6.0 LOW LEVEL WASTE POLICY

6.1 LOW-LEVEL RADIOACTIVE WASTE POLICY ACT

The Low-Level Radioactive Waste Policy Act (LLRWPA) was passed in 1980 (Public Law 96-573) in response to recommendations from state supported organizations. Under this Act each state is responsible for management and providing the capacity for the disposal of Low Level Radioactive Waste (LLRW) generated within its borders. Disposal of LLRW is regulated by Agreement States or by the NRC (in non-Agreement States). The Act does not address low-level defense waste, which is the responsibility of the Department of Energy (DOE) under the Atomic Energy Act. Therefore, LLRW that is defense or Federal R&D related is excepted.

The Act encourages States to form regional compacts to collectively meet their obligations instead of proliferating the number of facilities for disposal of LLRW. The basis for this position is that LLRW can be most efficiently and safely managed on a regional basis. The Act also permitted compacts ratified by Congress to exclude waste generated outside the borders of States in that compact.

In addition, DOE is responsible for certain higher-activity civilian wastes licensed by the NRC. These are:

- Greater-than-Class-C waste
- Spent fuel
- High-level waste

The LLRWPA designated January 1, 1986, as the date after which compacts could restrict the use of their disposal facilities by excluding waste generated outside the compact region. However, by 1983 it had become clear that no new disposal facilities would be operational by the 1986 milestone. As a result, in January 1986, the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) was enacted. The LLRWPAA extended the January 1, 1986 deadline by 7 years to January 1, 1993. By that date, new LLW disposal facilities were expected to be operational, and the rights of the LLW generators to dispose of their LLW at the three sites then operating would end.

The Amendments Act also established:

- Categories of low-level waste for which a state is responsible
- Quotas for individual nuclear reactors
- Volume ceilings for operating disposal sites
- Federal responsibility for greater than Class C wastes from commercial generators

It required the NRC to establish procedures for:

- Licensing disposal technologies other than shallow land burial
- Reviewing petitions to allow certain wastes to be classified below regulatory concern
- Timely licensing of new sites

Under the Amendments Act, DOE is to provide technical assistance and information to the States and regional compacts on:

- Alternative low-level radioactive waste disposal technology designs
- Volume reduction options
- Transportation practices for LLRW shipment
- Health and safety considerations for LLRW management

6.2 REGULATIONS (10 CFR 61)

In late 1982, the Nuclear Regulatory Commission set forth the criteria and requirements for commercial near-surface LLRW disposal facilities in 10 CFR 61. All of the facilities currently being developed by States use near-surface disposal and are covered by requirements of 10 CFR 61. Near-surface disposal facility is defined as a land disposal facility in which radioactive wastes are disposed of in or within the upper 30 meters of the earth's surface. Near-surface disposal does not include disposal facilities which are partially or fully above-grade, with no protective earthen cover (referred to as aboveground disposal facilities).

10 CFR 61 sets the radiological standards for all LLRW sites. It limits releases of radioactive material to the general environment to an annual dose not exceeding or equivalent to:

- 25 mrem to the whole body
- 75 mrem to the thyroid
- 25 mrem to any other organ

Doses to workers during operation must meet the requirements in 10 CFR 20, including As-Low-As-Reasonably-Achievable (ALARA).

10 CFR 61 also requires:

- LLRW disposed at the site is protected from inadvertent intrusion after closure
- The site shall have long-term stability after closure without ongoing maintenance
- A waste classification system shall be maintained.

Several other regulations, in addition to Part 61, should be addressed.

- 10 CFR Part 20, specifically Subpart K and Subpart L Section 2108, in addition to the general radiation protection requirements of the other Subparts
- 10 CFR Part 35, Section 92, Decay in Storage (applicable only to medical use byproduct material)
- 10 CFR Part 50, Sections 50.34a, 50.36a, 50.54(ee), and Appendix A General Design Criteria 60 & 64.

