation, Epidemiology and Cancer, Dinner Meeting of the Baltimore – Washington Chapter of the Health Physics Society and American Nuclear Society, Feb 25, 2010

The adoption of the LNT model combined with a judged value of a dose and dose rate effectiveness factor (DDREF) provides a prudent basis for the practical purposes of radiological protection, i.e., the management of risks from low dose radiation exposure. (ICRP Publ 103, 2007).



Source or mode	Annual average dose (worldwide)	Typical range of individual doses	Comments
Natural sources of exposure			
Inhalation (radon gas)	1.26	0.2–10	The dose is much higher in some dwellings.
External terrestrial	0.48	0.3–1	The dose is higher in some locations.
Ingestion	0.29	0.2–1	
Cosmic radiation	0.39	0.3–1	The dose increases with altitude.
Total natural	2.4	1–13	Sizeable population groups receive 10-20 millisieverts (mSv).
Artificial sources of exposure			
Medical diagnosis (not therapy)	0.6	0-several tens	The averages for different levels of health care range from 0.03 to 2.0 mSv; averages for some countries are higher than that due to natural sources; individual doses depend on specific examinations.
Atmospheric nuclear testing	0.005	Some higher doses around test sites still occur.	The average has fallen from a peak of 0.11 mSv in 1963.
Occupational exposure	0.005	~0–20	The average dose to all workers is 0.7 mSv. Most of the average dose and most high exposures are due to natural radiation (specifically radon in mines).
Chernobyl accident	0.002[b]	In 1986, the average dose to more than 300,000 recovery workers was nearly 150 mSv; and more than 350,000 other individuals received doses greater than 10 mSv.	The average in the northern hemisphere has decreased from a maximum of 0.04 mSv in 1986. Thyroid doses were much higher.
Nuclear fuel cycle (public exposure)	0.002[b]	Doses are up to 0.02 mSv for critical groups at 1 km from some nuclear reactor sites.	
Total artificial UNSCEAR 2008 Report Vol. I, Sources and Effects of Ionizing Radiation, Report to the General Assembly	0.6http://www.icrp.org/icrpaedia/exposure.asp	From essentially zero to several tens	Individual doses depend primarily on medical treatment, occupational exposure and proximity to test or accident sites.

