# NRC CONSIDERATIONS FOR AUTHORIZATION OF LOW-ACTIVITY RADIOACTIVE WASTE DISPOSAL UNDER 10 CFR 20.302 AT REACTOR AND NON-REACTOR SITES

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## ABSTRACT

Pursuant to Section 20.302 of 10 CFR Part 20, any licensee or applicant for a license may apply to the NRC for approval of proposed procedures to dispose of licensed or any other radioactive material in a manner not otherwise authorized in the regulations. Guidance to academic, medical and industrial licensees seeking authorization pursuant to this regulation has been published as NUREG-1101, "Onsite Disposal of Radioactive Waste." This NUREG describes disposal methods and techniques likely to be acceptable to the NRC staff in its evaluation of an application. Guidance is also provided to supplement Section 20.302 to assure that appropriate information is included in the application so that an adequate evaluation can be performed of all data and factors relevant to the proposed burial. In addition, NUREG-1101 identifies categories of radionuclides defined for subsurface disposal. Limiting conditions are described for each category of radionuclides with respect to total radioactivity buried, waste packaging, burial frequency, and other conditions acceptable for subsurface disposal. Guidance for reviews of applications from reactor utilities for disposal of reactor-generated waste, pursuant to §20.302 is being prepared for incorporation into the Standard Review Plan (NUREG-0800).

## INTRODUCTION

The use of nuclear material in nearly all licensed processes generates radioactive waste material. To assure protection of public health and safety and the environment, the regulations require that no licensee shall dispose of licensed nuclear materials except as authorized in the regulations. The disposal of licensed nuclear material by means not specifically described in the regulations is governed by Section 20.302 of 10 CFR Part 20, NRC's "Standards for Protection Against Radiation." This regulation states:

> Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

Section 20.302 of the regulations is applicable to all licensees of the NRC including medical, academic, industrial, and reactor licensees. Various methods of disposal may be authorized under §20.302, such as burial in soil, incineration, or storage for decay. In most cases, licensee-proposed disposals pursuant to §20.302 have been for burial of low-activity waste on the licensee's property. In a few instances, incineration of radioactive waste at the licensee's facility has been authorized under §20.302 and §20.305. Several reactor as well as non-reactor licensees have requested authorization for disposal of contaminated waste by various means other than incineration or onsite burial.

### Description of Waste

Table I summarizes the types of waste proposed for disposal by NRC licensees. Concentrations in these wastes are typically of the order of .01 μCi/cm$^3$ for non-reactor licensees and 10 pCi/cm$^3$ or less for reactor licensees.

Table I

Materials Proposed for Disposal

| Reactor Licensees | Institutional/Industrial Licensees |
|---|---|
| Soil, sand | Paper, plastic, glass |
| Wood | Animal bedding, carcasses |
| Sludge | Sand, soil, rock |
| Waste oil | Liquid scintillation media |
| Roofing materials | Tissue culture |
| Feedwater heaters | Ash residue |
| Secondary side resins | Plant matter |

Institutional waste refers to radioactive waste generated at universities, colleges, medical schools, hospitals, testing, and research laboratories. Typical institutional waste streams may include

absorbed or solidified organic and aqueous liquids, paper, plastic glass, and biological waste such as animal carcasses, plant and animal tissue, animal bedding, excreta and culture media.

The volume of waste, in cubic feet, ranges over four orders of magnitude. The largest volume contributors to institutional wastes are institutions conducting biological research with radioactive materials. Typical volumes vary from 50 $ft^3$ to 5000 $ft^3$. The most common radionuclides associated with bio-research wastes are H-3, C-14, P-32, S-35, Ca-45, Cr-51, and I-125, of which H-3 is dominant. A more complete list of radionuclides associated with institutional wastes, their half-lives, and principal radioemissions is given in Table II. Most of these radionuclides have half-lives less than 90 days. Radionuclide concentrations in institutional waste generally do not exceed 0.2 $\mu Ci/cm^3$ (approximately 6 $mCi/ft^3$) in liquid scintillation media and in contaminated trash.