6.2.1 Characteristics of LLW for Disposal Required by 10 CFR 61

The characteristics of the radioactive waste should be identified, documented, and verified in order to facilitate handling of the waste at the disposal facility and to protect the health and safety of the personnel at the disposal site. The following requirements of 10 CFR Part 61.56(a) must be met:

- Waste must not be packaged for disposal in cardboard or fiberboard boxes.
- Liquid waste must be solidified or packaged in absorbent material such that twice the volume of the liquid could be absorbed.
- Solid waste containing liquid shall contain as little free-standing and non-corrosive liquid as is reasonably achievable; however, the amount of liquid shall not exceed 1% of the volume.
- Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.
- Waste must not contain or be capable of generating quantities of toxic gases, vapors, or fumes harmful to persons handling, transporting, or disposing of the waste.
- Waste must not be pyrophoric. Pyrophoric materials contained in waste shall be treated, prepared, and packaged to be non-flammable.
- Waste in a gaseous form must be packaged at a pressure that does not exceed 1.5 atmospheres at 20° C. Total activity must not exceed 100 Ci per container.
- Waste containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the extent practicable the potential hazard from the non-radiological materials.

Additional requirements are sometimes applied by the facility operator or the licensing state authority.

In addition to those already mentioned, Class B and Class C radioactive waste must be stabilized. This is intended to ensure that the overall stability of the disposal facility is not adversely affected. Stability could also help to limit exposure to an inadvertent intruder since it provides a recognizable and nondispersible form.

Structural stability can be provided by:

- The waste form itself
- Processing the waste to a stable form
- Placing the waste in a disposable container or structure that provides stability after disposal

Structural stability may be established by the submittal of a topical report that is reviewed by the regulatory authority. The objective of the typical report is to demonstrate that the regulatory requirements for stability will be fulfilled based on the tested performance of the approved solid waste form or high integrity container. A lab scale sample of the stabilized waste is typically tested to verify the stability criteria are met. Generally, upon receipt of the waste at the site, a visual inspection is performed to ensure that structural stability has been achieved.

6.2.2 Alternate Disposal Under 10 CFR 20.2002

Title 10, CFR Part 20.2002 allows licensees to petition the NRC to utilize an alternative, safe, risk-informed disposal method for certain radioactive wastes. At LWRs, these petitions typically involve very low level Class A wastes that are also EPA regulated materials. Approved requests for alternate disposal for LWRs are issued by the NRC in the form of a letter to the licensee.

In practice, 10 CFR 20.2002 is most often used for disposal of low-activity radioactive waste in hazardous or local solid waste landfills that are permitted under the Resource Conservation and Recovery Act (RCRA), but it can be used for any type of disposal not already defined in the regulations, such as disposal on a licensee's site or on offsite private property. The term "low-activity waste" (LAW) does not have a statutory or regulatory definition, but generally means wastes that contain some residual radioactivity, including naturally occurring radionuclides, which can be safely disposed of in hazardous or municipal solid waste landfills. Such waste poses a small fraction of the hazard of waste at the Class A limits in 10 CFR Part 61. NRC may authorize its licensees to dispose of waste under 10 CFR 20.2002, but other low-activity waste not regulated by NRC is also disposed of in landfills and hazardous waste sites.

6.3 NRC POLICY ON LLRW ON-SITE STORAGE

Consistent with the LLRWPAA, which establishes a national policy for the permanent disposal of LLRW, the NRC encourages new disposal facility development. The NRC storage policy has recognized that storage will be needed in a interim basis but that it should not become de facto disposal. The NRC considers the long-term on-site storage of LLW to be a last resort measure. NRC's preference is that LLW be permanently disposed of as soon after it is generated as possible.

6.4 LLW DISPOSAL FACILITIES

Seven commercial low-level radioactive waste facilities have been sited and operated in the United States. Three remain in operation. Six sites relied on shallow land trench disposal.

6.4.1 Operational LLRW Facilities

The LLRW facilities that remain in operation (as of 2011) are located in:

- Barnwell, South Carolina
- Richland (Hanford), Washington
- Clive, Utah (limited waste)

Barnwell was opened in 1971, and accepted all three classes of LLRW from generators throughtout the country. In 1979, Barnwell reduced the annual volume of waste that it would accept and established allocations for nuclear power plants throughout the U.S. On July 1, 2008 the Barnwell facility was closed to all generators except those located in the Atlantic Compact (SC, NJ, CT). Barnwell *is operated* by EnergySolutions (formerly ChemNuclear.) Attachment 6-1 is a copy of the current Barnwell Site Disposal License.

The burial site at Richland was opened in 1965 by U.S. Ecology. It was closed for a period in 1979. The Richland site accepts all three classes of low-level waste from generators located in the Northwest (AK, HI, WA, OR, ID, MT, WY, UT) and Rocky Mountain (NV, CO, NM) Compacts.

