University of Pittsburgh

ME/ENGR 2100 Fundamentals of Nuclear Engineering

Radiation Protection:

Radiation Protection Standards

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Relevant Reading Assignments

- Chapter 9 of "Introduction to Nuclear Engineering," Lamarsh and Baratta, 3rd edition, Prentice-Hall (2001)
- Chapter 3 of "Nuclear Engineering: Theory and Technology of Commercial Nuclear Power," Knief, 2nd edition, American Nuclear Society (1992, reprint by ANS 2008)

Learning Objectives

- Describe current US radiation protection standards

- Explain the three primary and two subordinate dose reduction principles.

Describe current US radiation protection standards

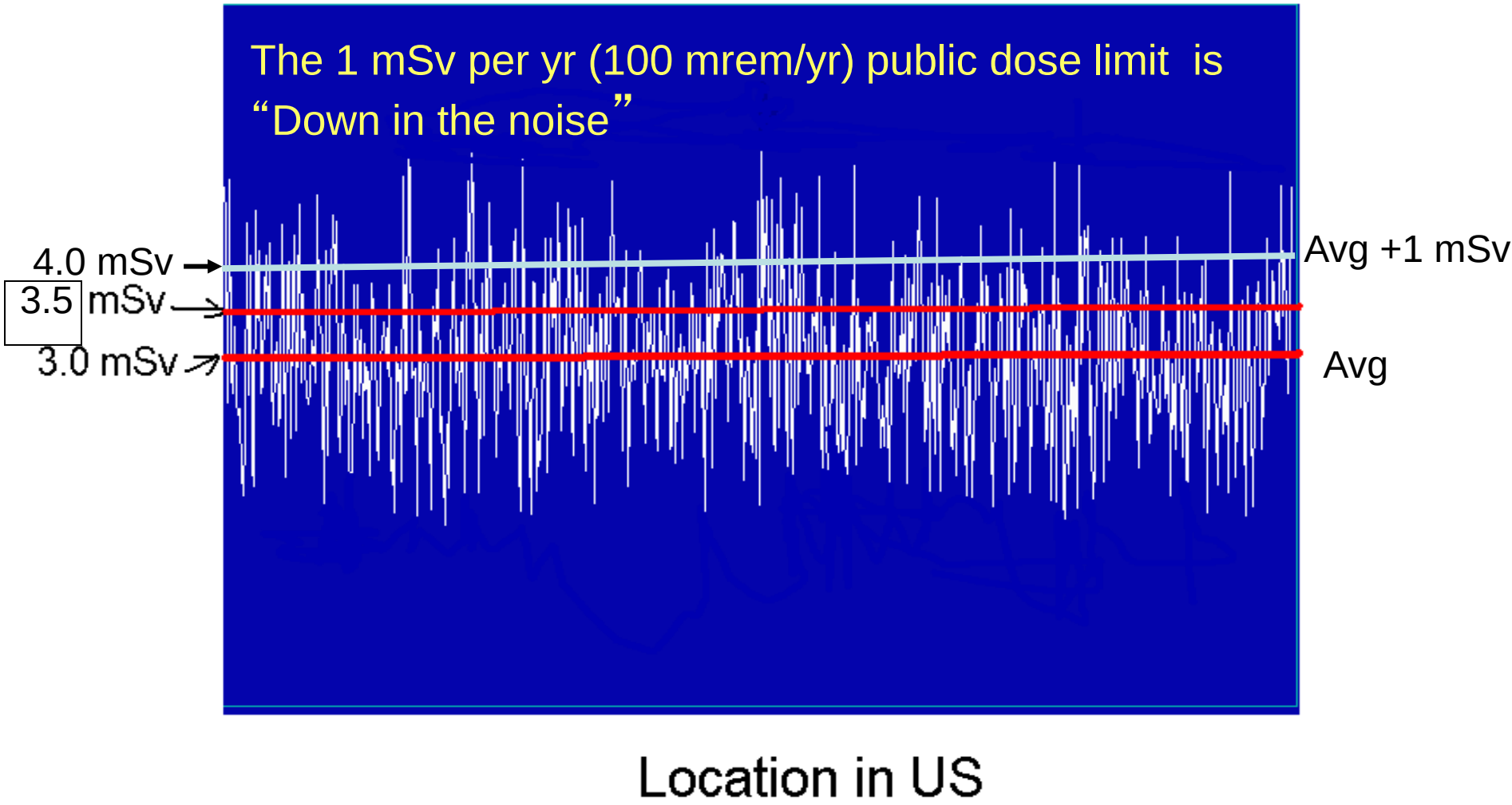
Background Radiation

- Natural background radiation
  - Varies in world with altitude and soil composition.

