VOLUME REDUCTION - A SOLUTION TO THE LOW-LEVEL RADIOACTIVE WASTE POLICY ACT AMENDMENTS OF 1985

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ABSTRACT

The Low-Level Radioactive Waste Policy Act Amendments of 1985 represent a compromise which will allow the three existing low-level disposal sites to remain open to out-of-compact waste through 1992. In exchange for continued access, a series of milestones, coupled with reactor burial volume allocations and burial surcharges, were instituted to ensure the development of new disposal sites by 1993. This paper demonstrates how a comprehensive low-level radwaste volume reduction program will mitigate the impact of these volume allocations and burial surcharges at operating reactors.

INTRODUCTION

The Low-Level Radioactive Waste Policy Act Amendment of 1985 (hereinafter referred to as the "1985 Amendments"), as passed by the U.S. Congress on December 19, 1985, correct the weaknesses of the Low-Level Radioactive Waste Policy Act of 1980 and establish a series of incentives and penalties to ensure the development of new disposal sites by 1993. In exchange for allowing out-of-compact waste generators continued access to the existing low-level disposal sites at Barnwell, SC; Richland, WA; and Beatty, NV, through 1992, the following was instituted:

- o Individual volume caps were established for the three existing disposal sites.
- o Individual reactor disposal allocations were established.
- o A comprehensive site development milestone schedule was developed that must be met by unsited compacts/states in order to retain access to existing disposal sites.
- o A cap on disposal surcharges was established that may be levied by the three existing disposal sites on out-of-compact generators.
- o A program for rebating a portion of the disposal surcharges was identified.

The individual reactor disposal allocations are based on whether the reactor is a PWR or BWR, whether the reactor is in a sited or unsited region, and the reactor startup date. Although the reactor allocation program uses 1983 national averages as a baseline, reactor size and individual historical volume generation rates were not considered. Therefore, the 1985 Amendments will represent problems of differing magnitudes to the affected reactors. This paper examines the situation faced by a variety of operating reactors (both in sited and unsited states) in complying with the 1985 Amendments, and demonstrates how a comprehensive volume reduction program addressing dry active waste (DAW), resins, and liquid concentrates will allow compliance with reactor disposal allocations and minimize disposal surcharges.

Volume Reduction Techniques Considered

Numerous types of volume reduction equipment and services are commercially available to the reactor operator. This paper does not attempt to be all inclusive in evaluating their impacts and economic benefit, but rather demonstrates how representative equipment and services can mitigate the potential effects of the 1985 Amendments. The equipment and services used for demonstration purposes in this paper are:

- o Mobile DAW Supercompaction Service

This service, utilized at U.S. nuclear reactors since May 1984, uses a trailer mounted, fully enclosed 1,000 ton ram force hydraulically operated compactor to process a reactor's DAW (see Fig. 1). Either 55-gallon or 52-gallon drums containing DAW are crushed and repackaged in suitable overpacks for disposal. This process achieves a net waste density in excess of 60 pounds per cubic foot, resulting in a volume reduction factor in excess of 2:1 when compared to normal compaction of DAW.

Fig. 1
Westinghouse Mobile Supercompactor

- o Bead Resin Dryer

This process, patented by the Westinghouse Electric Corporation, treats bead resin with superheated steam to remove intrinsic water from the beads through evaporation. Dried resin is packaged in a high integrity container for disposal (see Fig. 2). The process results in a volume reduction of 2:1 as compared to routine dewatering processes.

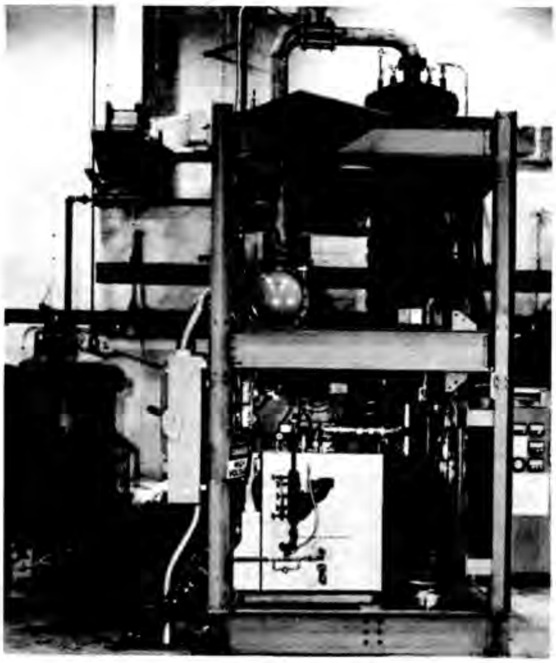

Fig. 2. Westinghouse Resin Dryer

- Powdered Resin Press

This equipment utilizes a 1,500-ton ram force hydraulically operated compactor to crush metal drums containing dewatered or centrifuged powdered resin (see Fig. 3). Crushed drums are packaged in high integrity containers for disposal. Integral drum handling equipment is provided to minimize man-rem exposure. This equipment results in a volume reduction factor in excess of 2:1 compared to routine dewatering operations.

Fig. 3. Crushed Resin Drums

- Liquid Volume Reduction System

This system concentrates 8-12 weight percent boric acid, resulting in a volume reduction factor of at least 4:1. When compared to the alternative of solidification, the volume reduction factor is in excess of 5:1 (see Fig. 4). A boron salt is precipitated through chemical addition, with the resulting residue packaged in a high integrity container.

Fig. 4
Precipitated Boric Acid

Reactor Case Studies

Operating reactors selected for the case studies are identified in Table I. The reactors selected provide a representative cross-section of operating reactors in both sited and unsited compacts. The volume allocations and burial surcharges established by the 1985 Amendments and used in the case studies are shown in Table II.

