NEW YORK STATE INTERIM WASTE MANAGEMENT COST EVALUATION

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ABSTRACT

The purpose of this study is to investigate and quantify the comparative costs associated with including or excluding Class A utility wastes at a centralized interim waste management facility in New York State. The objective of the study is to assess the unit costs and total statewide costs associated with two distinct scenarios: 1) the case where non-utility Class A LLRW is received, incinerated and stored at the centralized interim facility, and utility Class A wastes are held without incineration at respective nuclear power plant interim onsite facilities without incineration; and 2) the alternative case where both utility and non-utility Class A wastes are accepted, incinerated and stored at the centralized facility.

Unit costs to waste generators are estimated for each of the two cases described. This is followed by an estimation of the statewide cost impact to the public. The cost impact represents the cost differential resulting from the exclusion of utility Class A waste from the centralized NYS interim waste management facility. The principal factors comprising the cost differential include (1) higher unit disposal fees charged to non-utility waste generators, which are passed along in the costs of products and services; and (2) costs to utilities due to construction of additional onsite storage capacity, which in turn are charged to electric rate payers.

INTRODUCTION

The New York State Low-Level Waste Group (NYSLLWG), an ad hoc group of low-level radioactive waste generators, has been engaged in encouraging the New York State government to develop safe low-level waste disposal capability for in-state generators. It was under NYSLLWG's direction that a paper was written to document the assertion that there are economies of scale if temporary storage of low-level waste is accomplished at a central location rather than a separate location for each utility and a separate one for all other generators. This paper is presented to document the results of that study.

Purpose and Scope

The primary focus of the study was directed at an interim waste management approach which included an engineered, aboveground, monitored storage concept, coupled with provisions for waste volume reduction (incineration). The objective of the study was to assess the unit costs and total statewide costs associated with two distinct scenarios: 1) the case where non-utility Class A low-level radioactive waste (LLRW) is received, incinerated and stored at the centralized interim facility, and utility Class A wastes are held at respective nuclear power plant interim onsite facilities without incineration; and 2) the alternative case where both utility and non-utility Class A wastes are accepted, incinerated and stored at the centralized facility.

This investigation included consideration of projected utility and non-utility LLRW waste volumes, identification of principal facility and incineration system design features, in addition to associated capital, operational, licensing, decommissioning, waste transportation and ultimate waste disposal costs. Unit costs to waste generators were estimated for each of the two cases described. This was followed by an estimation of the statewide cost impact to the public.

WASTE VOLUME ESTIMATES

In order to perform an economic analysis of various LLRW storage and disposal alternatives, it was necessary to develop a reasonably accurate estimate of future LLRW volumes for New York State. Future LLRW volume has a direct impact upon the size requirement of the proposed storage and disposal facilities, and in turn determines the capital, operational and closure costs associated with such facilities.

Volume Estimates

The primary source of data used for LLRW volume estimates was referenced from the recent LLRW Management Study by the New York State Energy Office (Reference 1).

The assumptions and the methodology used to obtain future volume estimates for utility and non-utility LLRW are outlined below.

Utility Class A LLRW Volume (1986-1988)

Utility Class A LLRW Waste projected volumes for the 3-year period including 1986 through 1988 are shown in Table I. The 3-year period 1986 through 1988 is of interest because it corresponds to the 3-year operational phase for a NYS interim LLRW waste storage facility assumed in Reference 1.

Utility Class A waste volumes were estimated by using 1983 and 1984 waste generation rates and the volume projection trend for the 5 operating nuclear power plants in New York State. Of the utility waste volumes, 88% were assumed to be Class A, based on previous investigations (Reference 1).

Based upon the utility waste type distribution (Reference 1), it was estimated that approximately 60% of the utility Class A wastes are incinerable. Using this estimate, along with a volume reduction factor of 16 for compacted waste after incineration (Reference 2) and a volume increase factor of 2 after solidification (Reference 2), an effective volume reduction factor of 2.1 was obtained for utility Class A wastes. This factor was used to estimate the average utility Class A waste volume after incineration and solidification (Table I).