Attachment 6-2 is a copy of the U.S. Ecology Site License.

Envirocare *(*now EnergySolutions*)* opened in 1988 as a NORM disposal site in Clive, Utah. In 1991, the license was amended to include large volume, bulk low-level radioactivity waste materials with limited activity. Operations for the limited disposal activities began in 1992. The Clive facility does not accept wastes greater than Class A, but does accept wastes generated throughout the country. At Attachment 6-3 is a copy of the Clive Site License.

The 1979 actions were prompted primarily by a series of transportation and packaging incidents. At that time the host States made it clear that they could not continue accepting all the low-level radwaste throughout the United States.

The four closed LLRW sites in the US are located in:

- Beatty, Nevada
- Maxey Flats, Kentucky
- West Valley, New York
- Sheffield, Illinois.

A facility owned and operated by Waste Control Specialists (WCS), located in Andrews, TX, was licensed by the state of Texas in late 2009 to accept all three classes of low-level waste generated in the Texas Compact (TX, VT). WCS has indicated it has a long-term goal of expanding this facility to accept wastes from generators located throughout the country.

A listing of recent disposal fees at Barnwell is provided for reference in Attachment 6-4.

6.5 WASTE CLASSIFICATION

There are many different categories of radioactive waste. Some of the most commonly known radioactive wastes include: high-level waste (HLW); LLW; transuranic waste (TRU); and uranium mill tailings waste. This radwaste training manual focuses on LLRW generated as a result of operations at commercial light water reactor (LWR).

6.5.1 Classes of Low-Level Radwaste

In its rulemaking for land disposal of low-level radioactive waste (10 CFR Part 61), NRC established four classes of low-level waste designated as:

- CLASS A
- CLASS B
- CLASS C
- Greater than Class C (GTCC)

The waste classification system is based on radionuclide concentrations within the wastes and is designed to provide protection to inadvertent intruders and to limit the potential effects from contamination via groundwater migration. As radionuclide concentration limits increase, the waste class designation progresses from A to B to C to GTCC. Through this progression, more rigorous controls are placed on each succeeding class of waste. Class B and C wastes must be stabilized; whereas, Class A waste may be segregated without stabilization unless it is disposed with stabilized Class B and C wastes. GTCC wastes are generally not acceptable for near-surface disposal and are most likely to be disposed of in a geologic repository as defined in 10 CFR Part 60.

The U.S. Department of Energy (DOE) is charged with the responsibility for providing disposal of GTCC wastes.

Class A, B, and C wastes must comply with minimum waste form (packaging) and characteristics requirements. These minimum requirements are intended to protect workers during waste handling. Therefore, all Class A liquid wastes may require solidification or absorption to meet the free liquid requirement.

6.5.2 Classifying Low-Level Radwaste

The system of radioactive waste classification is established at 10 CFR Part 61.55. It is generally based on radionuclide half-lives and concentrations.

Class A waste packages contain radionuclides that pose the smallest risk to public health or are present only in low concentrations. They have minimal requirements for packaging and disposal. Class A wastes do not have to be stabilized, if the packages are not placed with Class B or Class C wastes during disposal.

Class B waste packages contain only radionuclides at concentrations sufficient to ensure that they could not pose a health risk to the public or the environment after appropriate radionuclide decay is considered. Never the less, Class B wastes must be stabilized so the package lasts for 300 years to ensure ample time for decay before any movement into the environment would be a problem.

Class C wastes contain concentrations of radionuclides that, without proper controls, pose a significant potential health risk to members of the public or the environment. Class C waste must be stable for 300 years and provide protection from exposure to inadvertent intruders for at least 500 years.

The heart of the classification system consists of two radionuclide tables. Table 1 of 10 CFR 61.55 (reproduced as Table 6.5-1) includes a list of some principally long-lived radionuclides, while Table 2 of 10 CFR 61.55 (reproduced as Table 6.5-2) includes a list of some shorter-lived radionuclides. Waste classification can be derived directly from the appropriate table if the waste stream contains only one radionuclide. For waste streams that contain more than one radionuclide, waste classification must be established through the sum of the fractions rule discussed in 10 CFR 61.56. LLRW streams containing only radionuclides that are not listed in either Table 1 or 2 of 10 CFR 61.55 are classified as Class A waste.