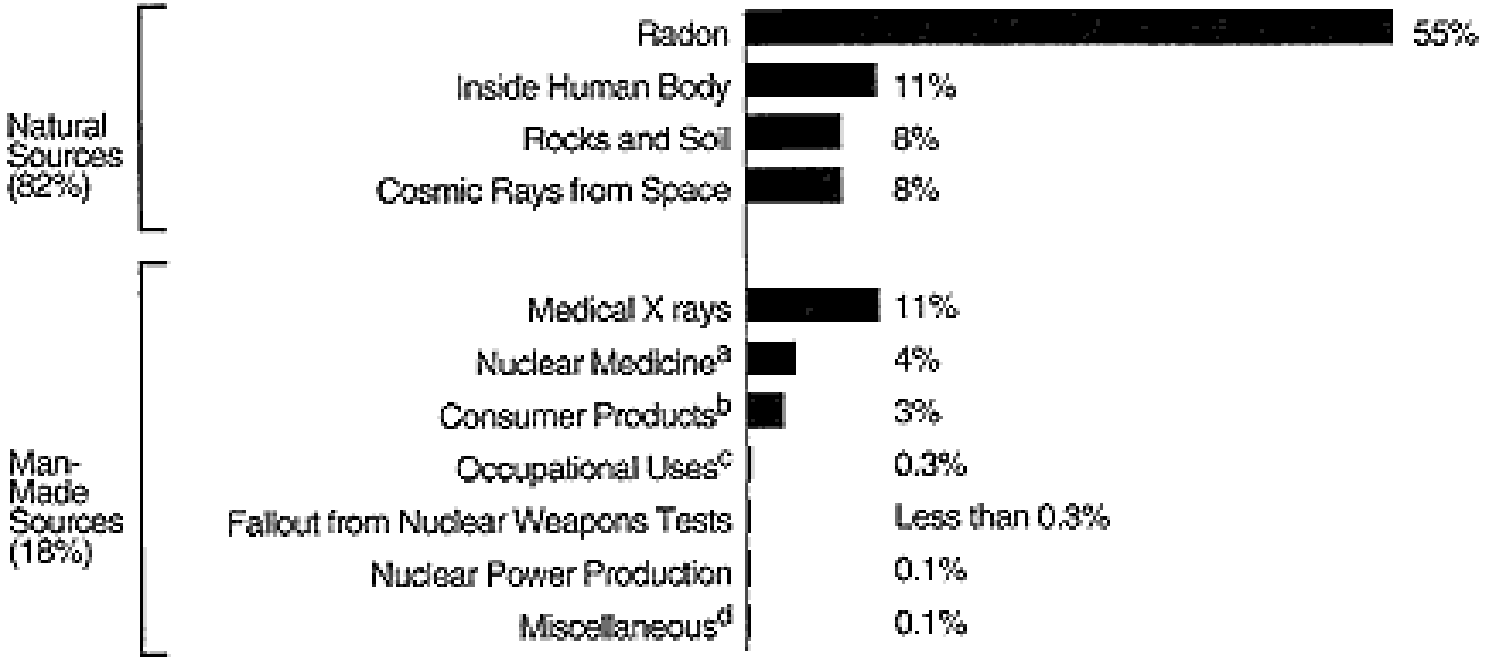
US Average -- 300 mrem/y + 50 mrem/y

		[ICRP]
Cosmic	30 mrem/y	0.3 mSv/yr
Terrestrial	30 mrem/y	0.3 mSv/yr
Internal (Food/Water)	40 mrem/y	0.4 mSv/yr
Inhaled (Radon)	200 mrem/y	2.0 mSv/yr
Medical / Etc.	50 mrem/y	0.5 mSv/yr

Variation in Natural Background radiation in US



Sources of Radiation Exposure



[a] Involves the use of radioactive materials in diagnosing and treating patients with cancer and other diseases.

[b] Building materials, tobacco, mining and agricultural products, water supplies, etc.