TABLE I

Reactors Chosen for Case Studies

Case No.	Reactor Type	No. of Units	Sited or Unsited	1985 Waste Volumes (CF) DAW	Liquids	Bead Resin	Powdered Resin	Misc.
I	BWR	1	Unsited	13,500	-0-	-0-	4,000	1,250
II	PWR	1	Unsited	6,000	1,000	-0-	-0-	500
III	BWR	1	Unsited	9,000	2,500	3,000	1,000	1,000
IV	PWR	1	Unsited	9,000	-0-	1,000	-0-	1,000
V	PWR	2	Unsited	20,000	1,000	3,000	-0-	2,000
VI	BWR	1	Unsited	23,000	-0-	5,500	-0-	2,000
VII	BWR	2	Unsited	50,000	-0-	-0-	21,000	2,000
VIII	PWR	2	Sited	16,000	-0-	1,000	-0-	1,000
IX	BWR	2	Sited	58,500	-0-	-0-	18,500	11,000
X	BWR	3	Sited	90,000	-0-	-0-	34,000	5,000

In evaluating the effects of the 1985 Amendments, the following assumptions were used:

- Reactor waste volumes would be decreased by 5% per year through waste minimization programs, improved housekeeping, etc.

TABLE II

1985 Amendements Volume Allocations
and Burial Surcharges

Volume Allocations

	4-Year Transition Period (1986 - 1989)	3-Year Licensing Period (1990 - 1992)
Sited Regions		
BWR's	110,400 CF	75,276 CF
PWR's	49,308 CF	33,624 CF
Unsited Regions		
BWR's	93,662 CF	55,188 CF
PWR's	41,832 CF	24,660 CF

Burial Surcharges

1986 - 87	-	$10.00 per CF
1988 - 89	-	$20.00 per CF
1990 - 92	-	$40.00 per CF

- o Burial prices charged by site operators (exclusive of surcharges) would escalate 12% per year.
- o The maximum surcharges allowed by the 1985 Amendments would be imposed.

When considering the effects of a comprehensive volume reduction program, improved processing of DAW was evaluated separately, due to the fact that it accounts for the largest fraction of the radioactive waste volume generated and shipped for burial. EPRI studies conclude that on the average 60% of a plant's low-level radioactive waste is DAW. For the ten plants studied in this paper, DAW represented 55-89% of the annual waste volume. Therefore, the application of advance volume reduction techniques to DAW merits attention in order to reduce a plant's waste volumes and overall burial costs. DAW supercompaction is also evaluated separately since this volume reduction technique is readily available and can be implemented immediately on a contract basis with any of a number of service contractors, or regional processing facilities.

The effects of bead resin dryers, powdered resin presses and liquid volume reduction systems are also studied separately, as this equipment requires some lead time for installation at the reactor and requires longer utility commitment.

Results of Case Studies

Figures 5 through 14 present the effects of a comprehensive volume reduction program on a reactor's waste volume shipped for burial. The figures compare cumulative waste volumes for the following cases:

- o No volume reduction (VR) program (5% annual reduction)
- o DAW supercompaction only
- o DAW supercompaction and other applicable volume reduction processes

The cumulative waste volumes for each of these cases are compared to the volume allocation established by the 1985 Amendments. The following conclusions can be reached from studying Figures 5 through 14:

- o Although the volume allocation program established by the 1985 Amendments used the 1983 industry average as a baseline, individual reactor operating histories were not considered. Therefore, operating reactors will have varying difficulty in meeting the volume allocation program.
- o DAW supercompaction, coupled with modest housekeeping improvements, will generally allow the reactor to comply with the volume allocation program. Unusual activity, e.g., recirculation pipe replacement, decontamination work, unplanned outages, may still result in the reactor exceeding its volume allocation.
- o The use of resin and liquid waste volume reduction equipment in conjunction with DAW supercompaction should provide sufficient overall volume reduction to ensure a reactor's ability to meet its volume allocation even when considering unusual activities.

As burial prices have continued to spiral, a reactor's annual costs for radwaste disposal have now reached substantial amounts. The imposition of burial surcharges, coupled with increased fees paid to the disposal site operator, will cause annual costs to reach levels that were undreamed of in the mid-1970's. The burial surcharge alone, when applied to DAW, represents a 40% surcharge in 1986 and is expected to represent an 82% surcharge in 1992.

Figures 15 through 21 present the cumulative burial surcharges for seven of the case study reactors. Reactors VIII, IX, and X, being in a sited compact, are not subject to surcharges. The figures compare cases for no volume reduction, supercompaction only, and supercompaction in conjunction with other applicable volume reduction processes. Study of these figures identify:

- o The cumulative burial surcharges, applicable to reactors in non-sited compacts, represent a significant additional expenditure (in excess of $10 million for Plant VII).
- o The use of a comprehensive volume reduction program can approximately halve this additional expenditure.

Figures 22 through 31 present cumulative burial charges, including surcharges where applicable, for the ten case study reactors. Study of these figures indicate:

- o Cumulative burial charges will reach substantial levels by 1992.
- o Volume reduction can achieve significant cost savings for a reactor (as much as $20 million for Plant X).

CONCLUSIONS

The Low-Level Radioactive Waste Policy Act Amendments of 1985 provide a new challenge to operating reactors in the United States. A volume allocation program, representing mandated volume reductions from 1983 national averages, represents a problem of differing magnitude to each reactor. Even reactors in sited regions are not immune from this problem.

A burial surcharge, applicable to reactors in unsited regions, represents a significant new operating cost, which coupled with constantly increasing fees charged by burial site operators will cause overall burial fees to reach unprecedented and previously undreamed of levels.

A comprehensive waste volume reduction program addressing DAW, resins and liquid wastes can allow a reactor to meet its volume allocation, as well as significantly reduce burial costs. Supercompaction of DAW, a technology readily available on a service basis, represents a logical first and immediate step in a reactors' planning for the period 1986 through 1992.

