A NEW PARADIGM FOR HIGH LEVEL RADIOACTIVE WASTE DISPOSAL

FRANK L. PARKER, NAE

DISTINGUISHED PROFESSOR OF ENVIRONMENTAL ENGINEERING,

Vanderbilt University, Nashville, Tennessee, 615 343 2371

frank.l.parker@vanderbilt.edu

The prevailing laws and regulations will have to be changed, the Commission, with its outstanding members and staff and a Noble Laureate as Secretary, will have an unique opportunity to make the process transparent, sustainable, believable and hopefully successful.

DISPOSE OF HIGH LEVEL WASTE IN A SUSTAINABLE, BELIEVABLE AND TRANSPARENT MANNER

The present system is broken:

- **1959 At the first international meeting on radioactive waste, U.S. national laboratories reported on successful laboratory scale studies of vitrification and immobilization of high level waste.**
- **1965 Project Salt Vault demonstrated field scale disposal of spent nuclear fuel at final repository temperatures and radiation doses.**
- **In 1972, AEC announced that a deep, geological repository would be built at the Salt Vault site in 5 years and at a cost of 25 million dollars.**
- **Hanford has yet to vitrify any high level waste.**
- **Concepts of Rethinking 1990 shown by Crowley at first meeting of BRC still valid. Proposed updates follow.**

THE LOW-LEVEL WASTE DISPOSAL SYSTEM IS ALSO BROKEN

Though low level waste disposal is not the primary focus of the Commission, its solution is also important. Many of the concepts that are important in high-level waste disposal are also important in low-level waste disposal. The BRC Charter also authorizes study of "materials derived nuclear activities".

a. No new Compact waste disposal sites have yet received waste since the authorizing legislation was passed in 1980.

b. For waste producers in many states, there is no place to dispose of Class B and Class C wastes. This is, in some instances, more critical than the high-level waste problem because many producers have extremely limited storage space for their wastes.

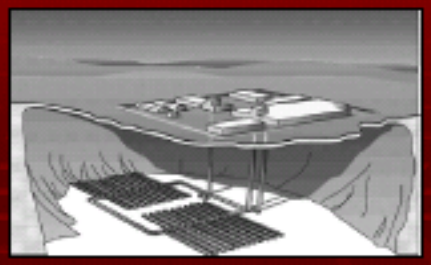
U.S. Repository Development Program

- The U.S. program, as conceived and implemented over the last decade (1980-1990), is unlikely to succeed DOE
- The U.S. program is characterized by a high degree of inflexibility with respect to schedule and technical specifications
- A more flexible and experimental approach for repository development is needed because:
  - Surprises are inevitable in these "first-of-a-kind" projects
  - Repository designs may need to be changed in response to new information
- Congress should reconsider the rigid, inflexible schedule embodied in the Nuclear Waste Policy Act and the 1987 amendments

(NAS, 1990) 7

From Crowley Presentation to BRC , May 25, 2010

Geological Disposal



- There is a worldwide scientific consensus that deep geological disposal is the best option for disposing of SNF/HLW
- Whether, when, and how to move toward geological disposal are societal decisions for each country—the decision process will be lengthy, and the time can be used to improve both the technical and societal bases for decisions
- The biggest challenges to geological disposal/disposition are societal, not technical
- A management system that is flexible, responsive to surprises, capable of midcourse corrections, and effective in its interactions with concerned segments of the public has the greatest probability of success

(NAS 1990, 2001)

8

Strictly technical solution will not work.

From Crowley Presentation to BRC , May 25, 2010

OTHER HIGHLIGHTS AND UPDATE 0F "RETHINKING"

- Quantitative predictions to 10,000 years "pushes the boundaries of our understanding".
- Choice is between geological disposal and on surface storage.
- Remediation is a better option than retrieval as the best site and immobilization techniques have already been chosen.
- Disposal in sub-seabed sediments should be considered.
- Much has been learned about siting and designing deep geological sites though the general principles in "Rethinking" are still valid.
- Much has been learned about gaining and regaining trust though the general principles in "Rethinking" are still valid.
- Limiting proliferation has become more important as the terrorists have become more sophisticated, opportunities have increased and the terrorists are more martyr inclined.
- Reducing human exposure to radiation has become more important as the average dose in the U.S. has almost doubled to 6.2 mSv/y.