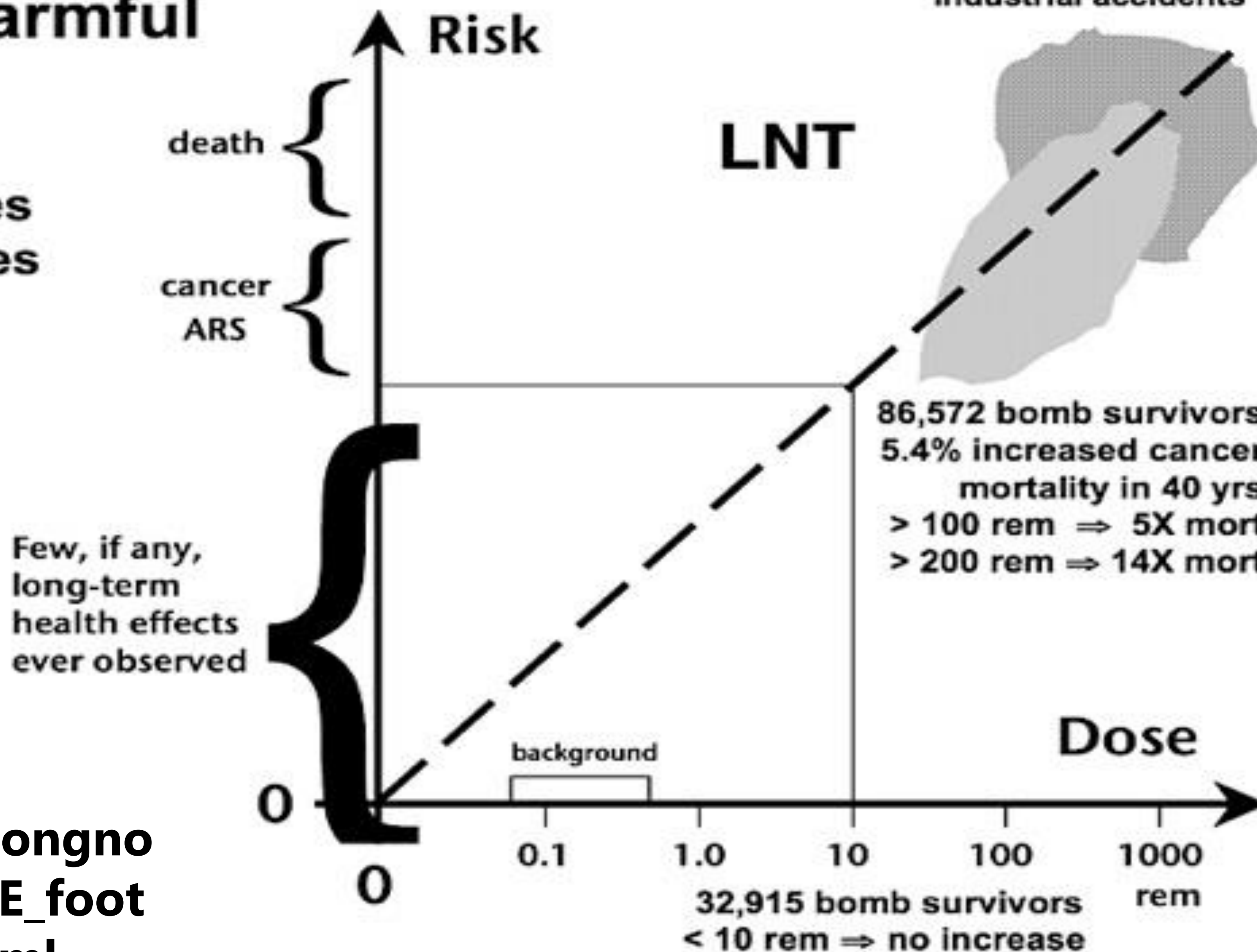
The LNT Hypothesis



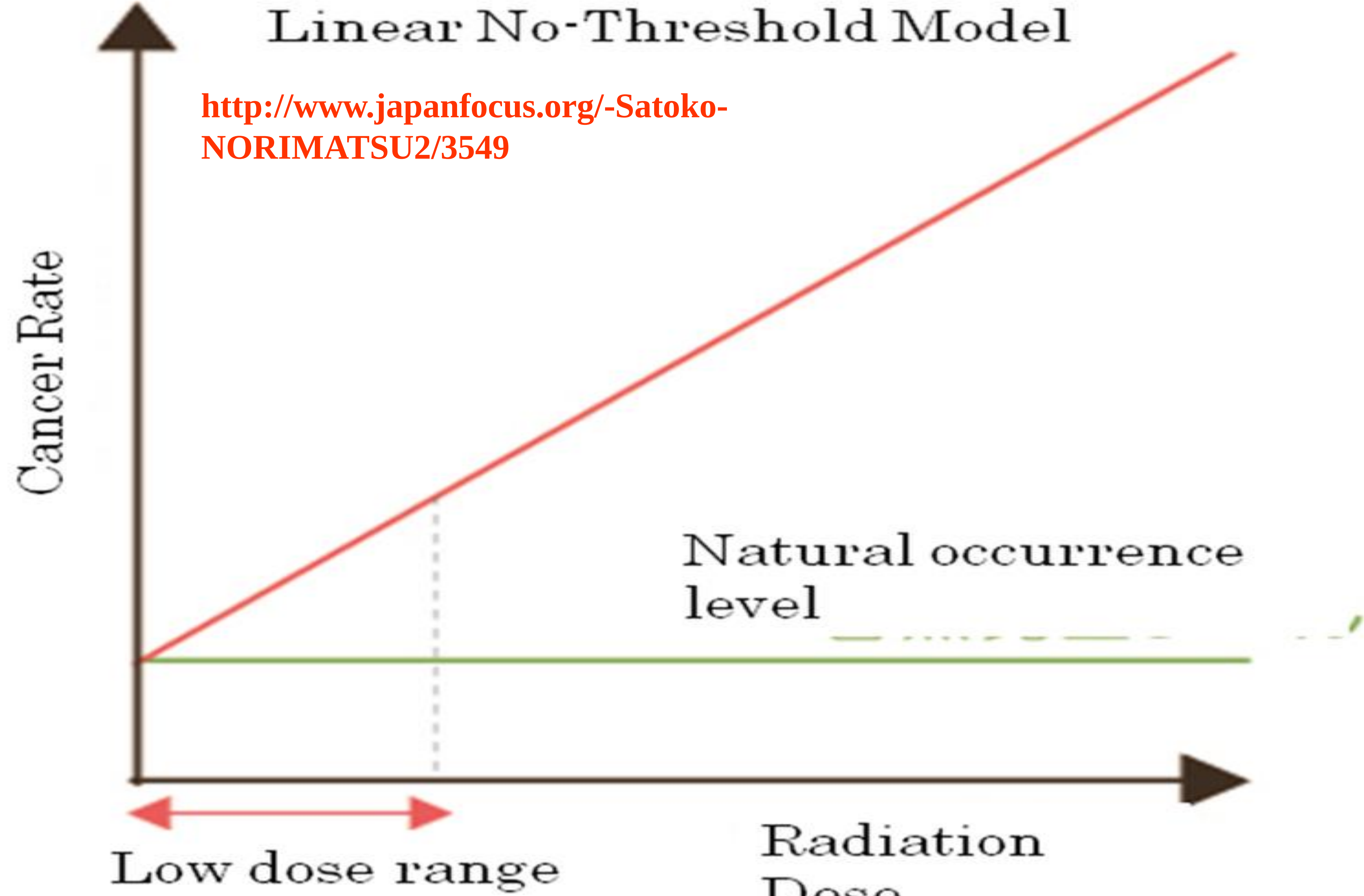
INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