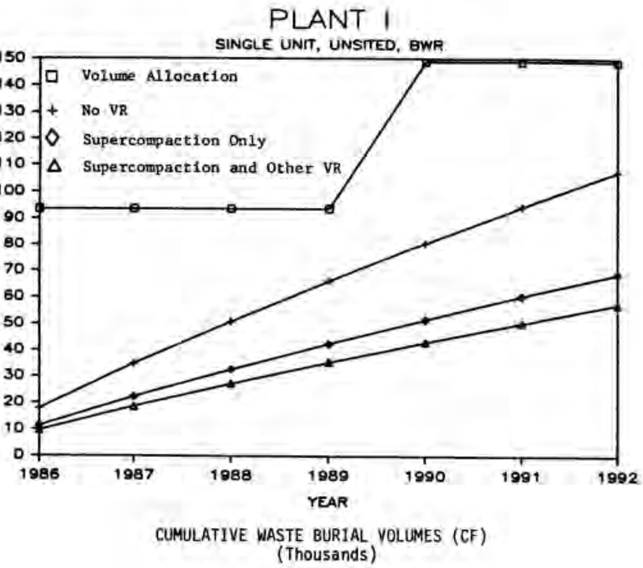

Fig. 5. Cumulative Waste Volumes vs. Allocation - Plant I

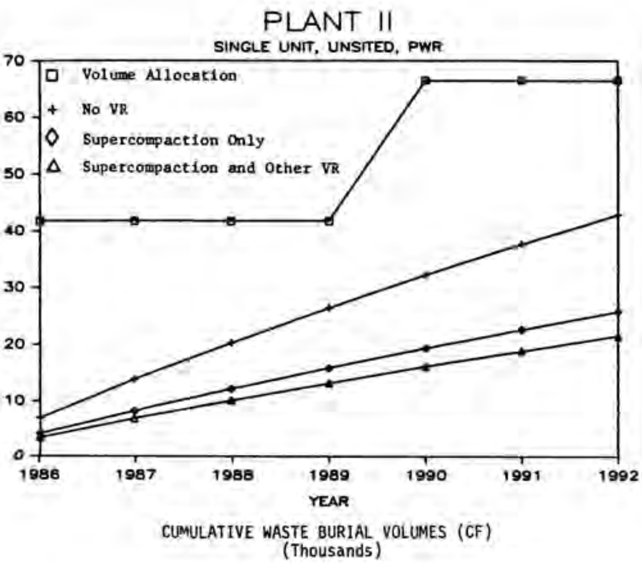

Fig. 6. Cumulative Waste Volumes vs. Allocation - Plant II

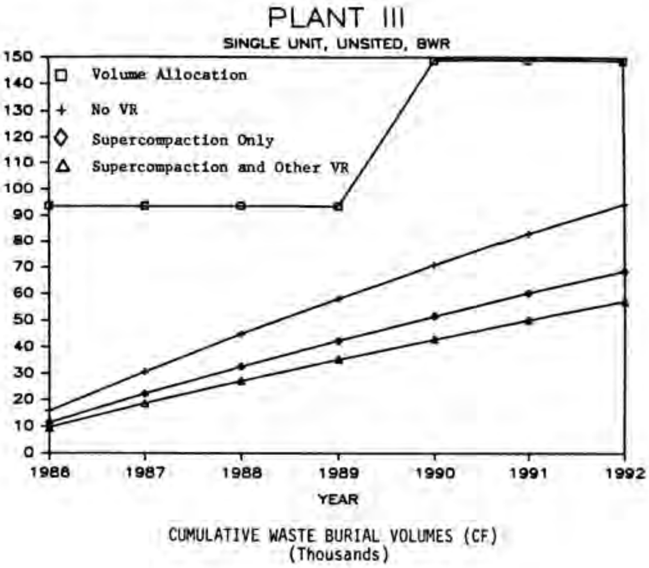

Fig. 7. Cumulative Waste Volumes vs. Allocation - Plant III

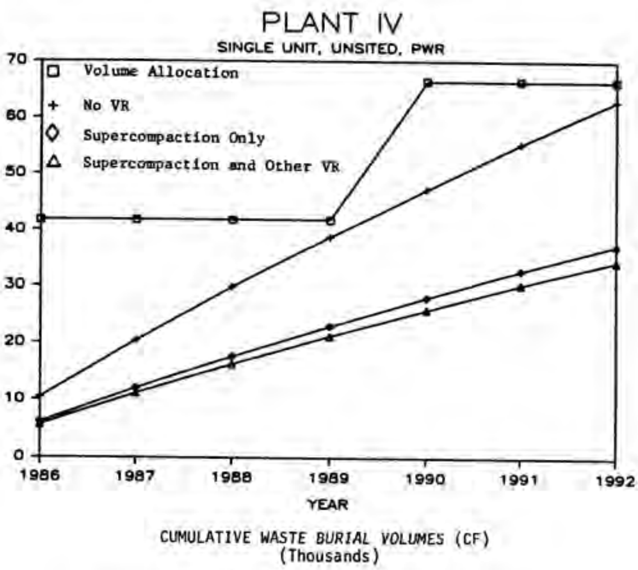

Fig. 8. Cumulative Waste Volumes vs. Allocation - Plant IV

