IMPACTS TO NUCLEAR UTILITIES OF 10CFR61

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ABSTRACT

The disposal of low-level waste from nuclear utilities is regulated by 10CFR61. The basic requirements are that the radionuclide content be quantified and identified and that the waste itself meet certain chemical and physical criteria. Waste packaging protocols are also delineated. In order to meet these requirements, on-site instrumental measurements and radiochemical analysis are required for each waste stream. Complex calculations, often performed by vendor computer programs, are employed to incorporate assay information into shipping manifests acceptable to low-level waste sites. Aside from the continuing increase in low-level waste site charges, 10CFR61 also added to the cost of utility waste disposal.

The methodology most applicable to power plants involves scaling difficult to measure nuclides (i.e. nuclides which do not emit easily measured gamma rays) to those which are both easy to measure and possess similar chemical and physical properties. This methodology has been in use for several years in determining the transuranic content of waste based on the 144Ce concentration. The NRC has accepted this technique and has, in fact, suggested its extension to the problem nuclides listed in 10CFR61.

These scaling factors are being based on the existing limited data base, engineering judgement, and preliminary data from on-going work. Important differences exist between Boiling Water Reactors (BWRs) and Pressurized Water Reactors (PWRs) which preclude the use of common scaling factors. In fact, important differences between substantially similar plant types may prevent generically categorized scaling factors from being used. Uncertainties in this regard will force every nuclear plant to develop a plant specific program for compliance with 10CFR61.

Data are now being gathered and methodologies proposed for compliance with 10CFR61. This paper will discuss the effort, radiation exposure, time and expense expected to be expended in satisfying the requirements of this new rule.

Utilities do not maintain laboratory procedures, instrumentation and calibration for a number of radionuclides listed in 10CFR61. In particular, this is true of 14C, 3H, 55Fe, 59,63Ni, 90Sr, 99Tc, 129I and the transuranics. As a result, it is necessary to engage outside contract radiochemical laboratories to perform these analyses. Since they are only required once a year, under normal conditions, it is cost beneficial to have the analysis done externally. Costs of compliance with 10CFR61 accumulate from sampling, shipping, analysis, radiation measurements, radiochemical analysis, computer programming, volume increases, waste treatment to meet 10CFR61 disposal standards, packaging and shipping to burial sites.

Sampling

There are several "costs" associated with the sampling required under 10CFR61. Because many plants lack specific sampling points designed for that purpose, obtaining representative samples of the process streams is very difficult to achieve. Typical problems include the inability to recirculate (mix) the sample, sample heterogeneity, and high activity content. For these reasons, careful attention to sample flow rates and sample line volume must be addressed. This creates an additional manpower and thus, cost burden for the utilities, especially when a series of samples are required to accurately characterize the waste stream. ALARA considerations provide an additional demand on the utility. For example, during a sampling operation of primary resin at a PWR, the radwaste operator received 700mRem in under three minutes to obtain the "representative" sample required. Sampling points and procedures should be established such that they are indicative of the waste source.

Shipping

Shipment of the samples from the generating facility to the outside radioanalytical laboratory is a relatively simple procedure and is routinely performed by the utilities. Demineralizer resin, coolant, evaporator concentrate, filter cartridges, smears, filter sludge and miscellaneous solid samples are shipped for external analysis. Only limited quantities are required for analysis and shipments meet Type A quantities of radionuclides in normal form matrices.

Shipments are made in Type 17H containers meeting DOT Specification 7A. Because of analytical laboratory limitations and potential for contamination, sample activity is generally limited to < 1 uCi of transuranics and a few millicuries of beta-gamma emitters. Specific license limitations may place special limits on individual radionuclides. This requirement has not posed any problems in supplying samples of suitable activity for analysis.

Costs of shipping may be broken down into packaging labor, container costs, and transport. The usual shipment is by truck and may take up to seven days, depending on the location of the generator. The containers can be returned, but often this is not cost effective. Costs to the waste generator are listed in Table I.

Radiochemical Analysis Costs

Laboratory assay of the radioactive constituents in low level waste samples must meet the minimum sensitivity requirements of the NRC Branch Position on Waste Classification (Table II). It is common practice to analyze waste samples to better than those minimum sensitivities to obtain positive results (as opposed to limits) for establishing correlations and for comparison to other data bases. The dilute waste streams are analyzed to even higher sensitivities. In order to meet these sensitivities, a laboratory needs to be experienced in sample preparation in selecting appropriate aliquots. It must have adequate chemistry procedures giving high decontamination factors from mixed waste isotopes. For example, 10 E-6 uCi of 99Tc is detectable in a high level resin aliquot of over 100 uCi total. Laboratory procedures, instrumentation and methods must be adequate to measure the required isotope, check for interfering contaminants, etc. Specialized low background instruments and repetitive counts, with long counting times, help achieve the targets at commercial laboratories.