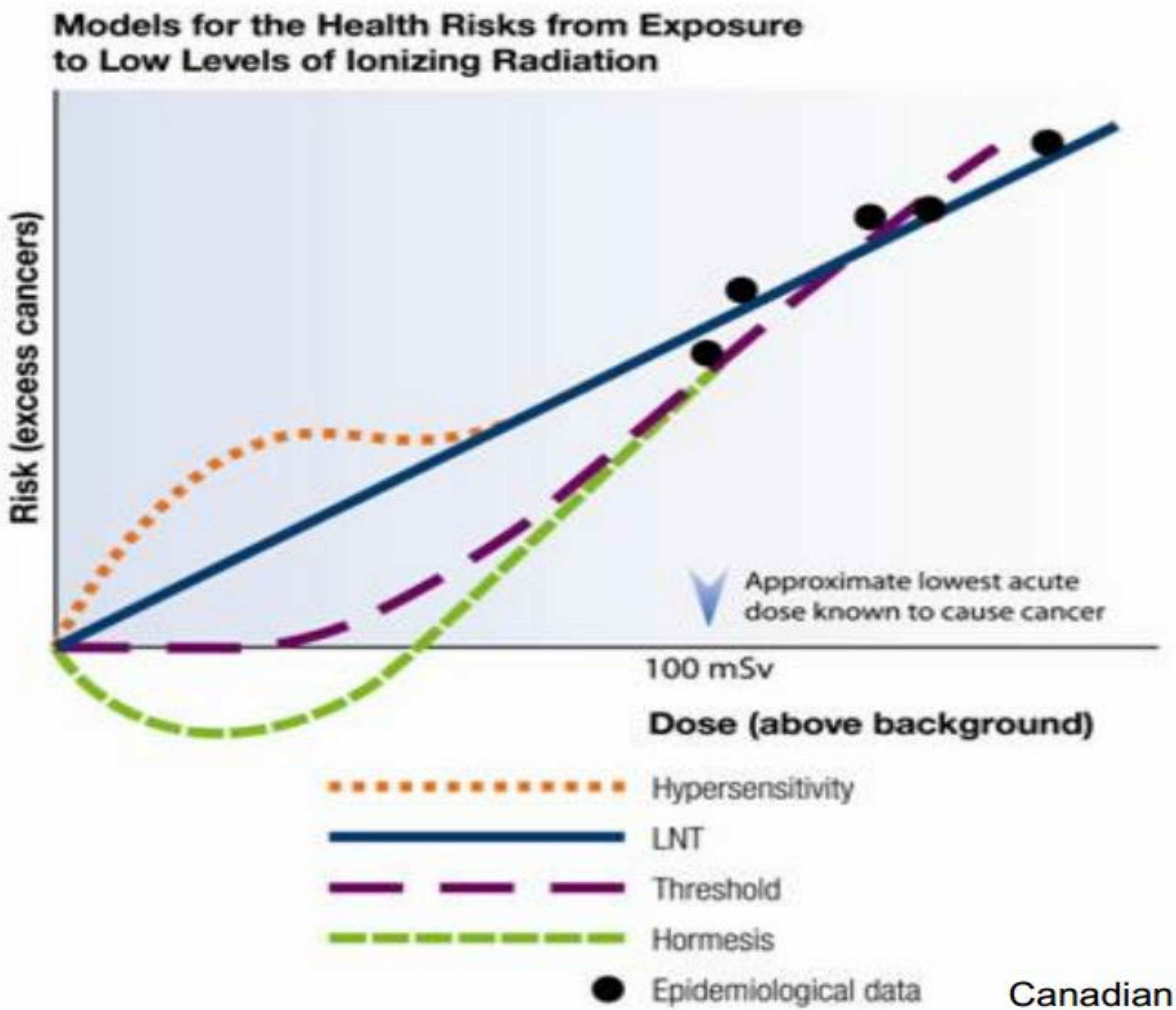
Linear-no-threshold hypothesis: even the smallest amounts of radiation are harmful