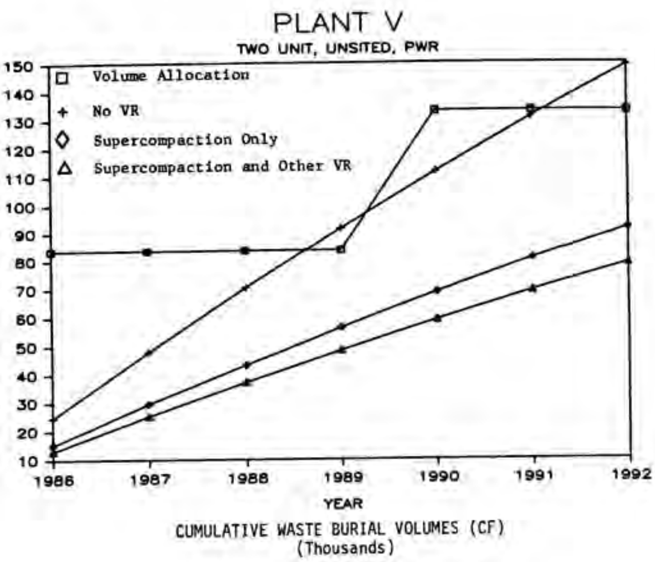

Fig. 9. Cumulative Waste Volumes vs. Allocation - Plant V

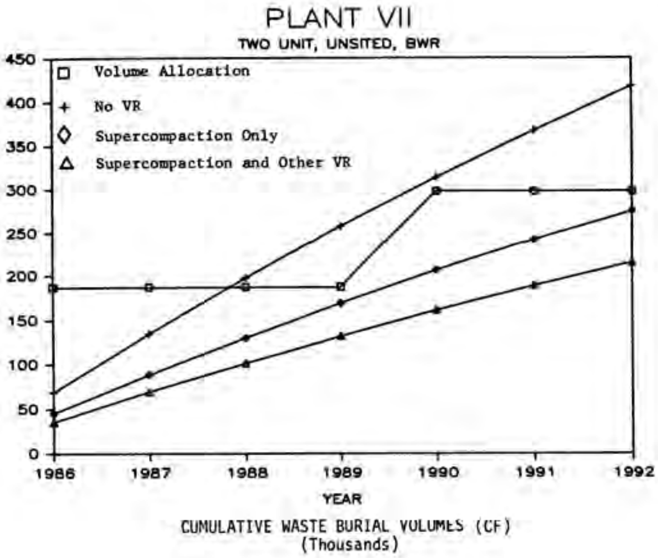

Fig. 11. Cumulative Waste Volumes vs. Allocation - Plant VII

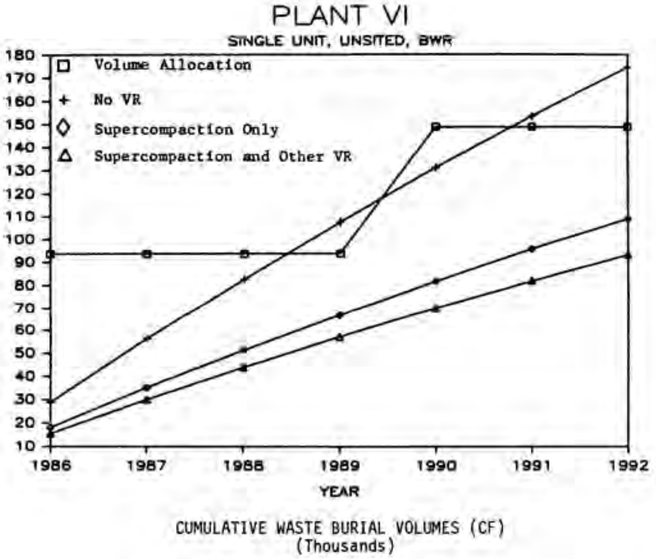

Fig. 10. Cumulative Waste Volumes vs. Allocation - Plant VI

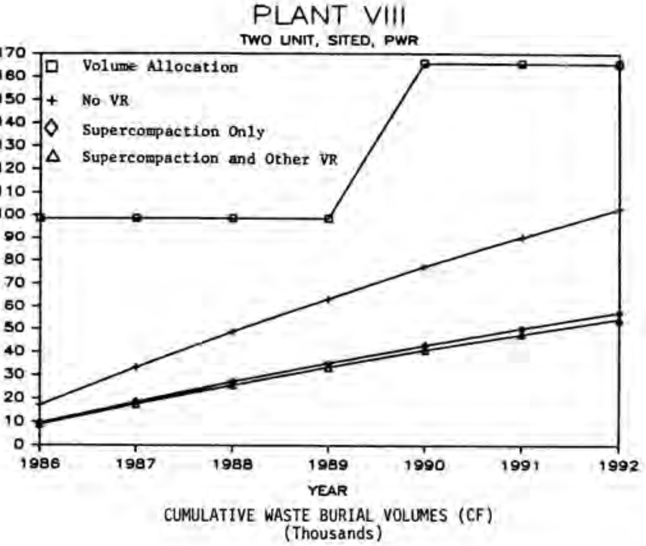

Fig. 12. Cumulative Waste Volumes vs. Allocation - Plant VIII

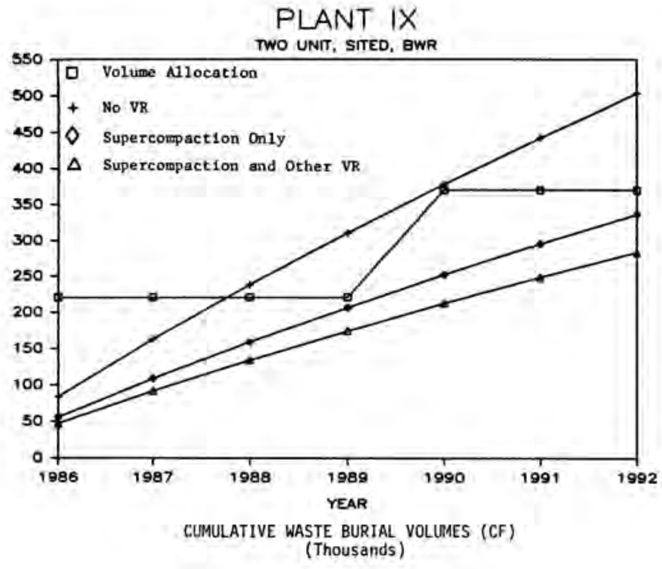