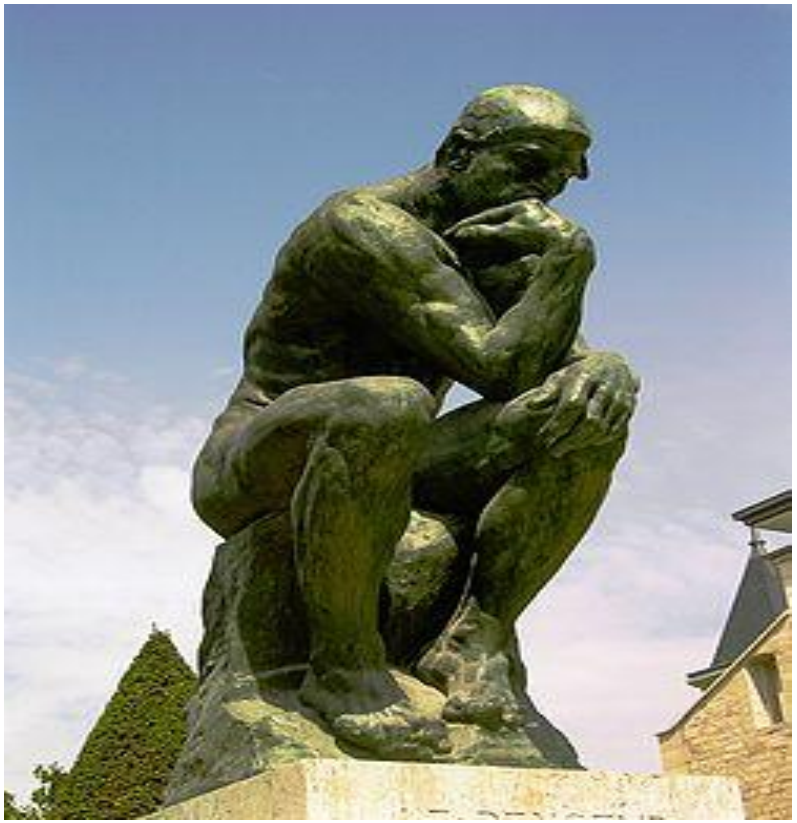
BOUNDARY CONDITIONS
REGAIN TRUST-ELIMINATE FALSEHOODS

1,000,000 YEAR WARRANTY
HURRY IN AND BUY IT TODAY!
I ALSO HAVE BRIDGES FOR SALE

AVOID EXTREMES of PRECAUTIONARY PRINCIPLE

GENTLEMEN, PLEASE FIND OUT HOW TO MAINTAIN LIFE ON EARTH WHEN THE SUN GOES EXTINCT IN ABOUT 5 BILLION YEARS

Balance intergenerational and intra-generational needs
Take into account distributional effects



BOUNDARY CONDITIONS
REALISTIC PROMISES (A)

OBJECTIVE-SUSTAINABILITY BUT WITH VALUE COMPLEXITY ("presence of of multiple, competing values and interests.")

Rawls- "just savings should be adopted."

Weiss "a fundamental principle of intergenerational equity"

Brundtland-"Sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs ."(Our Common Future, 4 August, 1987), p. 14)

"But the problem of nuclear waste disposal remains unsolved. Nuclear waste technology has reached an advanced level of sophisticetion.50/ This technology has not however been fully tested or utilized and problems remain about disposal."

BOUNDARY CONDITIONS
REALISTIC PROMISES (B)

Therefore, it is not necessary to 'solve' the nuclear waste 'problem' but we cannot leave future generations with greater burdens, environmental and economic, than we face today.

Consequently, we should plan, design and build systems based upon how far we can plan for the future with some confidence, say 100 years.