Utility Class A LLRW Volume (1989-2018)

The method used to estimate utility Class A waste volumes for the period between 1989 and 2018 was the same as that for the period between 1986 and 1988, except that the volume projection trend for 7 plants provided in the NYS LLRW Management Study, Final Report (Reference 1) was used and a constant volume generation was assumed for the period after 1993. Using this approach, an average of 145,000 ft^3/year utility Class A waste was estimated. This is equivalent to an average volume of 69,000 ft^3/year after some wastes (approximately 60%) are incinerated and resolidified.

Non-Utility Class A LLRW Volume (1986-2018)

Volume projections of non-utility waste provided in Reference 1 showed a very moderate increase (approximately 1% per year) over the next 10 years. For the purpose of this study, an average volume of 70,000 ft^3/year was adopted for the period between 1986 and 2018. This is equivalent to 66,500 ft^3/year of Class A waste (95% of non-utility wastes are assumed to be Class A).

Based upon the non-utility waste type distribution given in Reference 1, it was estimated that approximately 80% of the non-utility Class A wastes are incinerable. Using this estimate, along with a volume reduction factor of 16 and the volume increase factor of 2 discussed before, an effective volume reduction factor of 3.3 was obtained for non-utility Class A waste. The average volume of non-utility wastes after 80% are incinerated and solidified was then determined to be 20,000 ft^3/year.

Capacity Requirements for the Storage and the Disposal Facilities

From Class A LLRW volume estimates presented, capacity requirements for various storage facilities and the disposal facility were determined and summarized in Table II. These volume capacities were used in facility design, operation and closure consideration, and in the determination of unit costs (dollars/ft^3) for waste storage and disposal.

TABLE I

Projected Average Utility Class A LLRW Volume (1986-1988)

Facility	VOLUME (ft^3/yr) Without Incineration/Solidification[a]	With Incineration/Solidification[a]
Indian Point Unit 2	33,000	15,720
Indian Point Unit 3	11,270	5,370
J.A. Fitzpatrick	22,530	10,730
R.E. Ginna	11,640	5,540
Nine Mile Point Unit 1	20,760	9,890
TOTAL	99,200	47,250

(a) An effective volume reduction factor = 2.1 is used when utility Class A LLRW is incinerated followed by solidification.

TABLE II

Capacity Requirements for Storage and Disposal Facilities

Facility	Required Capacity[a] (Thousands of ft^3)	Remarks
Indian Point Unit 2	124	Scenario #1 (Separate Storage Facilities), 3 years of storage
Indian Point Unit 3	43	Scenario #1 (Separate Storage Facilities), 3 years of storage
J.A. Fitzpatrick	85	Scenario #1 (Separate Storage Facilities), 3 years of storage
R.E. Ginna	44	Scenario #1 (Separate Storage Facilities), 3 years of storage
Nine Mile Point Unit 1	78	Scenario #1 (Separate Storage Facilities), 3 years of storage
Centralized Non-Utility Storage Facility	75	Scenario #1 (Separate Storage Facilities), 3 years of storage
Centralized Utility and Non-Utility Storage Facility	253	Scenario #2 (Combined Storage Facility), 3 years of storage
Disposal Facility	3,590	30 years of disposal, averaging 120,000 ft^3/yr

(a) A 25% Contingency is used.

GENERAL DESIGN FEATURES

Conceptual design features of the interim storage facilities and the permanent disposal facility were developed to provide a basis for the cost estimates for the two proposed Class A LLRW management scenarios.

Storage Facility

The conceptual storage structure was assumed to be an aboveground and non-seismic related building consisting of a combination of steel frame structure encased in cast-in-place concrete and precast concrete panels. The storage structure would be designed with consideration of the increase in specific activity of non-utility/utility waste after incineration.

The structure is divided into a 1) high specific activity storage area, 2) low specific activity storage area, 3) container inspection and washdown area, 4) repacking area, 5) truck bay, 6) equipment control area, 7) equipment room, and 8) office area.

Systems and Equipment

The storage facility was assumed equipped with a 1) remote handling and monitoring system, 2) radiation monitoring system, 3) heating, ventilation and air conditioning system, 4) electrical lighting system, 5) fire protection system, 6) floor drainage system with a sump, 7) security system, 8) environmental monitoring system, 9) waste handling equipment including an overhead crane, forklift, truck and trailer, and 10) Health Physics survey equipment. The facility is also designed with the capability of selectively retrieving stored wastes.