Fig. 13. Cumulative Waste Volumes vs. Allocation - Plant IX

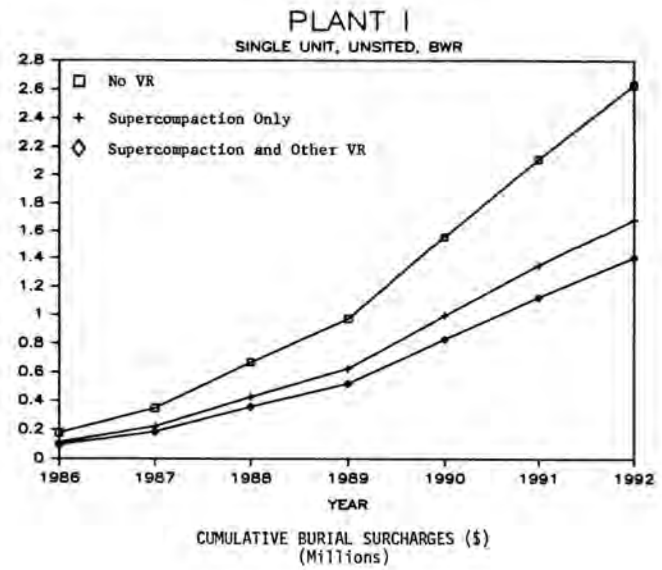

Fig. 15. Cumulative Burial Surcharges - Plant I

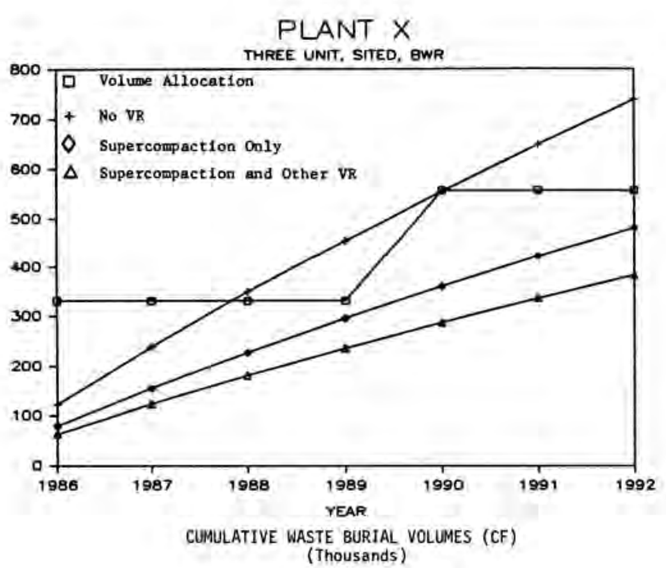

Fig. 14. Cumulative Waste Volumes vs. Allocation - Plant X

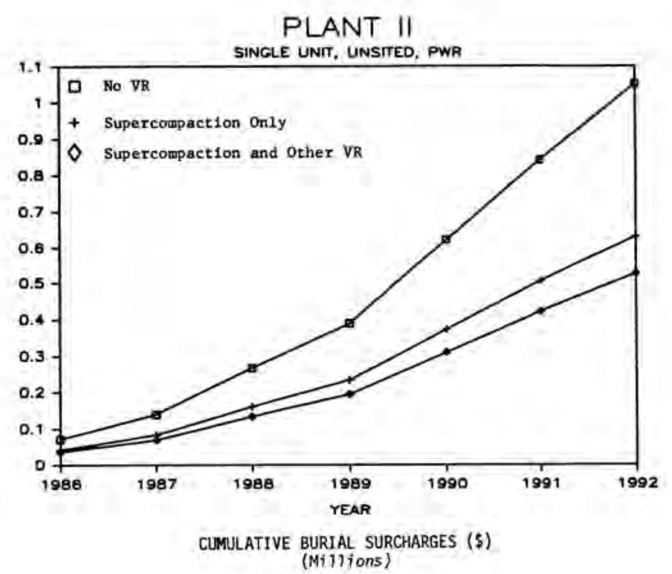

Fig. 16. Cumulative Burial Surcharges - Plant II

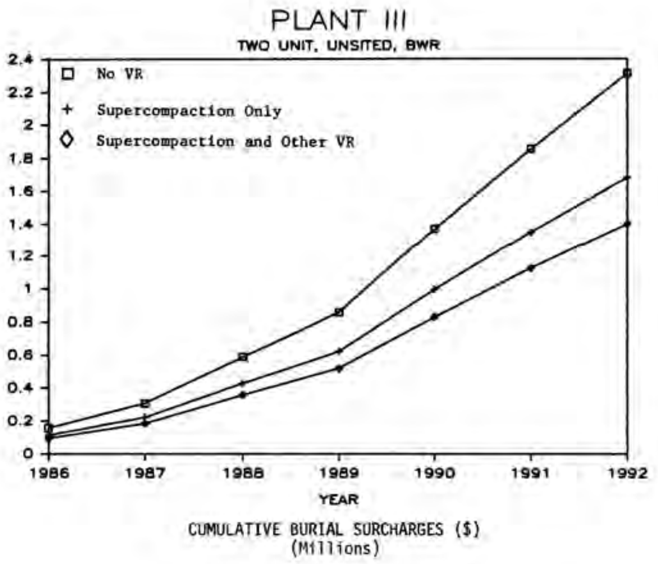

Fig. 17. Cumulative Burial Surcharges - Plant III

