HAZARDOUS WASTE

1. **WASTE: Its a growing crises!!**

   *We (US) generate an avg. of 4 lbs of "garbage" each day!

   *every 5 yrs = volume of Statue of Liberty!

   *4 Billion tons per yr.

2. **History**

   (a) Dilute and disperse

   (b) Concentrate and contain

   (c) Resourse and recovery

   (d) Siting of facilities; NIMBY

3. **Types of Waste:**

   (a) Solid Waste

   (b) Hazardous Chemical Waste

   (c) Radioactive Waste

4. Management

   (a) RCRA - 1976

   cradle - grave control of hazardous waste

   (b) What is hazardous waste?

   Materials/Wastes that are:

- highly toxic to people
- explode or ignite in air
- extremely corrosive
- unstable

(c) CERCLA - 1980

Superfund

liabity

RADIOACTIVE WASTE

1. Radioactivity

   (a) spontaneous decay of isotopes which

   produces:

   - alpha particles (+2 chg)
   - beta ptcls (-1 chg)
   - gamma rays (electromag radn, penetrating)

   (b) Statistical phenomena,

   impossible to predict time

   (c) Each radioisotope has characteristic rate of decay

   Measured in terms of Half-life:

   - time required for half of the atoms initially present to decay
   - varies from fractions of seconds to BY
   - is constant

Element	Half Life
U-238	4.5 BY
C-14	5,730 yrs
Ra-222	3.82 days

2. Nature of Radioactive Wastes:

   (a) those of concern have intermediate half lives (100's yrs)

(b) Some rad wastes are also toxic chemical poisons

e.g. Pt-239 (half-life 24,000 yrs.)

(c) Danger stems from biological concentration; produce a concentrated radiation source to the body:

Iodine-131 (hf 8 days) - thyroid gland
Fe-59 (45 days) - concentrates in Fe-rich hemoglobin in blood
Ce-137 (30 yrs) - nervous system
Sr-90 (29 yrs) - bones, teeth, milk

3. Radioactive wastes are by-products from:

- nuclear reactors that produce electricity
- weapons manufactured from plutonium

4. Rad Waste can be grouped into 2 categories:

(a) Low-level (rad)

(b) high-level (way rad)
e.g. (U tailings are v. haz.)

5. Low-level rad wasts:

- Defined as: Materials containing only small amounts of rad substances, or wastes that contain relatively low-radioactivity

- Over 90% rad wastes are low level
- Do not generate heat

- Do not usually require extraordinary disposal precautions

  dilute and disperse

- cf. Oak Ridge Ntl Lab, TN vs. Beatty, NV

6. High Level Rad Wastes

   - Those with a high level of radioactivity
   - Produced as fuel assemblages in nuclear reactors
   - Here waste-management problems involve removal, transport, storage, and eventual disposal of spend fuel assemblages.

7. Scope of disposal problem for Hi Level Rad Waste

   (a) Hi-level rad waste is extremely toxic.

   (b) Problem with chemically varied hi-lvl waste;

   how to isolate from biosphere with confidence that they will stay isolated for thousands of yrs or longer.

   (c) Hazardous rad mtls produced from nuclear reactors include:

   fission products such as:

krypton-85	half-life 10 yrs
Sr -90	29 yrs
Ce- 137	30 yrs

   (d) Usually $\geq$ 10 hf-lives are required before a material is no longer considered a health hazard

   i.e. need 100's of yrs for above to decay to safe level

8. 1985, EPA specified that hi lvl waste be isolated in such a way as to cause fewer than 1000 deaths in 10,000 yrs

   (expected fatality rate associated with unmined U ore)

9. w/o disposal program, 40,000 metric tons of spent fuel elements will be in storage at US reactor sites by yr 2000!

   8000 metric tons of solidified hi level waste will be stored at US DOE repositories at Hanford, WA; Savannah River, GA; and Idaho Falls, ID

   *serious problems with leaks.

   *this is only a temporary solution.
   permanent disposal sites and methods are necessary.

10. **Suggestions: Space, Ice, Plate Tectonics**

    (a) **Exotic schemes** proposed for disposal of high level rad waste

        - rocketting them into the sun!
        - putting encapsulated wastes into thick ice sheets, Antarctica!
        - Subduction zones

    (b) **Seabed Disposal**

    (c) **Bedrock Caverns for liquid waste**

    (d) **Disposal in geologic environment**;
        bedrock disposal of solid hi-lvl wastes

i. agreement that geologic environemnt provides the most certain safe containment of hi level rad waste.
stable bedrock offers the best soln
(over polar ice caps, or deep sea seds)

ii. Geologic Disposal Program Objectives

iii. General design of a bedrock disposal site or repository involves the **multiple barrier** concept.

iv. Bedrock types considered:

A. granite

B. basalts - Hanford is a test case.

C. tuffs - pyroclastic materials depos during large scale explosive volcanism.

D. shale - clay rich seds,

E. Salt! - WIPP, NM

v. Solidification of liquid hi level waste prior to disposal within:

certain minerals (zircon)
glasses (borosilicate)

*suggested that they first be vitrified, then sealed in canisters, and then place canisters in some kind of bedrock cavern, etc.

(e) Nuclear Waste Policy Act of 1982

1986 - Hanford, WA (basalt)

- Yucca Mtn, NV (tuff)

- Deaf Smith Co. TX (salt)

1987 - Yucca Mtn, NV

11. Yucca Mountain, NM

- Several natural barriers are present:

  arid climate = restricts downward movement of water

  strong rock = welded tuff with sorption prop

  thick vadose zone = deep water tbl.

- addn engineering barriers would be constructed to present waste from escaping

12. Long term safety?

how credible are long term geologic predictions?

input = output

will climate stay the same?

potential for earthquakes?

13. No hi lvl Rad Waste Disposal yet