Waste streams with radionuclide concentrations that exceed those in Tables 1 or 2 of the regulation are not generally acceptable for disposal at a 10 CFR Part 61 licensed facility.

6.5.2.1 LLRW Classification Procedure

The first step in a classification procedure could be to determine the average concentration of gamma-ray emitters in the bulk waste and to apply scaling factors to establish concentration estimates of the complete list of required radionuclides. Tritium concentration in the waste may be calculated by estimating the volume of water in the waste, multiplying by the tritium concentration in the reactor coolant for the plant, and dividing by the volume of waste.

The radionuclides that are of interest are divided into long- and short-lived radionuclides. They are listed in Tables 1 and 2 of 10 CFR 61.55, respectively.

The radionuclides listed under 10 CFR 61.55 Table 1 are:

- C-14
- Ni-59
- Nb-94
- Tc-99
- I-129
- Pu-241
- Cm-242

This list also includes any alpha emitting transuranics with a half-life greater than 5 years.

A long half-life radionuclide in sufficient concentrations can present a potential hazard because it can persist long after the loss of effectiveness of such precautions as:

- Institutional control (i.e., 100 year perpetual care)
- Improved waste form (i.e., 300 year stability)
- Deeper disposal (i.e., 5-meter or intruder barrier)

The short-lived radionuclides listed in 10 CFR 61.55, Table 2 are:

- H-3
- Co-60
- Ni-63
- Sr-90
- Cs-137

It also includes all radionuclides with a half-life less than 5 years.

Typically, about 95 percent of the LLRW disposed of in near-surface disposal facilities decays to a negligible quantity within 300 years. The short-lived radionuclides of concern in the disposal environment can be controlled through the use of institutional controls, improved waste form and deeper disposal.

If the LLRW package does not contain any of the radionuclides listed above, by default it is classified as Class A.

6.5.2.2 Sum-of Fractions Rule

The sum-of-fractions rule must be applied in determining the classification of a mixture of radionuclides; i.e., the value listed for each radionuclide in the tables is for a single nuclide. The sum-of-fractions is determined by dividing each radionuclide concentration in the waste by the appropriate limit and adding the resulting values. The appropriate limits must be taken from the same column of the same table. This resulting sum must be less than 1.0, if the waste class is to be determined by that column.

6.5.2.3 Determining Radionuclide Concentrations in LLRW

Licensee programs for determining radio-nuclide concentrations, and consequently waste classes, are established and maintained through the four methods discussed below.

6.5.2.3.1 Materials Accountability

Radionuclide concentrations can be found by calculating the difference between the quantity of radioactive material entering and exiting a given process. This method is useful for licensees that only possess a limited number of radionuclide species in known concentrations and activities.

6.5.2.3.2 Classification by Source

Radionuclide concentrations can be determined through knowledge and control of the waste source. This method is useful for characterizing specific wastes that are generated by relatively constant processes within separate and controlled areas. It is very similar to the materials accountability method.

6.5.2.3.3 Gross Radioactivity Measurements

Radioactivity levels are measured, correlated, and calibrated with radionuclide concentrations in wastes prepared for shipment. This method requires periodic, detailed sample analysis involving measurement of specific radionuclides.

6.5.2.3.4 Measurement of Specific Radionuclides

Concentrations are established through direct measurement of certain radionuclides in the waste. This method can be used as the initial basis and periodic check for using scaling factors to determine concentrations of other radionuclides. Generally, more complex programs are necessary for licensees that generate Class B and Class C wastes. Figure 6.5-1 shows an example of an in-line sampler used during dewatering. A discussion on the use of scaling factors is found in Attachment 6-5.

6.6 WASTE CLASSIFICATION, CHARACTERIZATION, AND SOLIDIFICATION REQUIREMENTS

10 CFR Parts 20.2001 through 20.2006 lists the requirements for disposal of licensed material. In most cases, residual wastes from effluent control systems containing detectable radioactivity must be transferred to a licensed disposal facility. 10 CFR Part 20.2006 lists the requirements that must be met for transfer of low-level radioactive waste intended for disposal at a land disposal facility.

Implementation of radionuclide concentration and waste classification compliance programs can range from the simple to the complex.

10 CFR Part 20 Appendix F requires the licensee to conduct a quality control program to ensure compliance with 10 CFR Part 61.55 and 10 CFR Part 61.56.