- cancer risk doubles when dose doubles
- it triples when dose triples
- it halves when dose halves



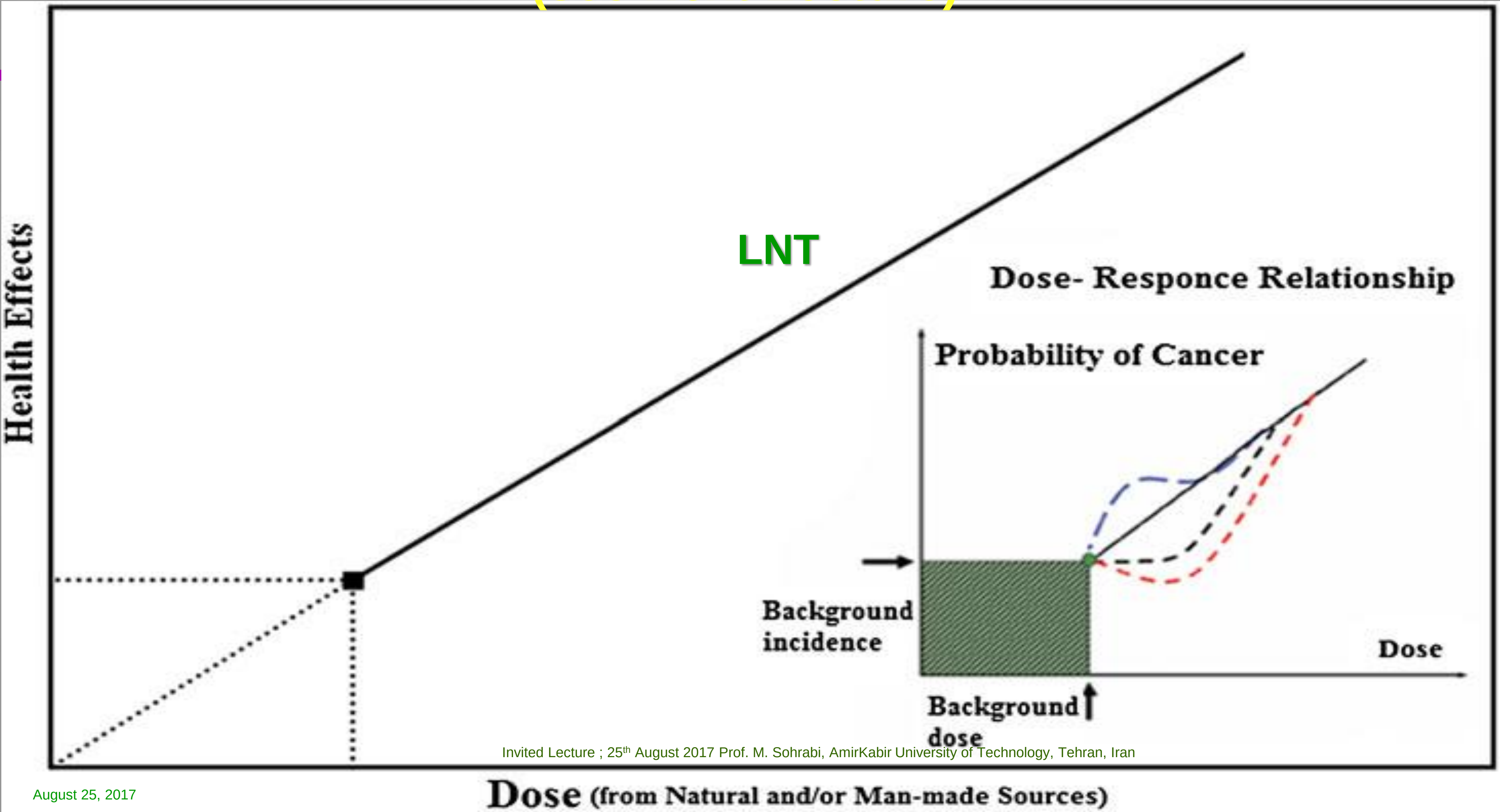
http://discipline.longnow.org/DISCIPLINE_footnotes/LNT.html