Direct Ge(Li) measurements of gamma emitters are the least expensive. However, it may be necessary to obtain greater sensitivity, or discrimination through chemical separation and purification. Radiochemistry provides several orders of magnitude increased sensitivity. For example, for a slight extra cost, the radiochemistry method for 144Ce can provide an accurate 144Ce result for use in correlating with the transuranics, when no detectable activity was obtained by Ge(Li) analysis.

Typical costs for a complete panel of analyses are difficult to state. Prices which are charged can vary widely. A reputable, well equipped laboratory, with an expert staff of professional radiochemists and physicists, backed by trained technicians can be expected to produce accurate data. Quality Assurance programs are a must, but they cannot be expected to substitute for costs for expertise, know-how and top performance in the wide range of waste analysis requirements. The price per sample will depend upon the usual factors involved. The more custom items a utility requires, the higher the cost; the greater the quantity to be done at once, the lower the unit cost. For this reason, no useful prices can be stated in a presentation such as this, other than to state that the range is from $2,000 to $3,000 per sample. Plants are allocating approximately $10,000 to $20,000 per unit per year in analytical costs for justification/reverification of radionuclide correlations.

Chemical/Physical Analysis

Section 61.56 of 10CFR61 deals with waste characteristics. It prohibits the burial of toxic, explosive, reactive, ignitable, pathogenic, or complexing and chelating agents, without prior treatment. It is expected that as decontamination and decommissioning activities increase, the analysis of these wastes will become a significant cost factor. Since these wastes are radioactively contaminated, it is necessary for analysts to institute special handling and precautions, in addition to those procedures required for carcinogenic, toxic, or pathogenic materials. The presence of millicuries of radionuclides may make sample dilution necessary which can limit the sensitivity of stable metal and organic analysis. Commerical sources licensed to receive radioactive samples, with a capability for performing the special analysis are limited. Table III lists typical costs for analyzing waste samples according to federal hazardous waste characteristics. Usually only one or two of these analyses will be necessary.

Computer Programming and Manifest Requirements

10CFR61 imposes additional calculational requirements for completion of the shipping manifests. These include: low specific activity (LSA) determination using the APG sum-of-the fraction method; Type A/Type B waste determination; waste classification i.e. Class A, B, or C, requiring the licensee to sum the fractions obtained from 10CFR61 Table I and II values; and others. Due to the complexity of the calculations, errors are inevitable and thus, duplicate calculations or computerization is required. In addition, the amount of documentation and papers required to complete the manifest and shipping package is voluminous. A recent shipment of dry active waste, specifically 10 boxes, required 63 pieces of paperwork. Finally, depending on the waste shipped, the entire paperwork package and associated calculations can require three to eight hours to complete.

The use of computer programs designed for 10CFR61 specifically, have assisted the utilities in both speed in preparation and accuracy in calculations. The programs can: maintain waste container information, prepare shipping information, including an estimate of shipping costs, assist in operational planning and generate summary and trending reports, among others. For these reasons, it is suggested that utilities evaluate the cost vs. benefits associated with computer programs designed to assist the user in the manifest requirements of 10CFR61.

Packaging and Shipping

The packaging and shipping costs to burial sites have remained basically unchanged due to 10CFR61. However, certain preliminary determinations must be made as to the effectiveness of the package, which involves the verification of construction tests and markings as detailed in 49CFR and 10CFR Part 71. Prior to packaging the material, the packaging (cask, liner, box, drum, etc.) must be inspected. The scope of inspection will vary with the type of packaging and the amount of material being shipped. Waste packaging operations must include controls or inspections to assure no free standing liquid and that the volume of the package is minimized consistent with the volume reduction policies in effect at the utility. A determination must be made that package integrity will not be compromised under the conditions normally incident to transportation. These additional inspections demand extra manpower commitments previously not required.

Disposal charges, as well as radiation, weight, Curie, and drum surcharges have remained unchanged. An example disposal cost summary for a recent BWR resin shipment is shown in Table IV. Other charges that have been added include those for wastes containing greater than 0.1% chelating agents.

These wastes must be segregated from Class B and C wastes by at least ten feet in all directions in the burial trench. As a result, the burial cost for these wastes will increase accordingly.

Conclusion

As delineated in the above topics, a considerable commitment in both manpower and funds are necessary for individual utility compliance with 10CFR61. Current generic projects, such as the EPRI project, RP 1557-6, "Radionuclide Correlations in Low-level Radwaste" are providing some level of relief by quantifying the levels of Part 61 nuclides in power plant wastes and establishing a basis for correlations between the easily-measured indicator nuclides and those which are more difficult to measure. Nevertheless, utilities must continue to sample their waste streams on an annual basis to reverify plant specific data. This will continue to impose a burden on all utilities who produce and ship waste.