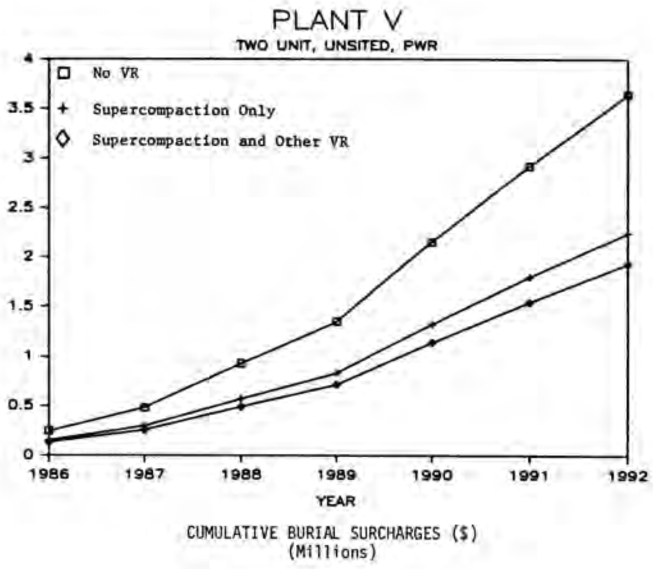

Fig. 19. Cumulative Burial Surcharges - Plant V

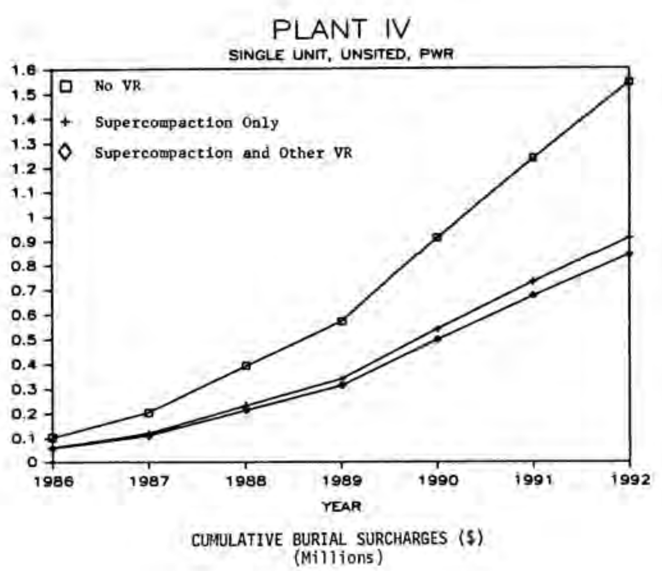

Fig. 18. Cumulative Burial Surcharges - Plant IV

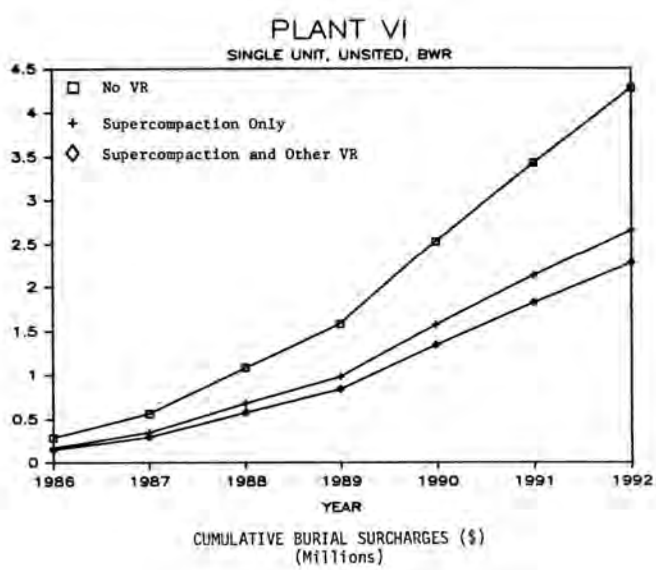

Fig. 20. Cumulative Burial Surcharges - Plant VI

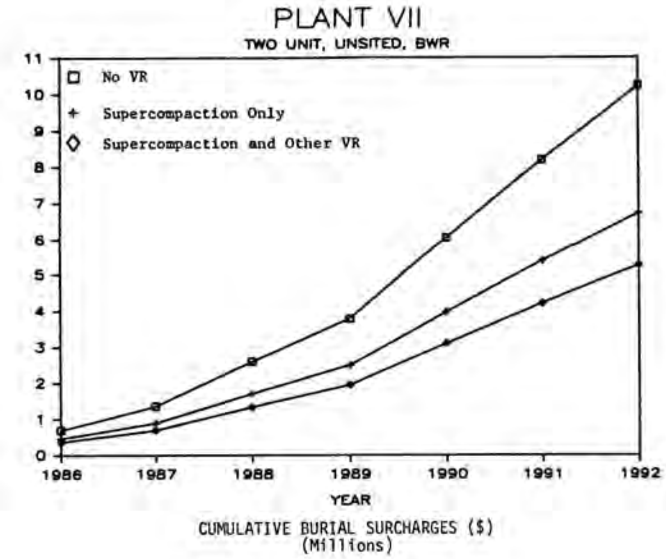

Fig. 21. Cumulative Burial Surcharges - Plant VII

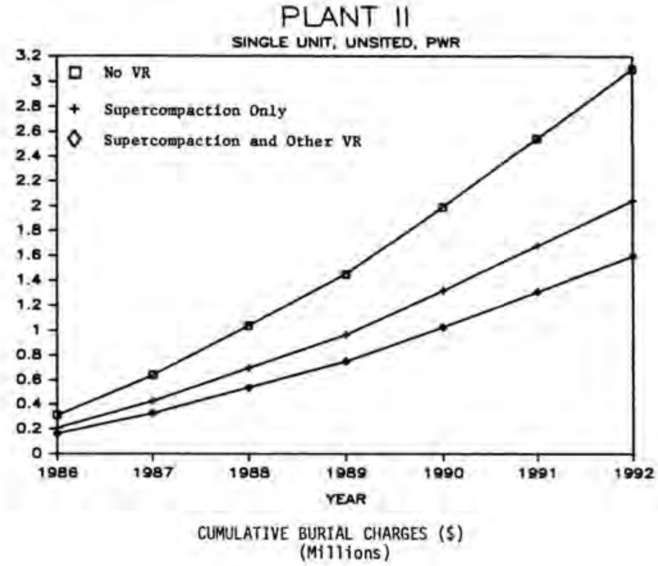