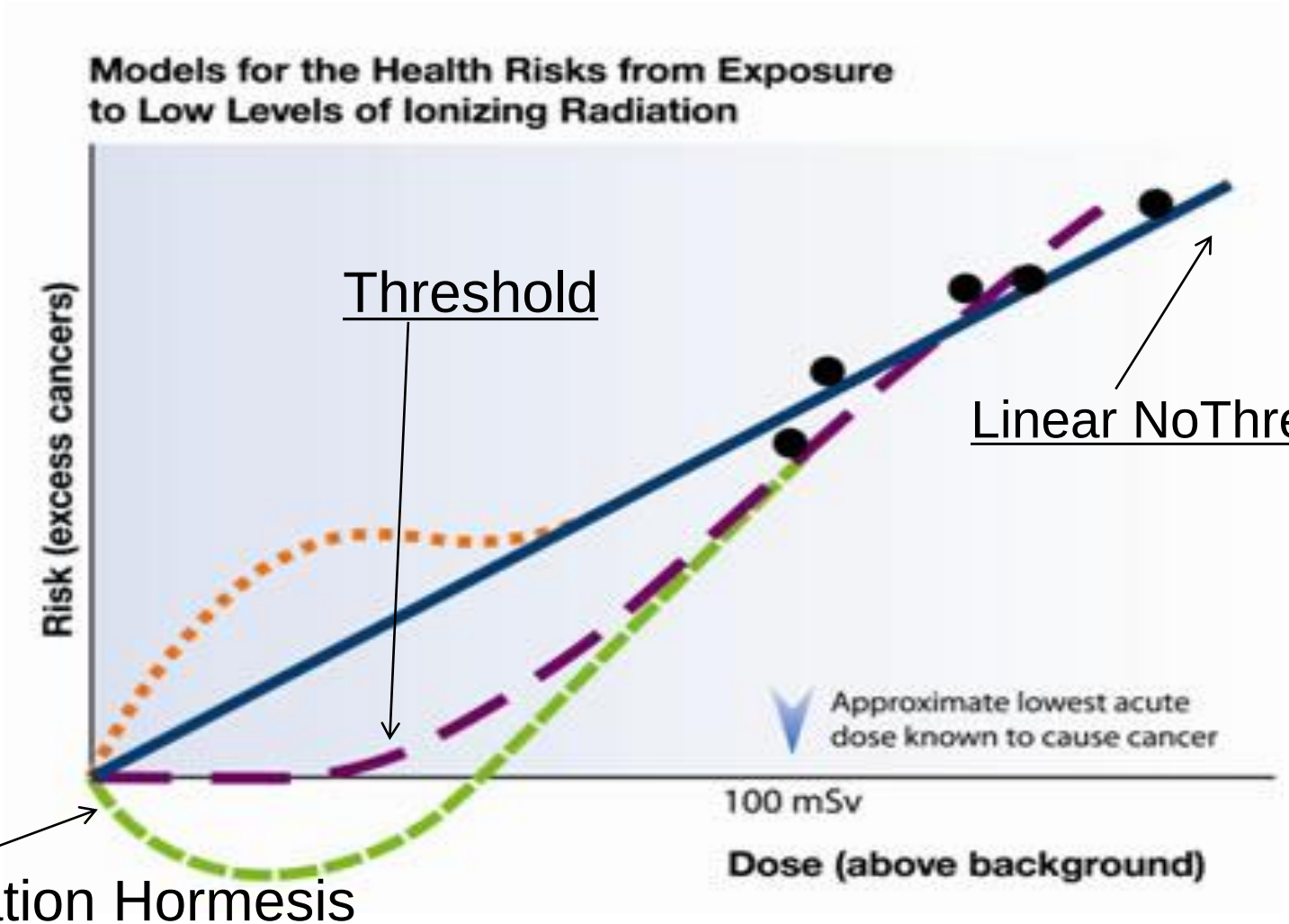
[c] Uranium mines, industrial and medical users, etc.

[d] Department of Energy facilities, smelters, transportation, etc.

* Source: National Council on Radiation Protection and Measurements, Report No. 93.
(Total adds up to more than 100% due to rounding off of percentages.)

From: *National Institutes of Health:* [Look up XKCD chart]

Linear No Threshold Hypothesis for evaluation of radiation health effects



External Radiation Standards

- Universal annual radiation dose limits

	Occupational	Public
Whole body	5 rem	0.1 rem
Lens of the eye	15 rem	5 rem
Other tissues	50 rem	5 rem

- Special situations
  - 25 rem "Lifesaving" (on voluntary basis)
  - 10 rem "Equipment/Property saving"
  - Remember: "no observable effects below 25 rem"

Annual acceptable public dose in US

- Despite the Variation in Natural Background, most locales in the US are below 6 mSv (600 mrem) per year.
- Regulatory value selected is 1 mSv (100 mrem) per year

Explain each of the three primary and the two subordinate dose reduction principles

Dose Reduction

- How do we optimize radiation exposure to get it as low as reasonably achievable?
- Three basic principles
  - Restrict proximity ***TIME***
    - Dose = Dose Rate × Time
  - Increase the ***DISTANCE*** from the source
    - For example, Point source: "1-over-r-squared" reduction
  - Use ***SHIELDING*** material

Dose Reduction and control

- Other subordinate approaches:
  - Allow to ***DECAY*** away with time
  - Provide ***CONTAINMENT***
    - Isolate contaminated materials & surfaces
      - Containment enclosures
    - Isolate workers
      - Respirator
      - Protective clothing
  - Provide engineered controls
    - Procedures, physical controls
- Also Monitor (personal dosimetry, area monitors), though this dose not prevent dose, merely informs of its accrual