I would like to ask the Subcommittee the rhetorical question-did you, after you reached the age of consent, do as your parents wished? Why, then, should we expect future generations do as we wish without us having any understanding of the conditions they will face at that time?

BOUNDARY CONDITIONS- REALISTIC PROMISES-C

A number of options meet this 100 year objective:

- **The surface storage option, now in pools and dry casks, is inadvertently being tested as some of these wastes have been stored on the surface for over 60 years.**
- **We should also look at a centralized surface storage facility, deep geological disposal and a tunnel under the ocean to a sub-seabed site (already in existence in Sweden), among others.**
- **At the end of the 100 year period, the disposal options should be examined under the conditions prevailing at that time.**
- **Before any decision is made, the option should be examined theoretically, modeled and tested at a pilot scale.**

DISPOSAL IN SUB-SEABED SEDIMENTS I

Disposal of high level waste (spent fuel) in deep ocean sub-seabed sediments was successfully explored in the 1970s and 1980s.

Recovery of some of the 4.5 billion tons of uranium in the ocean, already demonstrated at a pilot scale at 2-3 times the spot price for uranium, would eliminate the need for reprocessing to conserve uranium resources. This would reduce the opportunities for nuclear proliferation. If externalities were taken into account, e.g. mining site remediation, costs might even be lower than market costs.

The London (Dumping) Protocol of 1996 was modified in 2006 to allow sequestration of CO2 in sub-seabed geological formations (oceanic acidification). Why not for spent fuel?

DISPOSAL IN SUB-SEABED SEDIMENTS II

Opposition by island nations to disposal into the seas may be reduced as they are among the first to be affected by global warming. Note that all of the radioactive material that would have been put into Yucca Mountain is more than an order of magnitude less than what is naturally in the ocean and if delayed for 300 years would be 3 orders of magnitude less.

BECQUERELS (CURIES) DO NOT EQUAL SIEVERTS(REMS)

MOBILITY AND BIOAVAILABILTY MUST BE CONSIDERED

RADIOACTIVITY IN THE OCEAN	BECQUERELS
Natural	1.50E+22
Directly Dumped	8.50E+16
Fallout	1.5 E+18
Reprocessing Plant Effluent	1.00E+17
Yucca Mountain when full 70,000 MTHM	8.00E+20
Yucca Mountain after 300 years	1.8 E+19