Fig. 23. Cumulative Burial Charges - Plant II

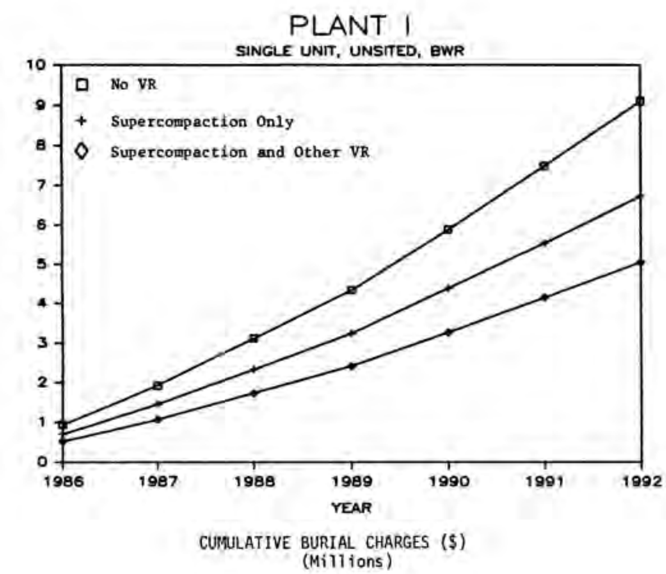

Fig. 22. Cumulative Burial Charges - Plant I

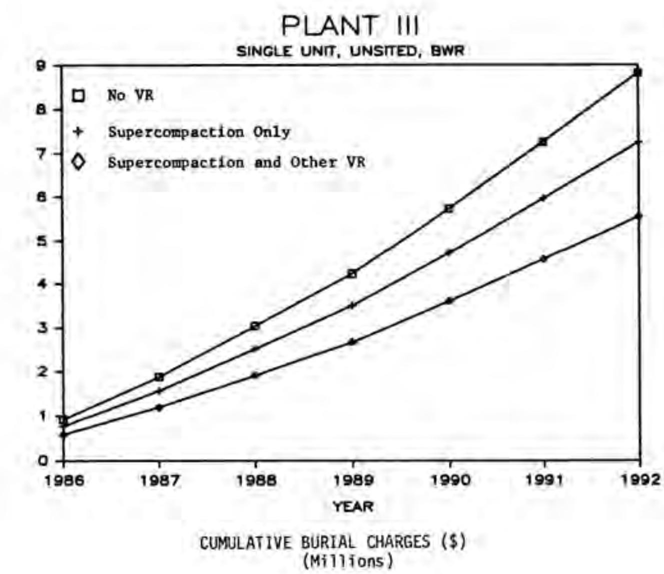

Fig. 24. Cumulative Burial Charges - Plant III

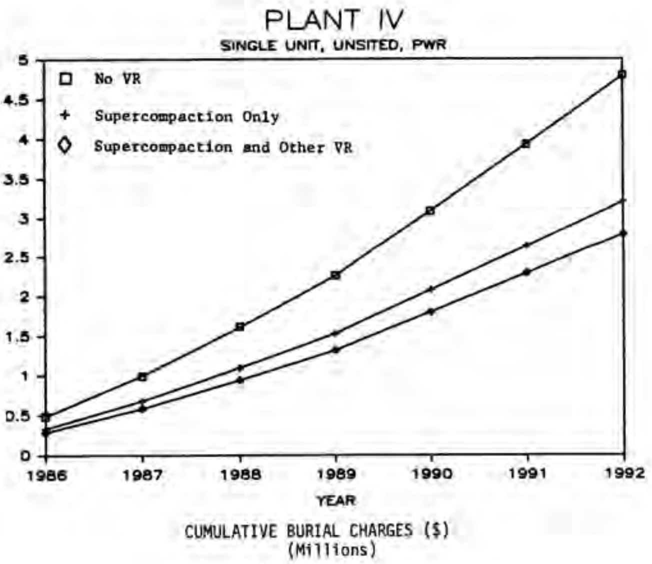

Fig. 25. Cumulative Burial Charges - Plant IV

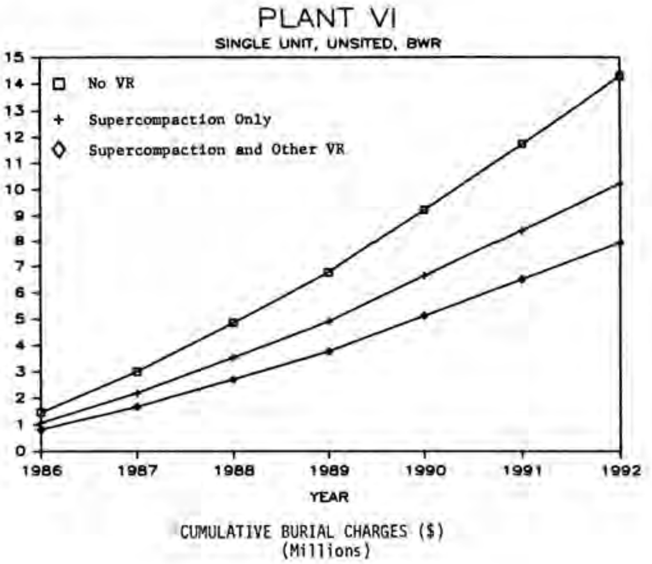

Fig. 27. Cumulative Burial Charges - Plant VI