Linear No-Threshold Model
http://www.japanfocus.org/-Satoko-NORIMATSU2/3549
Cancer Rate
Natural occurrence level
Low dose range
Radiation Dose



Canadian Nuclear Safety Commission (2011)

LNT Model based on URPS (2015) (see Next Lecture)



Hormesis Model

A.M. Vaiseman, Radiation Hormesis: Historical Perspective and Implications for Low-Dose Cancer Risk Assessment, Dose Resposne 2010; 8(2): 172–191.

- **Radiation "Hormesis Model", unlike "LNT Model", assumes that adaptive/protective mechanisms can be stimulated by low-dose radiation and that they can prevent both spontaneous and toxicant-related cancers as well as other adverse health effects.**

- **The "LNT Model" is practically in current use until a strong proof against it or on the "Hormesis Model" is approved.**

- **The validity of either one is not the scope of this talk.**

Examples of Some Excellent Current Epidemiology Studies of Workers:

- **US Million Nuclear Workers Study (Bouville et al., Health Phys 108 (2): 206-220, 2015), based on external and internal doses.**
- **International Nuclear Worker Study (INWORKS) (Richardson et al. Br Med J 1-8, 2015), based on external doses.**
- **Risk of basal cell carcinoma in US radiologic technologists (1983-2005) (Lee et al. Occup Environ Med 72(12):862-9, 2015), based on only occupational external doses.**

An Example of Excellent Current Epidemiology Studies of Workers

http://www.icrp.org/icrpaedia/limits.asp

- **US Million Nuclear Workers Study** (Bouville et al., Health Phys 108 (2): 206-220, 2015),
- **It is based on external and internal doses.**
- **Other exposures workers receive as a member of public not included in the doses.**
  - NBG Radiation
  - Cosmic rays
  - Terrestrial
    - External (Gamma)
    - Internal (Radon), and
    - others
  - Planned Exposure Situation (1 mSv/year)
  - Accidental exposure
  - Medical Exposure

An Example of Excellent Current Epidemiology Studies of Workers

http://www.icrp.org/icrpaedia/limits.asp

- International Nuclear Worker Study (INWORKS) (Richardson et al. Br Med J 1-8, 2015), based on external doses.
- It is based only on external doses.
- Other exposures workers receive as a member of public not included in the doses.
  - Occupational internal doses.
  - NBG Radiation
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An Example of Excellent Current Epidemiology Studies of Workers

http://www.icrp.org/icrpaedia/limits.asp

- **US radiologic technologists (1983-2005) (Lee et al. Occup. Environ Med 72(12):862-9, 2015),**
  Risk of basal cell carcinoma: based on occupational external doses.

- **Exposures of workers, also as member of public, not included such as:**
  NBG Radiation
  - **Cosmic rays**
  - **Terrestrial**
    - **External (Gamma)**
    - **Internal (Radon), and**
    - **others**

  Planned Exposure Situation (1 mSv/year)
  Accidental exposure
  Medical Exposure

Worker's Dose Limits

- **Effective Dose to a worker from Occupational Exposure:**

  20 mSv per year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv.

  After a woman worker declares a pregnancy, the dose to the embryo/fetus should not exceed about 1 mSv during the remainder of the pregnancy

Role of NBG Radiation in Dose Limitation and Epidemiology of Workers

All epidemiological studies of workers have not considered :

- **NBG doses which are natural unfractionated doses from nature,**
- **Internal doses of workers adequately.**
- **NBG doses in normal areas even low is over a 50 years life time quite significant,**
- **NBG doses carry equal risks like doses from man-made sources.**
- **While NBG doses may not be significant contribution to health effects e.g. in emergency situations, it is of high importance at low dose limitation and epidemiological studies of workers.**
- **Effect of NBG doses (unfractionated) is much more significant than that of occupational doses in particular when fractionation effect is fully considered for low dose epidemiology studies of workers and even public.**

Some Questions ??
on Present RP Status

- Is the health risks/unit dose of NBG from that of the man-made exposures?
- Should we apply "Risk Limit" to set "Dose Limit"?
- Should a member of public have the same "Risk Limit" in different parts of the world?
- Is "Dose Limit"of public standardized?
- Should a worker have the same "Risk Limit" in different parts of the world?
- Is worker "Dose Limit" standardized?
- Is the risk in the LNT response above UNSCEAR mean global NBG radiation dose Justified?

