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Overview of the US NAS Report: Radiation Source Use and Replacement

Briefing to WINS Workshop on Alternative Technologies to Radioactive Sources

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Task

Congressional Request 2005 Energy Policy Act

STATEMENT OF TASK

The principal task of this study is to review the current industrial, research, and commercial (including medical) uses of radiation sources to identify uses for which:

(1) the radiation source can be replaced with an equivalent (or improved) process that does not require the use of radioisotopes; or

(2) the radiation source can be replaced with another radiation source that poses a lower risk to public health and safety if it is involved in an accident or used in a terrorist attack.

The study should explicitly consider technical and economic feasibility and risks to workers from such replacements.

Process

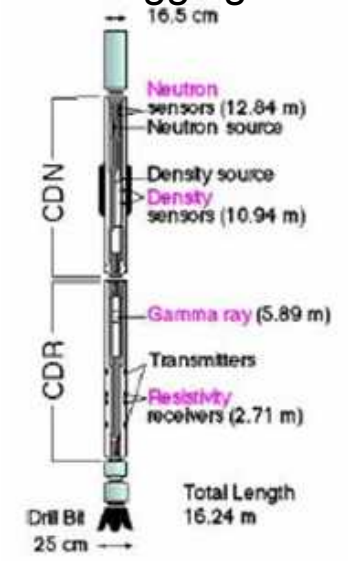
- The Committee spent ~1 year studying US Category 1 and 2 devices and their alternative technologies
  - Members of the Committee gave tutorials on their areas of expertise
  - Briefings were also presented to the Committee by outside experts and industry representatives
  - The Committee toured key facilities

Committee Charter
IAEA Category 1 and 2 Sources in US

Category 1, Co-60 Teletherapy

Category 1, Cs-137 Self-Contained Irradiator

Category 2, Am-241/Be, Well Logging



Category 2, Ir-192, Radiography

Replacements Exist

- **Lower hazard replacements exist for nearly all applications of Category 1 and 2 radionuclide sources. At this time, these replacements may not all be practical or economically attractive, but most of them are improving and many are viable now.**

Summary of Alternatives

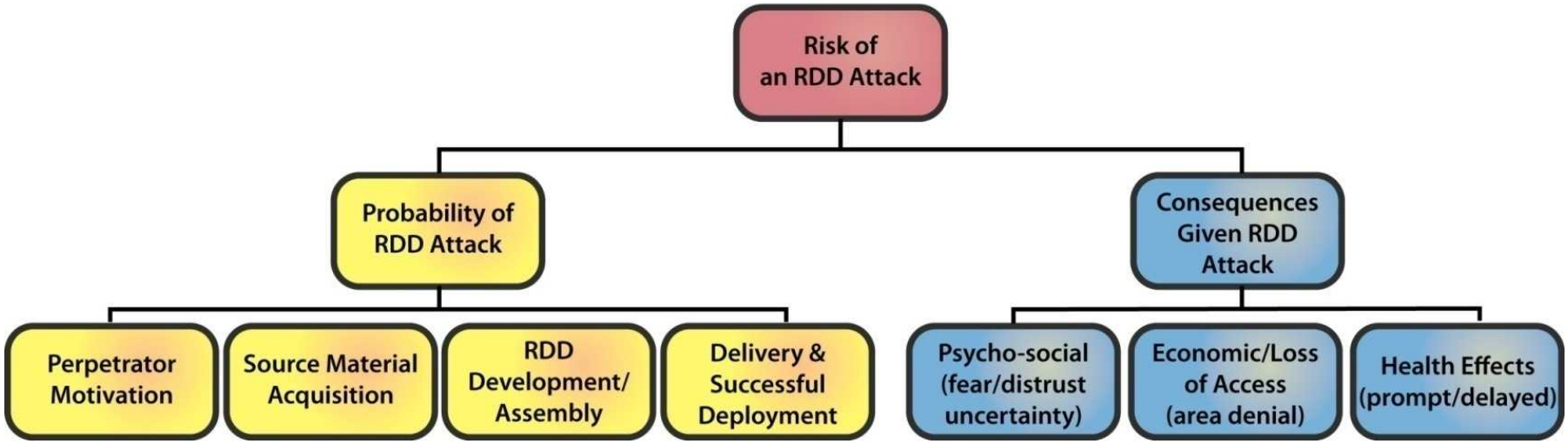
Application	Current Radionuclide	Non Radionuclide Alternative	Comments
Teletherapy	Co-60	LINAC	Co-60 largely replaced in US with linacs. Co-60 still used in developing countries. Radiosurgery (gamma-knife) a special case, but linacs compete here too.
Radiography	Ir-192 (Co-60)	Ultrasound Portable X-ray	Advances in ultrasound techniques and portable x-ray. Experts estimate that ~75% of all radiography could be replaced by ultrasound or x-ray. **Roadblocks:** trained personnel; regulatory factors.
Well Logging	Am-241/Be	D-T Accelerator (14.1 MeV neutrons)	Most logging is done with AmBe for low energy neutrons (porosity and element analysis logs) and D-T accelerator for high energy neutrons (C/O and n,γ inelastic scatter logs). Schlumberger has proprietary system for using DT for all logs. **Roadblocks:** database, inertia.
Self-Contained Irradiators	Cs-137 (Co-60)	X-ray Irradiators	X-ray irradiators already exist and are being marketed for blood irradiation and research. **Roadblocks:** database (research), inertia, lack of competition (blood), operational ease (blood).