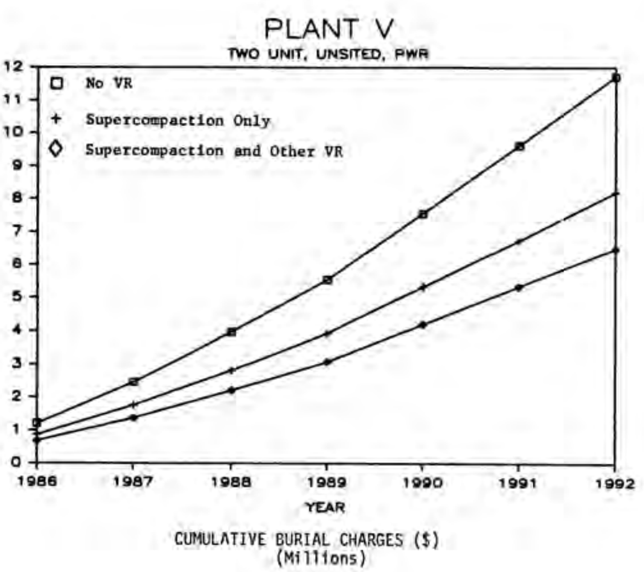

Fig. 26. Cumulative Burial Charges - Plant V

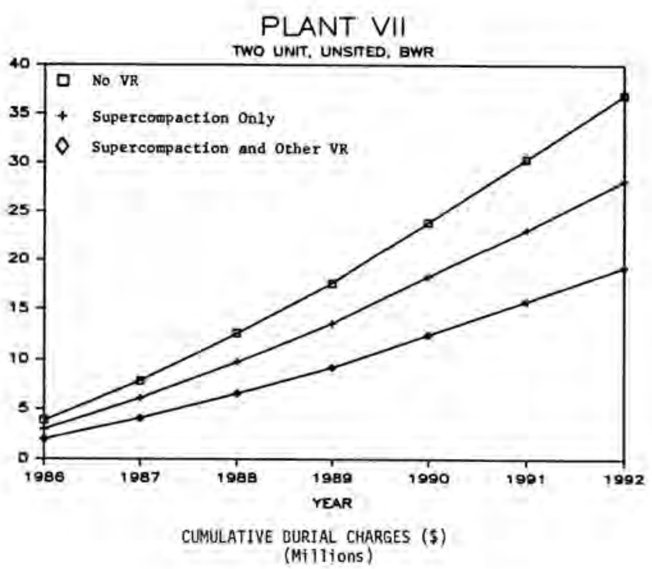

Fig. 28. Cumulative Burial Charges - Plant VII

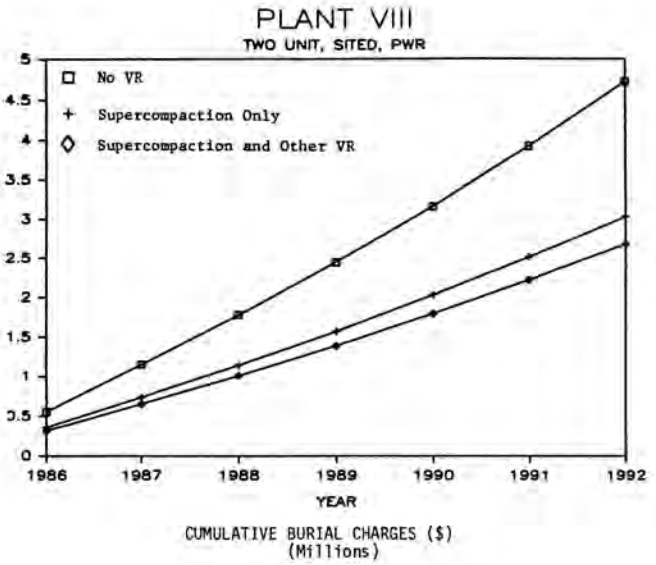

Fig. 29. Cumulative Burial Charges - Plant VIII

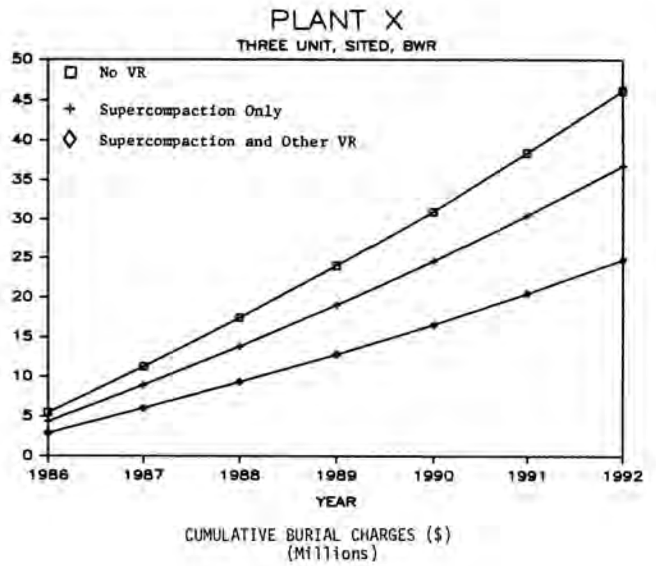

Fig. 31. Cumulative Burial Charges - Plant X

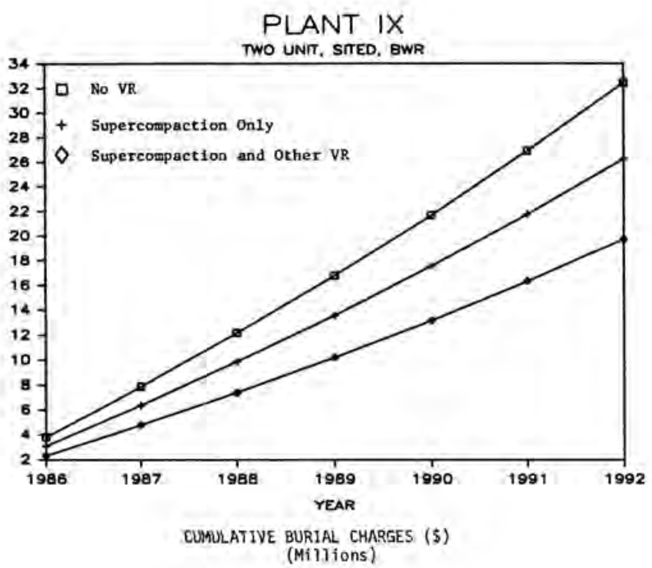

Fig. 30. Cumulative Burial Charges - Plant IX