Some Questions ??
on Present RP Status

- Is worker "Dose Limit" standardized not being also considered as a member of Public?
- Is "Fractionation Factor (FF)" necessary to apply to "Fractionated" and "Unfractionated" exposures to equalize exposure situation risks?
- Should epidemiological studies of consider also lifetime NBG dose in the lifetime occupational dose?
- Should exposure of radiation workers and public is standardized on a global risk basis?
- Is 1 $mSv.y^{-1}$ public "Dose Limit" from planned exposure situations on top of UNCEARS's 2.4 $mSv.y^{-1}$ global mean NBG dose justified?

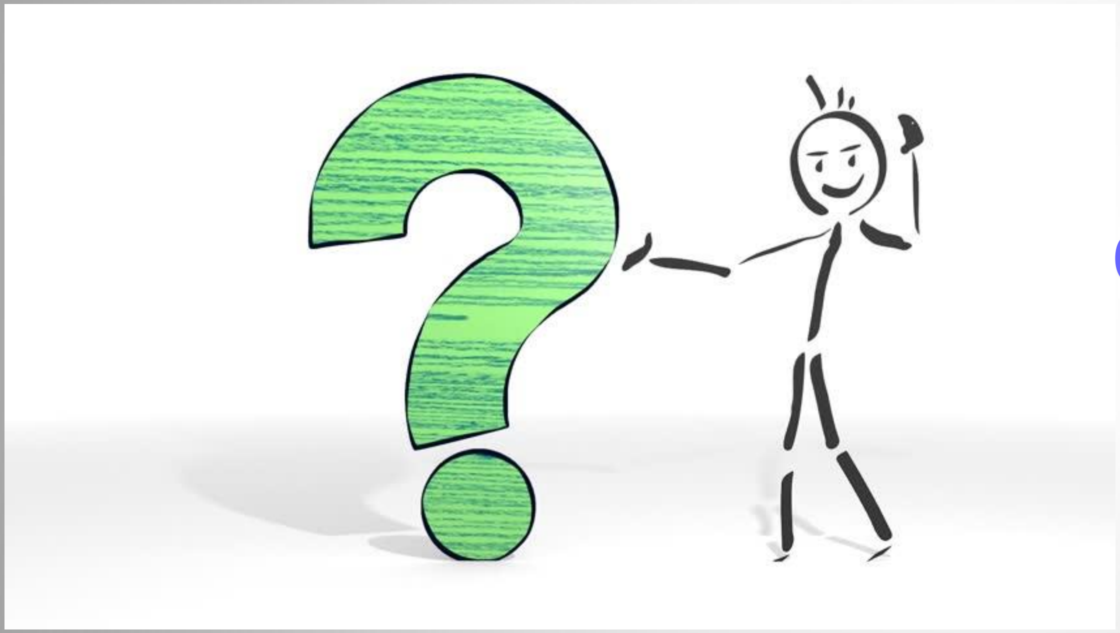
Some Questions ??
on Present RP Status

- Is Reference Level of 1 $mSv.y^{-1}$ for gamma exposures and 10 $mSv.y^{-1}$ for radon and progeny indoors practical?
- Is a reference level of 10 $mSv.y^{-1}$ for radon indoors (reduced in terms of activity level from 600 (ICRP 103) to 300 $Bq.m^{-3}$ (ICRP "Statement on Radon" in 2009) and a reference level of 100 $Bq.m^{-3}$ WHO well coordinated?
- Do we need to evolve RP philosophy, concepts and procedures?
- Can the "Universal Radiation Protection (URPS) Hypothesis" evolve the system?

- What is the "URPS"?


(URPS)
A UNIVERSAL RADIATION PROTECTION SYSTEM

What is "URPS Hypothesis"?



Questions ?? are welcome

It is discussed in the continued Lecture
PART II

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Thank You