Additional Design Features for Centralized Facility

Additional design features are required for a centralized storage facility in which non-utility waste will be stored. Non-utility wastes containing biologically degradable or potentially corrosive, flammable or explosive chemical mixtures need to be treated (incinerated and solidified) before storage. Therefore, it was assumed that the design would include an incineration/solidification facility for waste receipt, assay, processing and packaging. Additional administration building facilities would also be required to support the storage operations.

Disposal Facility

The disposal site discussed here was assumed to accept multiple waste types (Reference 3). The disposal site would consist of trenches and various aboveground facilities required to support the waste disposal activities (References 2, 4, 5).

Since final disposal fees are included in the overall costs for both scenarios No. 1 and 2, the disposal cost estimates did not affect the cost differential of the study.

COST ESTIMATES

Cost estimates presented in this section are based upon data from the literature (References (1, 2, 3, 6, 7) and professional judgement. Previous year costs given in the literature were adjusted to 1984 costs using an annual inflation rate of 6%. For the labor cost estimate, a 30% benefit with no overhead cost was used.

Results

Because of different storage volume requirements (Table II), the costs associated with two centralized storage facility designs and three utility onsite storage facility designs were estimated. The storage capacities assumed are approximately 15-20% higher than those listed in Table II. These additional storage capacity contingencies were assumed due to unforeseeable impacts associated with regulation changes, extended plant outages and questions concerning the timely construction of a permanent disposal facility.

Incineration and solidification costs were estimated for incineration facilities that would be appropriate for non-utility waste alone (Scenario #1) and for both utility and non-utility waste (Scenario #2).

Transportation costs were based upon assumed transportation distances from various generators in New York State to the central storage facility.

The estimated costs associated with a new, permanent disposal facility were based upon data given by References 1 and 3. The cost was estimated for a facility that would accommodate approximately 3.6 million cubic feet waste during a 30-year operational period.

Costs for 100 years of active institutional control, addressed in a manner similar to the approach used by the NRC (Reference 8), were included in the disposal cost.

It was also assumed that there were no overhead cost and profit charges involved in these cost estimates. Legal and insurance costs for various storage facilities were not specifically quantified, but these costs may be considered to be included within the estimated storage cost contingencies. For a facility operated by a privately financed contractor, the storage and disposal costs would increase. For example, an approximate 20% increase in unit disposal cost was estimated (Reference 9) for a disposal site operated by a contractor (assuming 35% overhead cost plus a profit charge of 10% of total operating costs).

ECONOMIC ANALYSIS

Method of Economic Comparison

The present worth method was used (References 2, 10-12) to compare the two interim Class A LLW storage alternatives in this study. The present worth of an alternative is that money that must be set aside at a given time to earn an annual interest equal to the discount rate (to cover the cost of the given alternative over its design lifetime, while the annual expenditures are being inflated at some assumed rate). In a present worth analysis, capital expenditures and annual operating and maintenance expenditures are treated separately.

Capital Expenditure

The present worth of all capital expenditures is determined by multiplying the escalated (inflated) value (when the expenditure takes place at other than year one) by the appropriate present worth factor (Reference 10).

Annual Expenditure

The present worth of future operating expenses was calculated by multiplying the cost in 1984 by the appropriate compound escalation factor and then multiplying this factor by the present worth factor for that point of time. For operating expenses that occur regularly over extended periods of time, the present worth of each annual expense is calculated and summed over the period in which the expenses are made to arrive at the total present worth (Reference 2).