10 CFR Part Appendix F also specifies that a manifest tracking system be implemented to supplement requirements pertinent to transfer and record keeping for waste sent to a licensed land disposal facility. It identifies the information that must be included in the shipment manifest.
In classifying radioactive wastes for disposal, waste streams should be physically sampled to confirm the types of radioactive wastes present in the stream. The classification assigned to the waste depends on the concentration of the radionuclides listed in the Part 61 tables. The guidance in Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems Structures, and Components in Light Water-Cooled Nuclear Power Plants," should be met.

The characteristics of the radioactive waste also should be identified, documented, and verified in order to facilitate handling of the waste at the disposal facility and to protect the health and safety of the personnel at the disposal site.

A current issue of concern is the blending of low-level radioactive waste. With the closure in 2008 of the Barnwell, SC disposal facility to wastes from generators outside the Atlantic Compact, only generators in the Atlantic, Northwest and Rocky Mountain Compacts have access to disposal facilities for Class B and Class C Wastes. In the 1995 BTP on Concentration Averaging (Attachment 5-10), the NRC discouraged the blending of different waste classes for the sole purpose of lowering the overall waste classification (For example, mixing spent reactor water clean-up resin [typically a Class B or Class C waste] with spent condensate resins [typically a low Class A waste] at a BWR so that the higher activity concentration waste could be disposed of as Class A). However, since most reactors no longer have access to facilities that accept Class B or Class C waste, they must indefinitely store the waste on-site. In 2010, the NRC revisited the issue of blending waste in SECY-10-0043 (Attachment 5-11). NRC guidance now is that waste blending to reduce materials that otherwise would be Class B or Class C wastes to allow for them to be disposed of as Class A waste is acceptable PROVIDED THAT the Class B or Class C waste is blended with Class A waste, and not just clean (i.e., non-radioactive) materials. As noted in Section 5.9, the State of Utah Radiation Control Board does not accept this new NRC position, and does not consider blended waste acceptable for disposal at the Clive, UT disposal facility.

Two waste classification exercises can be found at the end of this chapter (Attachments 6-9 and 6-10). The second exercise is data taken directly from one shipment of spent bead resin from an operating BWR. As you can see, due to the complicated nature of the calculations, and the time involved in performing these calculations, commercial LWRs utilize vendor supplied software for performing this work. Currently the most common software package for this is RADMAN, from WMG, Inc. While the software received topical report approval from the NRC years ago, the NRC only approved the base calculations for waste classification. The inspector needs to independently verify the licensee's work, especially their quality assurance program for data entry and software validation.

6.6.1 Structural Stability

Class B and Class C radioactive waste (and Class A waste when placed with Class B and C) must have characteristics that ensure stability of the waste and, thus, the overall stability of the disposal facility. Stability requirements for Class B and C wastes are intended to limit exposure to an inadvertent intruder since it provides a recognizable and non-dispersible form.

Structural stability requirements are established to ensure that the waste does not degrade and:

- Promote slumping, collapse or other failure of the cap or cover
- Impart a substantial increase in surface area of the waste form that could lead to an increased leach rate
- Ensure that the waste remains in a recognizable non-dispersible state

The purpose of imposing these stability conditions is to:

- Prevent water infiltration and leaching
- Limit exposure to an inadvertent intruder

The structural stability of the waste form can be provided by:

- Natural characteristics of the waste
- Processing the waste to a stable form (solidification or encapsulation)
- Emplacing the waste in a container or structure that provides stability

Generally, upon receipt of the waste at the site, a visual inspection is performed to ensure that structural stability has been achieved.

To ensure that Class B and Class C wastes maintain long-term stability (300 years), it should comply with the conditions listed below.

The waste should:

- Be in a solid form or in a container, or structure that provides stability after disposal
- Not contain free standing or corrosive liquids (<1% by volume when disposed of in stable containers or <0.5% by volume for wastes processed to a stable form)

The waste or container should be resistant to:

- Degradation caused by radiation effects
- Biodegradation

The waste or container should also remain stable if exposed to moisture or water after disposal.

As-generated, waste should be compatible with the solidification medium or container.

6.6.2 Uniform Waste Manifest

Under 10 CFR 20, Appendix G (Attachment 6-6), a uniform waste manifest system has been established, using NRC Forms 540, 540A, 541, 541A, 542 and 542A. A complete Form 541 is presented with waste classification Exercise 2 found in Attachment 6-10 at the end of this chaper.

