

# DEVELOPMENT OF A COMPREHENSIVE RADIOACTIVE WASTE CLASSIFICATION SYSTEM

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## ABSTRACT

Several previous studies have been conducted with the intent of developing a rational system for classification of radioactive wastes [1,2,3]. Although none of the proposed systems has gained general acceptance, certain waste classes, specifically high-level waste and low level waste suitable for shallow land burial have been essentially defined by regulation. Wastes which remain undefined include: those intermediate level wastes which require more restrictive controls than that provided by shallow land burial but not the high degree of isolation needed for high level wastes, and wastes below regulatory concern (BRC) which entail so low a radiological risk that they can be managed according to their nonradiological properties. This study has developed a framework within which the complete spectrum of radioactive wastes can be defined.

## BACKGROUND

The two fundamental concerns related to the management of radioactive wastes are: (1) high hazard due to its radiotoxicity, and (2) because of the long half-life of component radionuclides, its hazard can persist for time periods considered to be of unprecedented duration for purposes of institutional control. These concerns are embodied in the Nuclear Waste Policy Act (NWPA) [4] which defines high level waste as being "highly radioactive" waste that "requires permanent isolation."

## CLASSIFICATION SYSTEM

In this study, an approach has been developed that reflects both of these concerns in the framework of a radioactive waste classification system. In this approach, the class of any radioactive waste stream is dependent on its degree of radioactivity and its persistence as shown in Fig. 1. To be consistent with existing definitions, four waste classes are defined. In increasing order of concern due to radioactivity and/or duration, these are:

- BRC Waste - these wastes have such low content of radioactive materials that they can be considered essentially nonradioactive and managed according to their nonradiological characteristics. Synonyms for this waste class include de minimis waste and below-threshold waste.
- Low Level Waste (LLW) - Maximum concentrations for wastes considered to be in this class are those prescribed in 10 CFR 61 [5] which provide maximum limits for wastes that can be disposed of by shallow land burial methods.
- Intermediate Level Waste (ILW) - this category defines a class of waste whose content exceeds Class C (10 CFR 61) levels, yet does not pose a sufficient hazard to justify management as a high-level waste (i.e., permanent isolation by deep geologic disposal). Some examples of waste that could be included in this class are: transuranic waste, greater than Class C low level waste, and certain naturally occurring and accelerator produced radioactive material (NARM).
- High Level Waste (HLW) - HLW poses the most serious management problem and requires the most

restrictive disposal methods. HLW is defined in NWPA as wastes derived from the reprocessing of nuclear fuel and/or as "highly radioactive wastes" that "require permanent isolation."

The attribute of "radioactivity" can be evaluated by any of several measures. These include: specific activity (Ci/g, or Ci/m<sup>3</sup>), hazard indices (e.g., dilution volume or other toxicity measures), external radiation (R/hr, measures based on pathway dose conversion factors (PDCF's) and heat output (W/g or W/m<sup>3</sup>). Boundary values to differentiate waste classes can be determined on the basis of existing regulatory guidance (primarily 10 CFR 61), literature review (covering previous classification recommendations), and risk assessment applying calculational models.

For example, as a first approximation, Table I presents proposed boundary values that can be used to evaluate persistence or radioactivity:

The boundaries between waste classes can be established utilizing these boundary values for "radioactivity" and persistence. For example, using radioactivity concentration (Ci/m<sup>3</sup>) equivalent to Pu-239 as a measure the following waste classes and definitions evolve:

- BRC waste is any waste stream which, after 10 years of decay, has an equivalent concentration of less than 0.001 Ci/m<sup>3</sup>
- LLW is a non-BRC waste which, after 100 years of decay, has an equivalent concentration less than 0.1 Ci/m<sup>3</sup>
- ILW is any waste greater than LLW which, after 1000 years of decay, has an equivalent concentration less than 10 Ci/m<sup>3</sup>
- HLW is any waste which, after 1000 years of decay, has an equivalent concentration greater than 10 Ci/m<sup>3</sup>

