Technical Basis of the 10 CFR Part 61 Classification System

Matthew W. Kozak
INTERA, Inc.
Denver
mkozak@intera.com

Scope

- The 10 CFR Part 61.55 Waste Classification System
- The IMPACTS Methodology
- IMPACTS Methodological Approaches
- Concepts and Precedents
- Subsequent Developments

Waste Classification System

- Identifies concentrations of radionuclides generally acceptable for near-surface disposal
- Derived from the IMPACTS Analysis Methodology
  - Detailed evaluation of waste streams of concern
  - Evaluation of disposal in trenches
  - Reflects waste management experience in the 1970s
- Based on the idea that LLW would decay to innocuous levels within a few hundred years

The Impacts Methodology
(A Short History)

- Database and Impacts Methodology for 10 CFR 61 Oztunali *et al*. (1981) NUREG/CR-1759
- Update of Part 61 Impacts Methodology: Oztunali and Roles (1986) NUREG/CR-4370
- De Minimis Impacts Oztunali and Roles, 1984
- IMPACTS-BRC 1.0 Forstom and Goode, 1986
- IMPACTS-BRC 2.0 O'Neal and Lee, 1990
- IMPACTS-BRC 2.1 Rao *et al*., 1992

Methodological Approaches

- Intrusion Scenarios (concentration limiting)
  - Intruder-Construction
  - Intruder-Discovery
  - Intruder-Agriculture
  - Intruder-Well
- Offsite Scenarios (activity limiting)
  - Boundary well
  - 500 m well
  - Release to stream
  - Bathtubbing

Intruder Modeling Approach

- Assumed facility design
  - Trench
  - Specified trench dimensions (180 m x 30 m x 8 m deep)
  - Assumed packing efficiency (50%)
  - 1 m thick cap
- Assumed construction behavior
  - Dimensions of house foundation (3 m deep)
  - Time onsite, breathing rate, etc
  - All obviously speculative
  - After that, a straightforward dose calculation
- Same basic approach used today

Groundwater Modeling Approach

$$H_2 = \sum_i \sum_n \frac{f_o \, C_{ni} \, f_i \, V_L \, M_o \, t_c \, 10^{(1-IA)} \, f_{2n} \, PDCF - 7}{Q} \qquad (5)$$

Leach Fraction

Fraction of year that leachate contacts waste

Actually Fractional Saturation

Accessibility Index

Retention Factor

Not Retardation

Protection of Intruders (DEIS)

- Controlling the disposal of specific waste-streams
- Waste form and packaging
- Use of engineered or natural barriers to intrusion
- Institutional controls
  - Limited to assumed 100 year control
  - Assumption used for the purposes of limiting wastes
  - No intention for release at that time
  - Presumption that earlier doses are worse than later

Use of Modeling Results for Waste Classification

- Limitation of intrusion doses to 500 mrem/y
  - Dose higher than 25 mrem/y based on lower likelihood
  - Considered an accidental event
- Waste concentrations to limit dose = Class A
- Requires improved waste form = Class B
- Use of waste form and depth to limit the likelihood of intrusion = Class C
- Waste that does not meet these criteria = Greater Than Class C (GTCC)

Classification by Radionuclide Type

- Long Lived: Only differentiates Classes A and C
  - Concentrations in Class A x 10 = Class C
  - Likelihood and consequence of this
  - Implications for GTCC
- Short Lived: Differentiates all classes
  - Class A x factors of 40 – 4000 (or unlimited)= Class B
  - Class B x 10 = Class C; except Sr-90 x 50
- Mixed Short and Long Lived: Use of sum-of-fractions rule

Concepts and Precedents

- Intrusion analysis identifies waste concentrations appropriate for near surface disposal
  - Generically derived values for generic application
  - Site specific and design specific values as needed
- Values for long lived alpha activity have seen wide propagation
  - From OECD/NEA -> Many national programs
  - Class A 10 nCi/g = 366 Bq/g ~ 400 Bq/g
  - Generally found reasonable, with some issues
- Normal Residential Intrusion Zone

Subsequent Developments (1)

- State of Illinois (1990-1992) tried using the IMPACTS code for licensing the Martinsville site
  - Generic approaches intended for rulemaking
  - Site and design specific application
- Evolutionary change in design and safety concepts
  - Move to greater use of vaults and high integrity systems
  - Move from “dilute and disperse” to “concentrate and contain”
  - Move to greater disposal depths and thicker covers
  - Understanding that low dose constraints require long-term performance assessments even for low activities of long-lived species

Subsequent Developments (2)

- Proposed disposal of large amounts of depleted uranium in the Central Interstate Compact site (1992)
  - Uranium not in the waste classification system
  - Part 61: If waste does not contain any listed nuclides, it is Class A.
  - But it was analyzed
- Analysis including long times suggested that it should not be Class A waste

Table 4.5 Waste Classification Limits Assumed for the Part 61 Case

Isotope	Class Limits ($\mu Ci/cm^3$) Class A	Class B	Class C
H-3	4.0E+1*	**	**
C-14#	8.0E-1	8.0E-1	8.0E+0
Fe-55	7.0E+2	**	**
Ni-59#	2.2E+0	2.2E+0	2.2E+1
Co-60	7.0E+2	**	**
Ni-63#	3.5E+0	7.0E+1	7.0E+2
Nb-94#	2.0E-3	2.0E-3	7.0E+2
Sr-90	4.0E-2	1.5E+2	7.0E+3
Tc-99	3.0E-1	3.0E-1	3.0E+0
I-129	8.0E-3	8.0E-3	8.0E-2
Cs-135	8.4E+1	8.4E+1	8.4E+2
Cs-137	1.0E+1	4.4E+1	4.6E+3
U-235	4.0E-2	4.0E-2	4.0E-1
U-238	5.0E-2	5.0E-2	5.0E-1
TRU	1.0E+1##	1.0E+1##	1.0E+2##
Pu-241	3.5E+2##	3.5E+2##	3.5E+3##

*The notation 4.0E+1 means 4.0×10^1.
**No limit is set for these isotopes and classes.
#For activated metals, the limits for these isotopes are raised by a factor of 10.
##The limits for these isotopes are given in units of nCi/gm rather than $\mu Ci/cm^3$

Excerpt from FEIS NUREG-0945

Summary

- IMPACTS methodology for offsite releases is generic and not up to modern standards
  - Various nonphysical parameters
  - Does not affect the waste classification system
- The IMPACTS methodology for intruders is consistent with modern approaches
- Changes in designs and safety concepts mean that modern designs are not consistent with the original development of the waste classification system
- But it is flexible enough to accommodate these changes
- The basic idea that concentrations appropriate for the near surface are limited by intrusion remains important