6.7 SPENT FUEL STORAGE, DRY CASK STORAGE, MULTI- PURPOSE CANISTERS, AND INDEPENDENT SPENT FUEL STORAGE INSTALLATIONS

In 1977 under the Carter Administration, the U.S. defined the nation's policy regarding the permanent disposal of commercial nuclear power plant fuel by rejecting the option of reprocessing spent fuel. The Nuclear Waste Policy Act of 1982 (NWPA) and the Nuclear Waste Policy Amendments Act (NWPAA) of 1987 designated the Department of Energy (DOE) as the Federal agency responsible for disposal of high level waste (HLW) which includes nuclear power plant spent fuel; the Environmental Protection Agency (EPA) as responsible for developing appropriate environmental standards for high-level waste; and the NRC as responsible for licensing activities

related to the disposal and long-term storage of spent nuclear fuel. The NWPA called for DOE to begin accepting spent fuel from utilities in 1998; however, progress on a permanent waste disposal site has been stalled.

Over the last two decades, nuclear power plants have begun to move used fuel from their spent fuel pools into dry cask storage or independent spent fuel storage installations (ISFSIs) onsite.

The NRC's Spent Fuel Project Office is responsible for reviewing existing and projected applications for storage and transportation casks for certification. These casks may be sponsored by private vendors or individual nuclear utilities.

6.7.1 Dry Cask Storage License Types

Utilities may operate an ISFSI under two different types of licenses: general and site-specific. The procedure for acquiring a site-specific license is similar to that for reactors in that the technical merit of the design is assessed by the NRC, and utilities may customize the cask design in the initial stages in order to meet their specific needs. An opportunity for a public hearing is provided prior to issuance of the site-specific license, and license amendments are processed in a manner much like that for reactors.

A key provision for operation of an ISFSI under a general license is that licensees must use a cask design that has previously been approved by the NRC and must have a current Part 50 license. Once a cask design is approved, the NRC issues a Certificate of Compliance to the cask designer/vendor and incorporates the cask, by reference, through rulemaking. The list of approved cask designs is found in the NRC's regulations under Subpart K of 10 CFR Part 72.

With the general license, the utility is not required to formally apply for the license. Since the cask design has already been approved by the NRC, site-specific public hearings are not required prior to cask use. The public has the opportunity for involvement through the rulemaking process. However, utilities operating an ISFSI under a general license must ensure that they maintain and operate the ISFSI in accordance with the conditions and requirements of the certificate. These requirements may not be optimal for some sites.

6.8 RADWASTE TRANSPORTATION OVERVIEW

All of the waste classification and packaging activities described previously occur at generator facilities or LLRW processor facilities. These activities are regulated by NRC. However, transportation of radioactive materials and waste is subject to regulatory oversight of many federal agencies in addition to the NRC. These include:

- Department of Transportation (DOT)
- U.S. Environmental Protection Agency (EPA)
- U.S. Postal Service

This course only addresses the regulatory responsibilities of DOT and NRC. Course participants are referred to NRC's Transportation Course for complete details on transportation.

DOT is responsible for overseeing the safe transportation of all hazardous materials, including those that are radioactive. Oversight extends to all modes of transport in intrastate, interstate, or foreign commerce by all means except postal shipments. In fulfilling this responsibility, the DOT has promulgated detailed regulations that govern packaging, shipping, carriage, storage, and handling of radioactive materials (RAM) by all transport modes. These regulations are contained in Title 49 of the Code of Federal Regulations.

6.8.1 Overview: Regulation of Radioactive Materials Transportation

The NRC regulates its licensees for receipt, possession, use and transfer of radioactive materials. NRC also enforces DOT regulations that apply to its licensees as shippers. NRC and DOT developed and operate under a memorandum of understanding (MOU) because of these overlapping responsibilities.

There are three major objectives for regulating radioactive materials during routine and accident conditions in transport. They include:

- Protection of persons and property from radiation by package contents
- Providing containment of radioactive materials
- Preventing nuclear criticality

An additional objective for regulating the transport of radioactive materials is safeguarding against sabotage or theft of special nuclear materials.

NRC regulations that contain requirements pertaining to transportation of radioactive materials or wastes include 10 CFR Parts 20, 61, 71, and 73. DOT regulations pertaining to transportation of hazardous materials, including radioactive materials, are contained in 49 CFR Parts 171 through 177.