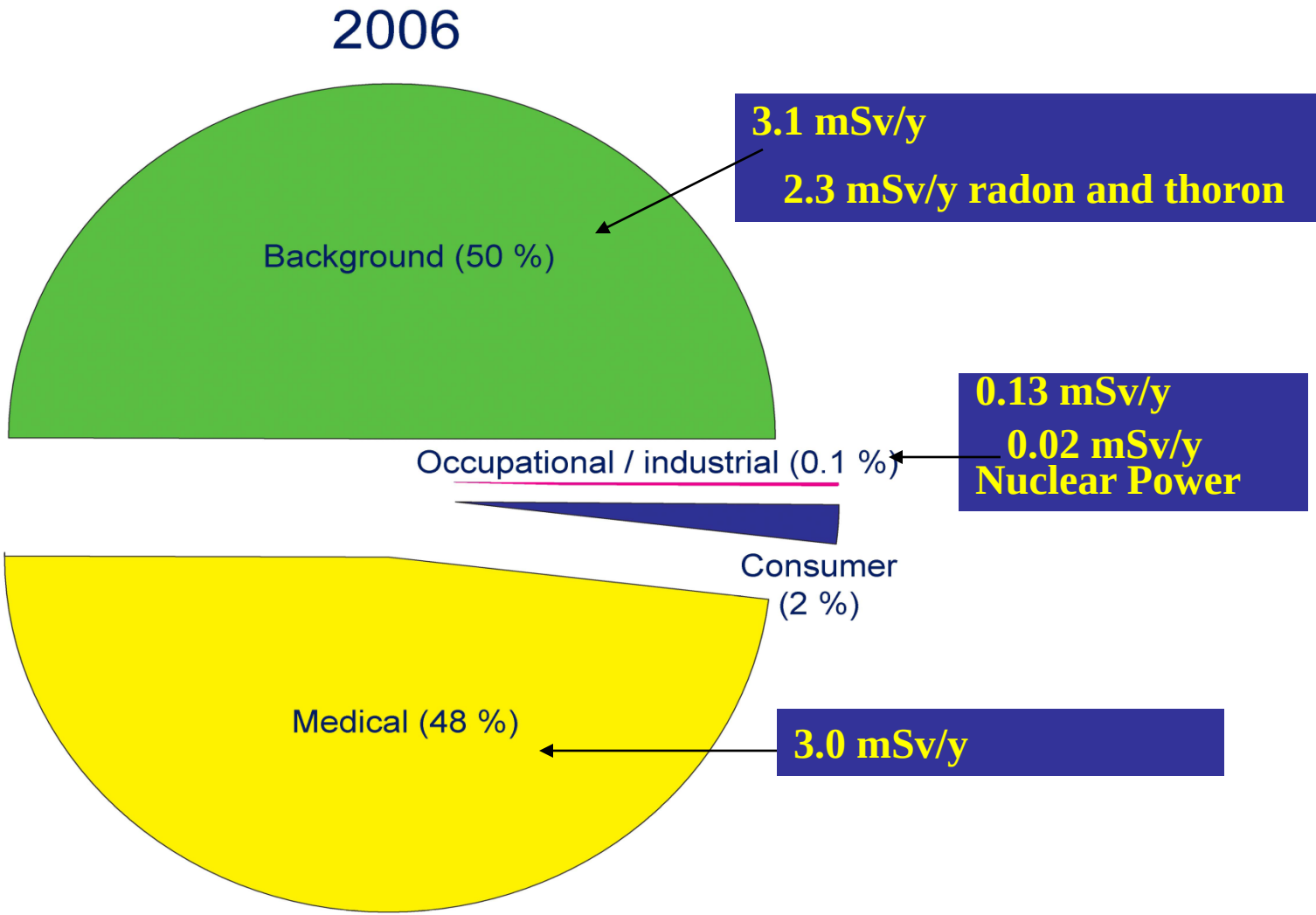
DISPOSAL IN SUB-SEABED SEDIMENTS II

"The results of this radiological assessment show that the disposal of high level waste in sub-seabed sediments could be radiologically a very safe option."
Feasibility of Disposal of High-Level Radioactive Waste Into the Seabed, V. 2 Radiological Assessment, 1988, NEA

Input data are 3,000 GW(e) years (100,000MTHM burnup) Main dose is from molluscs consumption and external exposure from beach sediments. (similar for both)

"Individual doses are at all times less than 10E-6 mSv/y".
Disposal Into the Sub-seabed, Performance Assessment of Geological Isolation Systems for Radioactive Waste, 1988, CEC

REDUCE RADIATION DOSAGES I



NCRP 160 Ionizing Radiation Exposure of the Population of the United States

REDUCE RADIATION DOSAGES II

- **"This Report neither quantifies the associated health risks nor specifies the radiation protection actions that should be taken in light of these latest data because these subjects are beyond the scope of this Report." (NCRP 160 Executive Summary)**
- **Regulations limit the dose to 0.04, 0.10, 0.15, 0.25 and 1.0 mSv/y. These regulations entail large costs and fears while we do nothing to reduce radon and medical dosages that are much larger and could be lowered at much lower costs. In the limiting case, medical and background doses are over 100 times the permissible dose for drinking water .**

REGAIN TRUST-PERSPECTIVE I

- **Nuclear war effects overwhelm all other considerations. Non-proliferation efforts should dominate.**
- **Value complexity must be taken into account. Multi-attribute solution required. However, technical solution must be of high quality and believable.**
- **Chernobyl 20 years later-"At the community level, poverty and lack of socio-economic opportunity are the biggest danger for the Chernobyl affected areas." (UN Chernobyl Forum 2009)**
- **Effects of low-level radiation, if they exist, are so low as to be non-detectable.**