RISK-BASED METHODOLOGY FOR PRIORITIZING SOURCES FOR REPLACEMENT

Options for Radiological Terrorism

Device Type	Dispersal Form	Economic Effects	Health Effects	Comments
Radiation Exposure Device (RED)	N/A	Low to Medium	Medium: Deterministic and stochastic health effects	No lasting economic impact
Rad-Food Dispersal (RFD)	Dissolve or mix	Medium to High	Medium to High: Deterministic and stochastic health effects	Other poisons more readily available?
Radiation Dispersal Device (RDD)	Many	Medium to Very High "Area Denial"	Low: Latent cancer risk (stochastic) drives population relocation	Could impact ~ 10,000's; **Area Denial--Unique aspect of radiological material**

RDD Risk Elements



Radionuclides Properties

Radionuclide and emission	Half-life	Chemical Form (typical)	Power to Contaminate* TBq/km^2	Application and Typical Activity
Co-60 (β,γ)	5.3 yr	Metal	0.37 (10 Ci/km^2)	Category 1 Irradiators, Teletherapy ≥ 37 TBq
Cs-137 (β,γ)	30 yr	Salt (CsCl) Powder	1.5 (40 Ci/km^2)	Category 1 Irradiators ≥ 37 TBq
Ir-192 (β,γ)	74 d	Metal	3.7 (100 Ci/km^2)	Category 2 Radiography ≥ 3.7 TBq
Am-241 (α,γ)	430 yr	Oxide Powder	1.5 (40 Ci/km^2)	Category 2 Well Logging ≥ 0.37 TBq

*Quantity needed for uniform dispersal over 1 sq. km to trigger the EPA Relocation Protective Action Guide. Values are approximate.

Past Experience with Cs-137

- Chernobyl, USSR April 1986
  - 2 Million Ci, Cs-137

- Goiania, Brazil Sept. 1987
  - 1400 Ci, Cs-137 (CsCl)

Source: The Radiological Accident in Goiania, IAEA 1988

NAS COMMITTEE RECOMMENDATIONS

Replace Cesium-Chloride Sources (I)

- Because of its characteristics and where the sources are located, radioactive cesium chloride is a greater concern than other sources for some attack scenarios.

- This is made worse by the lack of an avenue for permanent disposal of these sources.

Replace Cesium-Chloride Sources (II)

- In view of the overall liabilities of radioactive cesium chloride, the U.S. Government should implement options for eliminating Category 1 and 2 cesium chloride sources from use in the United States and, to the extent possible, elsewhere. The committee suggests these options as the steps for implementation.
  - i. Discontinue licensing of new cesium chloride irradiator sources
  - ii. Put in place incentives for decommissioning existing sources
  - iii. Prohibit the export of cesium chloride sources to other countries, except for purposes of disposal in an appropriately licensed facility.

Incentives to Replace Other Sources

- **The U.S. government should adopt policies that provide incentives (market, regulatory, or certification) to facilitate the introduction of replacements and reduce the attractiveness and availability of high-risk radionuclide sources.**

Questions?

Main Messages

- Applications of Radionuclide sources are important and beneficial.
- RDD-Area denial and its costs must be considered in the evaluation of security risks from these sources.
- It is Urgent to Take actions to implement near-term replacement of cesium-chloride sources.
- Adopt policies that provide incentives to replace other Category 1 and 2 sources.

Radiation Sources in the United States

- Approximately 5,000 devices containing nearly 55,000 Category 1 and 2 (“high-risk”) radiation sources are licensed for use today in the United States.
- The devices are used for applications that are important to society: cancer therapy, sterilization of medical devices, irradiation of blood for transplant patients and of laboratory animals for research, non-destructive testing of structures and industrial equipment, and exploration of geologic formations to find oil and gas deposits.