6.8.2 Labels and Packages

6.8.2.1 Labels

Licensees that generate LLW requiring shipment for disposal must label each package of waste to identify whether it is Class A, B, or C waste. Such labeling and classification must be conducted in accordance with the waste classification requirements established at 10 CFR Part 61.55. In addition to the waste classification label, transportation regulations require that licensees affix radioactive material labels to each package unless the radioactive materials meet the requirements of 49 CFR Part 173.421. The type of label to be applied is dependent upon the highest ranking of three factors:

- Radiation level at the package surface
- Transport Index
- Fissile characteristics of the package

The transport index is a dimensionless number that designates the degree of control to be exercised by the carrier during transportation.

Some vehicles transporting waste shipments must be placarded in addition to the labels that are affixed on each waste package. Such shipments include vehicles transporting packages with the "RADIOACTIVE-YELLOW III" label, and "highway route controlled quantity" shipments of low specific activity (LSA) waste. Course participants are referred to NRC's transportation course for further information on placard requirements.

6.8.2.2 Transportation Packages

Packages used to transport radioactive material to a disposal facility are selected on the basis of the potential hazard associated with the given radioactive material. Package quantity or concentration limits are established by regulation and are based upon the radiotoxicity of the radioactive material and its relative potential hazard in transportation.

There are *four* basic package types:

- "General" packages
- *Industrial Packages*
- Type A packages
- Type B packages

Attachment 6-7 contains the significance determination process (SDP) for issues and findings identified during inspections of reactor radwaste and transportation programs (Appendix D, Manual Chapter 0609).

Attachment 6-8 includes samples of available vendor-supplied high integrity containers used to process, transport and dispose of low-level radioactive waste (typically spent resins and sludge).

6.9 HIGH-LEVEL RADIOACTIVE WASTE

High-level radioactive waste (HLW) includes (1) irradiated (spent) reactor fuel; (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, and the concentrated wastes from subsequent extraction cycles, in a facility for reprocessing irradiated reactor fuel; and (3) solids into which such liquid wastes have been converted. HLW is primarily in the form of spent fuel from commercial nuclear power plants; it also includes some reprocessed HLW from defense activities and a small quantity of reprocessed commercial HLW.

Policies governing the permanent disposal of HLW are defined by the Nuclear Waste Policy Act of 1982 (NWPA) and the Nuclear Waste Policy Amendments Act (NWPAA) of 1987. Under these acts, the U.S. Department of Energy (DOE) is responsible for disposing of HLW, the U.S. Environmental Protection Agency (EPA) is responsible for developing appropriate environmental standards for HLW, and the Nuclear Regulatory Commission (NRC) has the licensing authority for the disposal and long-term storage of HLW.

To provide the long-term permanent isolation required, the NWPA specifies that HLW will be placed in one or more deep-underground geologic repositories to be built and operated by DOE. To this end, DOE is developing a waste management system consisting, in part, of a geologic repository in which HLW can be permanently isolated deep beneath the surface of the earth.

10 CFR Part 61.55, Table 1

Radionuclide	**Class A Limit**	**Class C Limit**
C-14	0.8 Ci/m3	8 Ci/m3
C-14 in activated metal	8.0 Ci/m3	80 Ci/m3
Ni-59 in activated metal	22 Ci/m3	220 Ci/m3
Nb-94 in activated metal	0.02 Ci/m3	0.2 Ci/m3
Tc-99	0.3 Ci/m3	3 Ci/m3
I-129	0.008 Ci/m3	0.08 Ci/m3
Alpha emitting transuranics with half-life > 5 years	10 nCi/g	100 nCi/g
Pu-241	350 nCi/g	3,500 nCi/g
Cm-242	2000 nCi/g	20,000 nCi/g

Table 6.5-1: 10 CFR Part 61.55, Table 1 Values

10 CFR Part 61.55, Table 2

Radionuclide	**Class A Limit**	**Class B Limit**	**Class C Limit**
Total of all nuclides with less than 5 year half-life	700 Ci/m^3	*	*
H-3	40 Ci/m^3	*	*
Co-60	700 Ci/m^3	*	*
Ni-63	3.5 Ci/m^3	70 Ci/m^3	700 Ci/m^3
Ni-63 in activated metal	35 Ci/m^3	700 Ci/m^3	7000 Ci/m^3
Sr-90	0.04 Ci/m^3	150 Ci/m^3	7000 Ci/m^3
Cs-137	1 Ci/m^3	44 Ci/m^3	4600 Ci/m^3

* There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other nuclides in Table 2 determine the waste to the Class C independent of these nuclides.