REGAIN TRUST-PERSPECTIVE II

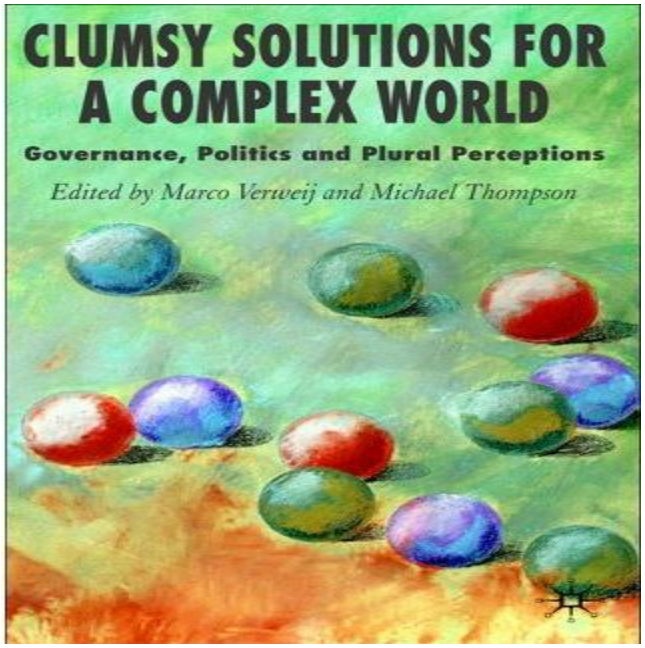
HARMONIZE LAWS AND REGULATIONS

- **a. Some Greater Than Class C more radioactive than some High level waste (determined by origin)**
- **b. Transuranic (TRU) waste buried before 1970 treated differently than TRU buried after 1970**
- **c. NRC and EPA regulations for the same material differ**

Congress has refused to intervene

- **a. Congress should require the harmonization. For example, mandate a committee of 1 representative from each of the affected agencies and an independent chairman. At the end of 6 months without an agreement, the Chairman would make the decision. Observe all procedural requirements.**

ANOTHER POSSIBLE WAY OF PROCEEDING?



Final Sentence of Fortum and Bernstein's Muddling Through, 1998, Counterpoint Publisher

"Let's Hope It Works"

- NO MATHEMATICALLY OPTIMAL SOLUTIONS ARE POSSIBLE. SO WE MUST STRIVE FOR SOCIETALLY ACCEPTABLE SOLUTIONS
- This book is one of many suggesting that formal optimization methods will not work for these complex problems that will continue over long time periods.
- Such an approach has been advocated for over 200 years.
  - **"Muddling through"**
  - **"garbage can solution"**

WILL THERE BE OPPOSITION? OF COURSE! IT WILL NOT BE EASY!

As Niccolo Machiavelli wrote about 500 years ago

"The reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order."

If not us, then whom? If not now, When?

THERE ARE NO GUARANTEES FOR SUCCESS BUT WITHOUT A NEW APPROACH, FAILURE IS ALMOST ASSURED.

BACKUP SLIDES

VALUE COMPLEXITY

Alexander L. George, Stanford University defined value complexity as the "presence of of multiple, competing values and interests."

Most strategic problems cannot be resolved through objective analysis, management, a simple phone call, outsourcing, cost-benefit tables or mathematical "solutionsThey tend to be resolved through subjectivity, human instinct, relationships, interdependence, leadership, personal intervention, and deliberative value judgments and tradeoffs.

B.S. Massachusetts Institute of Technology
Ph.D. Harvard University

National Academy of Engineering election citation
"For world leadership in the development of the basic information required for the safe disposal of high-level radioactive wastes."

Wendell D. Weart Award-Lifetime Achievement Award in Waste Management citation
"Professor Parker has profoundly shaped the present concepts of nuclear waste management and repository development during the course of his long and distinguished career."