TABLE I

Approximate Cost to Generator of Sample Shipment

Packaging Labor	
Waste	$ 60.00
HP	25.00
Internal Shielding, Bracing and Absorbent	50.00
Container Costs	25.00
Transport	
Air	200.00 - 300.00
Truck	50.00 - 75.00

TABLE II

Typical Sensitivities for Coolant Samples

NUCLIDE	Reported Units METHOD	LLD,No Interference uCi/mL*	MDA,With 60Co Interference uCi/mL*
3H	Distil - LSC	2.-7	2.-7
14C	Distil - LSC	5.-8	5.-8
51Cr	Ge(Li) anal.	5.-7	2.-5
54Mn	Ge(Li) anal.	7.-8	5.-6
55Fe	R'chem purif.- x-ray spec.	1.-7	1.-7
59Fe	Aliquoting - Ge(Li)	1.-7	1.-5
57Co	Ge(Li) anal.	3.-7	9.-6
58Co	Ge(Li) anal.	7.-8	5.-6
60Co	Ge(Li) anal.	1.-7	defined(5.-3)
59Ni	R'chem - x-ray spec	1.-7	1.-7

TABLE II (Continued)

NUCLIDE	Reported Units METHOD	LLD,No Interference uCi/mL*	MDA,With 60Co Interference uCi/mL*
63Ni	R'chem - x-ray spec	1.-8	1.-8
65Zn	Ge(Li) anal.	2.-7	1.-5
89Sr	R'chem - beta ct.	2.-8	2.-8
90Sr	R'chem - beta ct.	1.-8	1.-8
95Zr	Ge(Li) anal.	1.-7	8.-6
94Nb	Ge(Li) anal.	7.-8	4.-6
95Nb	Ge(Li) anal.	7.-8	4.-6
99Tc	R'chem-Ge(Li) yield, β ct.	2.-8	2.-8
106Ru	Ge(Li) anal.	6.-7	3.-5
110mAg	Ge(Li) anal.	6.-8	3.-6
124Sb	Ge(Li) anal.	7.-8	3.-6
125Sb	Ge(Li) anal.	2.-7	7.-6
129I	R'chem-chem yield-LSC	3.-8	3.-8
131I	Ge(Li) anal.	6.-8	2.-6
134Cs	Ge(Li) anal.	8.-8	5.-6
137Cs	Ge(Li) anal.	7.-8	4.-6
141Ce	Ge(Li) anal.	8.-8	2.-6
144Ce	Ge(Li) anal.	3.-7	9.-6
144Ce	R'chem-Ge(Li), β ct.	4.-8	4.-8
235 or 238U	R'chem-alpha spec	1.-9	1.-9
237Np	R'chem-tracer- α spec	1.-9	1.-9
238Pu	R'chem-tracer- α spec	1.-9,	1.-9
239,240Pu	R'chem-tracer- α spec	1.-9	1.-9
241Pu	R'chem-LSC	2.-8	2.-8
241Am	R'chem-tracer- α spec	1.-9	1.-9
242Cm	R'chem-tracer- α spec	1.-9	1.-9
244Cm	R'chem-tracer- α spec	1.-9	1.-9
243Am(239Np)	Ge(Li) anal.	3.-7	9.-6

* Format example 2.-7 = 2 x 10 E-7. The sensitivities can be varied.
LLD - Lower Limit of Detection for the addition of only the nuclide of interest.
MDA - Minimum Detectable Activity for the nuclide of interest with interferences present.

TABLE III

Typical Costs for Analyzing Waste Samples
For Federal Hazardous Waste Characteristics*

Characteristic	Analysis Method	Typical Cost per analysis, $
Ignitability	Flashpoint	30-45
Corrosivity	pH	5-15
Reactivity	Water/acid/base reaction	5-15
Sample Preparation for EP toxicity	24-h extraction at pH 5.5 in acetate buffer (nonliquid samples only)	100-250
Toxicity (8 heavy metals)	Inductively coupled plasma (ICP) using EP toxicity procedure (analysis only).	45-120
	Gas-chromatograph scan for chlorinated organics and pesticides	100-200
Toxicity (organics)	Gas-chromatograph/mass-spectrometer analysis (GC-MS)	650-1,500

* All costs exclude charges for any special handling requirements necessary because of the radiological aspect of the waste samples.

TABLE IV

Example Disposal Cost Summary

Container I.D. Number = LTD-484-1234
Destination = XYZ Waste Management Facility
Container Volume = 195. Cu. Ft.
Container Weight = 7536. Lbs.
Surface Dose Rate = 40.0 R/hr.
Total Activity = 583. Curies

1. Disposal Charge	2574.00
2. Radiation Surcharge	7800.00
3. Weight Surcharge	500.00
4. Curie Surcharge	6000.00
5. Drum Surcharge	0.00
Total Estimated Cost	16874.00