## RESULTS AND CONCLUSION

Several waste streams have been evaluated according to this methodology using a variety of different measures of "radioactivity." Fig. 2 provides results for the reference case in which equivalent concentration is used as the measure. Concentration versus time plots for several waste streams permit their classification based on the most restrictive region of the classification format that is traversed. An

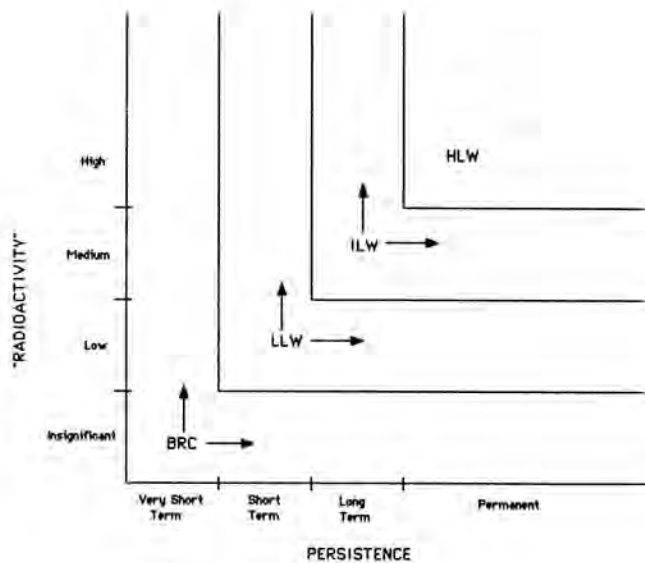


Fig. 1. Waste Classification Format.

unexpected result of this study is that the choice of measure selected to define the attribute of radioactivity does not appear to have a major impact on the resultant classification for those waste streams evaluated. Table II provides a summary of these findings for several measures used.

Results indicate that for the waste streams evaluated, the system provides a reasonable classification category (i.e., there are no major surprises in which waste generally thought to belong in one category would be converted to another category). Major advantages of this approach are that it can clearly and graphically distinguish waste classes, it considers both the level of radioactivity (or hazard index) and its duration consistent with the provisions of NWPA, and it provides a comprehensive and complete framework for all classes of waste.

#### REFERENCES

- 1.J. J. COHEN and W. C. KING, "Determination of a Radioactive Waste Classification System," UCRL-52535 (March 1978).

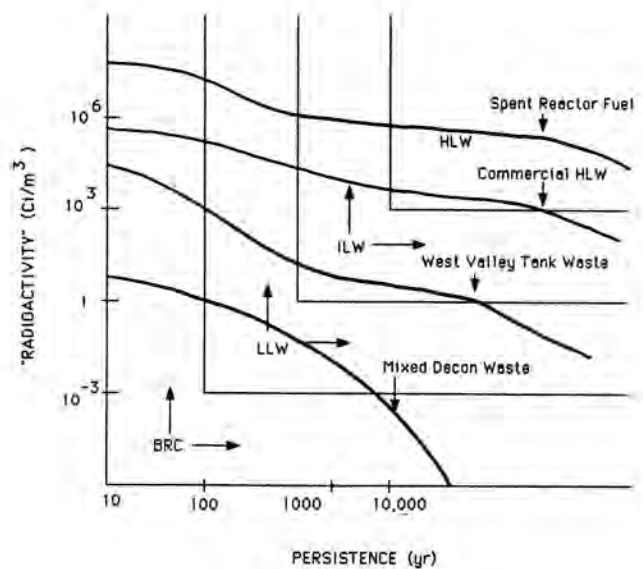


Fig. 2. Waste Stream Classification.

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- 3.F. GERA, "The Classification of Radioactive Wastes," Health Physics, Vol. 27 (1974).
- 4.U.S. Congress, "Nuclear Waste Policy Act of 1982," PL 97-245 (1982).
- 5.U.S. Nuclear Regulatory Commission, "Licensing Requirements for Land Disposal of Radioactive Waste," 10 CFR 61 (1981).