Table 6.5-2: 10 CFR Part 61.55, Table 2 Values

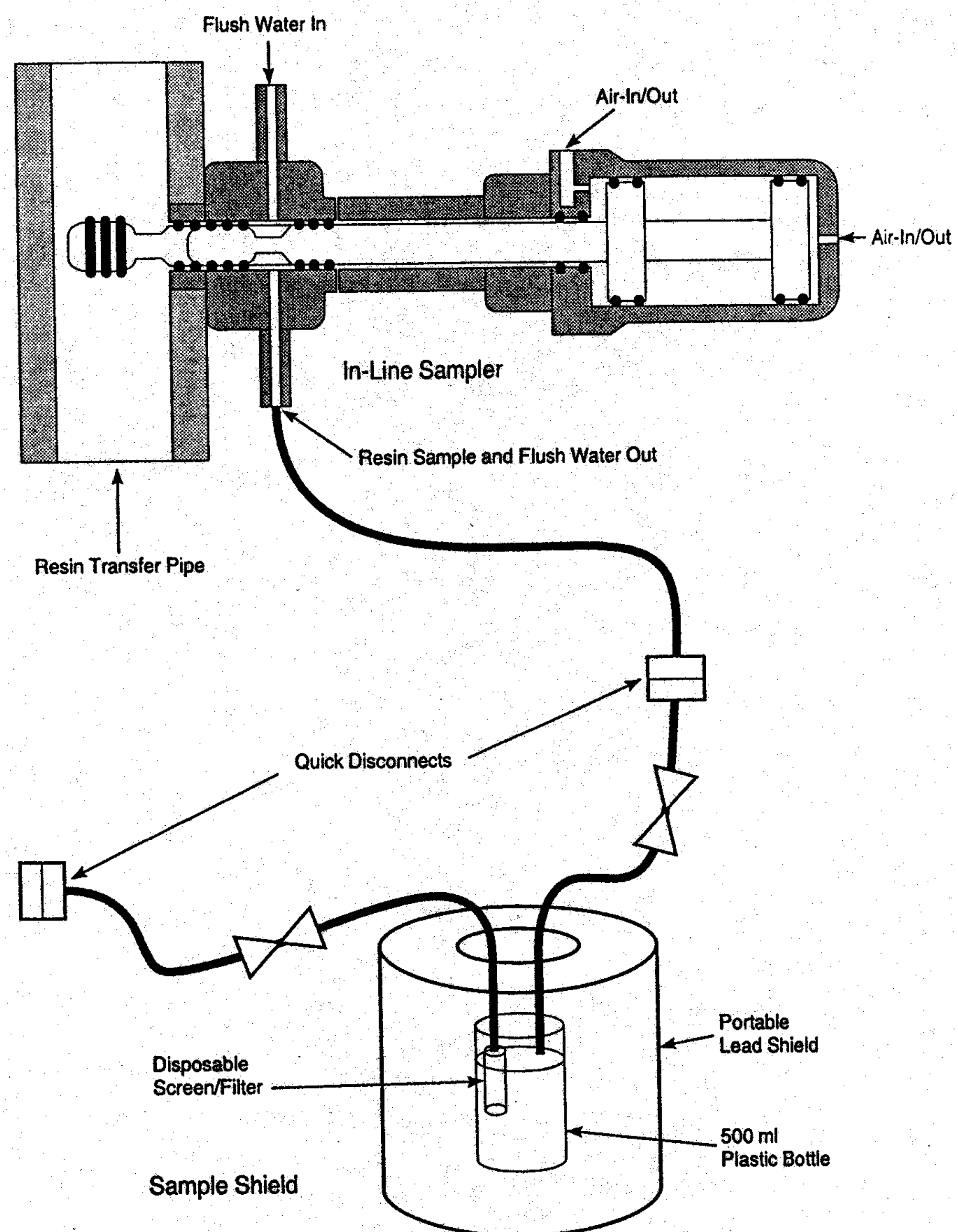

Figure 6.5-1 Example of an In-Line Sampling System

Chapter 6

Attachments and Exercises

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