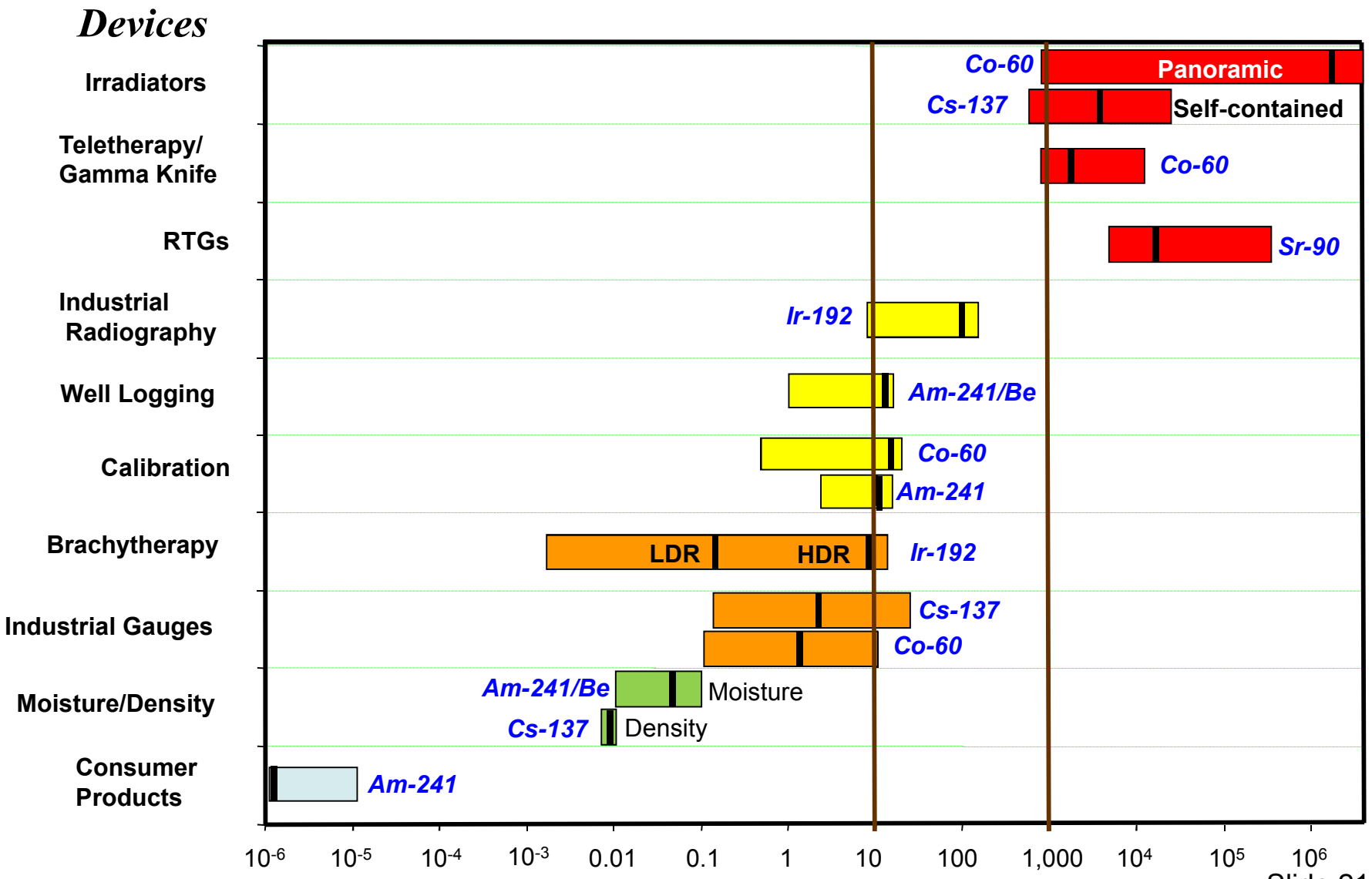
- RECOMMENDATION: Replacement of some radionuclide sources with non radionuclide radiation generators should be done with caution.

Security Risks and Area Denial

- Security and safety risks motivated the request for this study.
- Radiation sources can be significant risks for individuals, but are unlikely to cause deterministic health effects to large numbers of people.
- The widest ranging and most long lasting consequences from an RDD may be the economic and social disruptions resulting from contamination that leads to area denial.
- IAEA source categories are based on deterministic health effects. U.S. NRC & U.S. DOE's contamination criterion does not sufficiently account for differences in consequences of RDDs using different sources.

- RECOMMENDATION: For prioritizing its efforts to reduce security risks, the U.S. NRC should consider a radiation sources' potential to cause contamination of large areas resulting in area denial.

Radiation Devices & Activity Ranges†



† Derived from IAEA Categorization of Sources