Table II

Principal Radionuclides in Institutional Wastes

| Radionuclide | Half-life | Emission |
|---|---|---|
| H-3 | 12.3y | β |
| C-14 | 5730y | β |
| P-32 | 14.3d | β |
| S-35 | 88d | β |
| Ca-45 | 165d | β |
| Cr-51 | 27.8d | β, γ |
| Fe-59 | 45d | β, γ |
| Co-60 | 5.26y | β, γ |
| Ga-67 | 78.7h | β, γ |
| Se-75 | 120d | β, γ |
| Rb-86 | 18.7d | β, γ |
| Sr-90 | 28.1y | β |
| Mo-99 | 66.7h | β, γ |
| Tc-99m | 6.05h | β, γ |
| In-111 | 2.82d | β, γ |
| I-125 | 60.0d | β, γ |
| I-131 | 8.05d | β, γ |
| Xe-133 | 5.27d | β, γ |
| Cs-137 | 30.0y | β, γ |
| Yb-169 | 32d | β, γ |
| Tl-201 | 73h | β, γ |

Generators of industrial waste include producers and distributors of radioactive isotopes, manufacturers of materials and devices containing radioactive isotopes, and users of materials, instruments, and devices containing these isotopes. Certain industrial waste streams generate high volumes but relatively low levels of radioactivity, with radionuclide concentration levels generally below a few nanocuries per cubic centimeter. Such wastes are generated by industrial laboratories and radiopharmaceutical companies and have characteristics similar to institutional wastes.

The predominant radionuclides found in very low level wastes generated at reactor sites and proposed for §20.302 disposals are isotopes of cesium, cobalt, and manganese. Typical volumes vary from 1000 $ft^3$ to 100,000 $ft^3$. In almost all cases, concentrations are in the range 0.1 to 100 pCi/gm.

Regulatory Guidance

In accordance with the regulation, licensees are to provide information which includes a description of the contaminated material, the disposal conditions, the physical parameters of the site, and the nature of the environment. Sufficient information should be submitted to enable the NRC to assess the potential hazard to public health and safety and to determine whether the proposed action will have a significant effect on the human environment.

The NRC has published guidance primarily for academic, medical and industrial licensees seeking authorization to dispose of small curie quantities of radioactive materials by onsite subsurface disposal (1). The guidance document provides a description of information required from the applicant and disposal methods and techniques acceptable to the NRC staff in its evaluation of the application. It also identifies categories of radionuclides defined for subsurface disposal and limiting conditions with respect to total radioactivity, waste packaging, burial frequency and other conditions. Authorization for disposal would likely be granted if the proposed quantity of radioactivity fits any of the categories of radionuclides defined in Ref. 1 and if all requirements and associated disposal conditions described in the guidance are met.

A more detailed application and an analysis by the licensee would be warranted if the proposed disposal activity does not fit the guidance in Ref. 1. The licensee would then be expected to provide an analysis and evaluation of relevant information which will demonstrate that the proposed disposal can be safety carried out and there will be no undue impact on public health and safety or the environment.

For non-reactor licensees, the NRC has published additional guidance which describes the criteria and technical methodology which may be used to assess the radiological impact of proposed disposals by subsurface burial (2). The computer codes and the methodology is further described in Ref. 3 and is adaptable for other potential modes of disposal. Guidance for reactor licensees for the disposal of reactor-generated wastes, pursuant to §20.302, is being prepared for incorporation into the Standard Review Plan (4).

Radiological Impact Analysis

The radiological analysis generally consists of modeling the radionuclide release to the environment via site-specific critical exposure pathways and the projection of the potential radiological dose to an onsite individual and to an offsite member of the public.

For burial of radioactive waste in soil, the critical exposure pathways usually include one or more of the following:

- External exposure to direct radiation from buried waste.
- Internal exposure from ingestion of agriculture products grown in radioactive soil.
- Internal exposure from inhalation of resuspended radionuclides.
- Internal exposure due to drinking water from a downgradient well contaminated by migrating radionuclides.
- Internal exposure due to drinking water from an onsite well after cessation of disposal activities.