Assumptions

Major financial parameters and timeframes assumed in the calculation were:

- o Escalation (inflation rate = 6%)
- o Discount rate = 14.5% for short-term (3-5 year) case (e.g. interim storage)
  = 10% for long-term (30 years) case (e.g. disposal)
- o Fixed charge rate = 20% for capital expenditure
- o Because of potential future usage of the storage facility for other activities when waste storage is no longer needed (presumably in 1989), 80% of the capital cost was charged to waste storage cost.
- o Higher labor costs (10%)(Reference 13) were used for Indian Point Unit 2 and Unit 3 which are located near the New York metropolitan area. The additional labor cost was reflected in the storage structure cost, annual operating labor cost and closure labor cost.
- o Timeframes contemplated for the storage facility were assumed to be:
  1. Facility development period - 1 year (1985)
  2. Facility operation period - 3 years (1986-1988)
  3. Facility closure period - 1 year (1989)
- o Timeframes contemplated for the disposal site were assumed to be:
  1. Site development period - 5 years (1984-1988)
  2. Site operation period - 30 years (1989-2018)
  3. Site closure period - 1 year (2019)
  4. Site extended care period - 100 years (2020-2119)

Results

Table III presents a detailed unit cost breakdown for storage, incineration/solidification, transportation and disposal as well as the total unit costs for utility and non-utility waste. Costs are expressed in 1984 present worth dollars.

- o Storage Cost:

  Unit storage cost is the cost per cubic foot of waste generated, which is either stored at a utility's interim onsite storage facility or shipped to the centralized interim storage facility.

- o Incineration Cost:

  Utility wastes (Scenario #1, Separate Storage Facilities) were assumed to be incinerated at the disposal site at the end of 3 years of storage. It was assumed that incineration/solidification facility at the disposal site would be operated for 30 years. A 50% replacement cost was included in the annual operating cost. Non-utility wastes and utility wastes (Scenario #2, Combined Storage Facility) were assumed to be incinerated at the centralized interim storage site. A 3-year facility utilization period was assumed in this case.

The unit incineration/solidification cost is the cost per cubic foot of waste generated, which is either stored at a utility onsite interim storage facility or shipped to the centralized interim storage facility.

Unit costs listed in Table III were derived based on the assumption that 60% of utility wastes and 80% of non-utility wastes are incinerable.

The unit incineration/solidification cost is significantly lower for utility wastes than that for non-utility wastes (Scenario #1, Separate Storage Facilities). This is because 1) utility wastes will be incinerated and solidified at the disposal site using facilities that will be operated for 30 years and 2) non-utility wastes will be incinerated/solidified at the interim storage site using facilities that will be operated for only 3 years.

- Transportation Cost:

  One-way unshielded waste transportation costs were calculated based on data given in Reference 3. The numbers in parentheses in Table III reflect the one way mileage assumed.

- Disposal Cost:

  The disposal site is designed for 30 years of disposal with an assumed annual disposal rate of approximately 120,000 ft^3/yr. Costs for 100 years of extended care after the closure of the site are also included. It is likely that the calculated disposal cost shown in Table III is understated when compared with current disposal fees being paid for LLRW disposal at commercial disposal sites (References 14 and 15). Since final disposal fees are included in the overall costs for both Scenarios #1 and 2, the accuracy of disposal cost estimates does not affect the outcome of the analysis.

  The unit disposal cost is the cost per cubic foot of waste generated, which is either stored at a utility's onsite interim storage facility or shipped to the centralized interim storage facility. Effective volume reduction factors of 2.1 for utility waste, and 3.3 for non-utility waste after incineration/solidification are used to derive unit disposal costs listed in Table III.

- Total Unit Cost:

  Total unit cost is the cost per cubic foot of waste generated, which is either stored at a utility's onsite interim storage facility, or shipped to the centralized interim storage facility, incinerated, and eventually disposed of.

Table IV presents a summary of the total unit costs for utility and non-utility for Scenarios #1 and 2.

Table IV presents a summary of the total future costs for Scenario #1 and 2. Costs are expressed in present worth dollars (1984) for storage, incineration/solidification, transportation and disposal of total wastes generated in 1986, 1987 and 1988. Cost for the existing waste storage facility at Nine Mile Point Unit 1 is not included in the determination of the total future cost.

CONCLUSIONS

From results presented in Tables III, IV and V the following cost differentials are observed:

- The unit storage cost and the total unit cost for all generators in Scenario #2 (Combined Storage Facility) is lower than those in Scenario #1(Separate Storage Facilities).

- A higher unit incineration/solidification fee will be charged to utility generators who use the incineration/solidification facilities at the interim storage site.

- Scenario #2 (storing both utility and non-utility waste at a centralized interim storage facility) will result in a total saving of approximately 12 million dollars during the interim storage period. If the cost of the existing interim onsite storage facility at Nine Mile Point Unit 1 is included, the total cost differential will be even larger (approximately 20 million dollars).

These cost differentials suggest that Scenario #2 (Combined Storage Facility) would result in a lower state-wide cost impact to the public because of:

- Lower unit storage/disposal fees charged to non-utility waste generators, which will reflect in lower costs of products and services; and

- Lower total construction costs to utilities due to the usage of a centralized facility, which in turn, reduces fees charged to electric rate payers.

TABLE III

Unit Cost Analysis-Scenarios #1 and 2

Scenario #1 (Separate Storage Facilities)	Cost (dollars/ft³) (a)				
	Storage	Incineration/Solidification	Transportation	Disposal	Total
Utility	65.27 (b)	6.44	1.13 (80-400) (b)	5.23	78.07
Non-Utility	34.61	49.94	1.30 (250)	3.33	89.18
Scenario #2 (Combined Storage Facility)					
Utility	29.34	27.43	0.68-1.63 (80-400)	5.23	62.68-63.63
Non-Utility	18.67	36.57	1.30 (250)	3.33	59.87

a) Unit cost is the cost per cubic foot of waste generated, which is either stored at a utility's onsite interim storage facility, or shipped to the centralized interim storage facility.

b) Weighted average unit storage cost is based on capacity of the storage facility, and weighted average unit transportation cost is based on projected waste volume listed in Table I, Column 1. The cost for Nine Mile Point Unit 1 is not included because the interim storage facility is already built.

TABLE IV

Total Unit Cost Comparison - Scenarios #1 and 2

	Cost (dollars/ft³)	
	Utility	Non-Utility
Scenario #1 (Separate Storage Facilities)	78.07	89.17
Scenario #2 (Combined Storage Facility)	62.68-63.63	59.87

TABLE V

Total Future Cost

	Scenario #1 (Separate Storage Facilities) (Dollars)	Scenario #2 (Combined Storage Facility) (Dollars)
Storage	34,262,000	18,486,000
Incineration/ Solidification	13,154,000	16,454,000
Transportation	584,000	639,000
Disposal	2,220,000	2,220,000
TOTAL	50,220,000	37,799,000

REFERENCES

1. New York State Low-Level Radiation Waste Management Study, Final Report, State Energy Office, April 1984.

2. Alternatives for On-Site Retention of Low-Level Radwaste at Nuclear Power Plants, National Environmental Studies Project, Atomic Industrial Forum, Inc. AIF/NESP-015R, 1978

3. Directions in Low-Level Radioactive Waste Management, EG&G Idaho, Inc. for the U.S. Department of Energy, DOE/LLW-6Td, April 1983

4. Texas Low-Level Radioactive Waste Disposal Facility Conceptual Design, Texas Low-Level radioactive waste disposal authority, December 1983

5. Low-Level Radioactive Waste Disposal Siting: A social and Technical Plan for Pennsylvania, Final Report, Institute for Research on Land and Water Resources, the Pennsylvania State University.

6. Low-Level Radioactive Waste Preliminary Report, Radiological health Branch, California Department of Health Services, December 1982

7. On-site Storage of Low-Level Radwaste: A Survey, EPRI NP-3617, July, 1984

8. Final Environmental Impact Statement on 10CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste". U.S. Nuclear Regulatory Commission, November, 1982.

9. Texas Low-Level Radioactive Waste Disposal Facility: Economic Analysis, Texas Low-Level Radioactive Waste Disposal Authority, January 1984

10. N.N. Barish, Economic Analysis for Engineering and Managerial Decision Making, McGraw-Hill Book Company, 1962

11. J.A. White, M.H. Agee and K.E. Case, Principles of Engineering Economic Analysis, John Wiley and Sons, 1977

12. Low-Level Radwaste Engineering Economics, EPRI NP-3577, July 1984

13. Building Systems Cost Guide 1982, Robert Snow Means Company, Inc.

14. Private communication, C.H. Marshal, New York University Medical Center.

15. Private communication, F. Mis, Rochester Gas and Electric Corporation.