Most of the physical parameter values needed to model the system should be derivable from the information provided by the licensee. Where information is not readily available or uncertainty exists, conservative but realistic estimates of parameter values should then be made based on the limited information and on the likely range of parameter values applicable to the specific case. In general, the model should consider the characteristics of the source term; the characteristics of the source medium; the transport mechanisms; the critical pathways; and the exposure scenarios. Each of these considerations may be quantified, to the extent possible, in terms of site-specific data provided by the licensee.

For non-reactor licensees, site-specific parameter values necessary to permit modeling the critical pathways and radiation exposure scenarios are obtained from information in accordance with guidance provided in Ref. 1. For example, the depth of burial, the spatial array of the waste pits, the cover thickness, and the overall size of the burial site will influence the dose to an inadvertent intruder from direct external radiation. The size of the burial site and the subsurface location of the waste will also determine, to a great extent, the internal dose from ingesting crops and animal products derived from the site.

The rate at which the radionuclides enter the environment are also estimated from information provided by the licensee. The frequency of burials, the physical form of the waste, and the type of container, if the waste is packaged, are some of the parameters considered when estimating a release rate to the surrounding medium. The radioactivity released from the waste will also be limited by the amount of precipitation that infiltrates into the ground and comes into contact with the waste. Information on precipitation and the quantity of water percolating down to the waste may be obtained from the water balance information provided by the licensee. Radionuclide migration rates through the soil and in the groundwater strongly depend on the chemistry of the waste and the hydrological and geochemical characteristics of the site and are estimated from site-specific parameters.

## Dose Criteria

In general, the committed effective dose equivalent for the critical exposure pathways will determine whether the licensee-proposed disposal will or will not be authorized. Experience has shown that for disposal under prescribed conditions along with imposed restrictions as to the proximity of water wells on the licensee's property, conservatively estimated doses to the individual from any of the critical pathways generally do not exceed a few millirem for the radionuclides of concern.

In keeping with the principal of ALARA, that is, that radiation exposure and release of radionuclide materials should be maintained as low as reasonably achievable, dose levels conservatively estimated to be no greater than a few millirem per year to offsite individuals are considered to be acceptable levels without being unduly restrictive on the licensee. It is generally agreed that these levels present a very low risk to public health and safety since they are a small fraction of the dose due to background levels of radiation. These levels do not necessarily apply to cleanup criteria following accidental releases of radioactive material, nor do they necessarily apply to residual contamination such as may exist at inactive uranium mining and milling facilities. These situations are evaluated on a case-by-case basis where the potential risk from radiation exposure is weighed against the cost and the practicality of remedial action.

Recommendations to the licensee by the NRC are generally case specific. For example, quantities of longer-lived radionuclides proposed for burials may have to be limited in order to keep projected doses within acceptable limits. Another recommendation might be to not authorize burial of one of several radioisotopes proposed by the licensee for disposal because of excessive curie content of that one isotope. A frequent recommendation has been to authorize burials with the condition that no drinking water wells exist within a prescribed distance from the burial area. This presumes that the licensee controls the site surrounding the burial area and is capable of providing appropriate surveillance. Except perhaps for reactor sites, the NRC does not anticipate that disposals will be authorized which will require a period of long-term care. It is expected, however, that control of the site will be maintained for several years after final disposals.

## References


1. S. M. Neuder, "Onsite Disposal of Radioactive Waste: Guidance for Disposal by Subsurface Burial," U.S. Nuclear Regulatory Commission, NUREG-1101, Volume 1 (1986).

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3. W. E. Kennedy, Jr., R. A. Peloquin, B. A. Napier, and S. M. Neuder, "Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXI1 Computer Program," U.S. Nuclear Regulatory Commission, NUREG/CR-3620, Suppl. 2 (1987).

4. NUREG-0800, "Standard Review Plan," U.S. Nuclear Regulatory Commission, Washington, DC 20555.