REVIEW AND SELECTION

OF A DAW VOLUME REDUCTION COMPACTION SYSTEM

FOR USE AT A PRESSURIZED WATER REACTOR

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ABSTRACT

TVA has in the past contracted for the installation of incineration equipment at two of its nuclear plants. Review of the cost and other factors led to the decision not to proceed with incineration, but to evaluate other less costly volume reduction options for processing dry active waste (DAW).

The past history of selection of incineration as a processing method, its cancellation and subsequent selection of high forced compaction for use at TVA's Sequoyah Nuclear Plant, and TVA's evaluation of compactors which covered a range of compaction forces from 50,000 pounds force to 8,000,000 pounds force are reviewed.

BACKGROUND HISTORY ON VOLUME OF TRASH PROCESSING

Initial DAW composition information was received from Mr. Rich McGouey on a GPU plant. This information along with the information we had available to us from Commonwealth Edison's Zion plant was used to determine what data would be needed from our Sequoyah plant in order to perform an accurate costs evaluation. The results of our comparison were quite close as far as percentage of DAW makeup (see Table I).

TABLE I

DAW Distribution by Volume

	GPU %	TVA %
Plastic	29.2	27.0 - 32.0
Herculite	17.0	15.0 - 20.0
Disposable Anti-C's	15.3	10.0 - 17.0
Duct Tape	11.2	10.0 - 15.0
Rags	10.0	Cloth 23.0 - 27.0
Paper	4.0	3.0 - 6.0
Rubber Gloves & Boots	4.4	4.0 - 6.5
Canvas	3.1	- -
Metal	.6	- -
Wood	.2	- -
Glass	.4	- -
Others	4.6	.5 - 3.0
Non-combustibles found mixed in with the compactables	1.8	2.1

They revealed a waste stream made up of about 30% plastic, 17% herculite, 15% disposable anti-C's, 12% duct tape, 5% paper, 5% material composed of rubber and about 14% miscellaneous. This left about 2.0% noncompactables in our compactable waste. During nonoutage time the percentage of plastic, herculite, disposable anti-C's and duct tape increased as was to be expected. Outage percentages for plastic were around 30%, herculite 15-20%, disposable anti-C's about 15%, duct tape about 15%, cloth represented about 27%, paper about 9% and rubber about 6%. These are a little different from what GPU documented but close enough to be felt accurate. Percentage of noncompactables during an outage that were included in the compactable waste went up to about 2.5%. As a whole plastics represented about 45% of the waste volume with PVC being about 25%. Chemical composition for Sequoyah during nonoutage time averaged between 21 and 25% for PVC, 17-19% for plastic predominately polyethylene, 23-25% for cloth, paper 4-6%, rubber 4-6%, noncompactable 1.8-2%.

During the outage times PVC ran 22-32% significantly higher at Sequoyah than what GPU had seen. Plastic 18-22%, cloth 25-27%, paper 6-10%, rubber 6-9%, and noncompactables 2.5% (see Table II). The difference between GPU and the Sequoyah numbers were probably due to differences in the maintenance that was going on. Increased usage of herculite, it being a stronger type of plastic with a high PVC content, in areas where you have more potential for water on the step-off pads is one possibility. About 20-25% more trash appears to

TABLE II

Chemical Distribution by Volume

	Non-Outage Periods %	Outage Periods %
Polyvinylchloride	21 - 25	22 - 32
Polyethylene	17 - 19	18 - 22
Cloth	23 - 25	25 - 27
Paper	4 - 6	6 - 10
Rubber	4 - 6	6 - 9

About 20 to 25% more trash is produced per month during outage periods than during non-outage periods.

be produced during outage periods than nonoutage periods.

Areas where trash was generated during nonoutage periods; essentially nothing from the reactor building decon area about 18%, laundry about 15%, radwaste accounted for about 25%, chemistry laboratories between 3-5%, and the auxilliary building 34-40%. During outage periods; reactor building accounted for somewhere between 25-40%, decon was about 5%, laundry about 12%, radwaste about 20%, chemistry remained somewhere between 3-5%, and the auxilliary and fuel buildings averaged about 23% (see Table III). At Sequoyah a study was conducted with EPRI which yielded very accurate data on dose rates and activity buildup on the trash plus very comprehensive data on how much trash was being generated in these locations. About 80-90% of the trash we surveyed was less than 5 MR/Hr. (see Table IV). While 25-40% actually fell below 100 nanocuries per gram or less than 1000 nanocuries per bag. This has already been reported in more detail in last year's Waste Management '84 proceedings. Both GPU and Sequoyah did their studies for evaluation of waste to reduce the volume of trash being processed in radwaste, and also to evaluate incineration as a processing option. TVA had originally purchased a Calciner/Incinerator system for both its Sequoyah and Watts Bar plants. Upon reevaluation of the volume of trash being generated, the expected volume reduction factor (VRF) is able to be received because of the PVC content of our trash and the cost to build the facility. TVA elected to cancel its incineration option and look at less expensive ways of volume reducting its dry active waste. Equipment such as high pressure compactors and shredder compactors were expected to be cost effective.

TABLE III

Areas Where Trash Is Generated

	Non-Outage Periods %	Outage Periods %
Reactor Building	0	25 - 40
Auxilliary and Fuel Building	34 - 40	23
Radwaste Area	25	20
Laundry	15	12
Chemistry Labs	3 - 5	3 - 5
Decon Area	18	15

TABLE IV

Activity Distribution (hot spot)

Less than 5 MR/Hr surface contact	80 - 90%
Less than 50 MR/Hr surface contact	10 - 15%
Less than 100 MR/Hr surface contact	5 - 10%
Greater than 100 MR/Hr surface contact	1%

SHREDDER/COMPACTOR AND HIGH FORCED OR SUPERCOMPACTORS

We had data on thirteen (13) different high pressured compactor systems and two (2) shredder/compactor systems supplied to us from all over the world. Table V shows our prebid expectations. We used this data to develop a bid specification. Actual bids were received on seven (7) different compactors or shredder compactors (see Table V). We compared those against our present system and we developed several figures which we used to aid in our selection. The key facts in being able to make the recommendation were to know exactly what the composition was in our noncompactable waste and the volume of noncompactable waste that we would be processing. We also needed to determine what impact our noncompactables should have on the compaction force necessary to do the job. We felt it was important not to buy a system that was excessively large both in a physical sense and in compaction force if it wasn't necessary. During our prebid review we looked at systems that ranged from as low as 50,000 lbs compaction force to 8,000,000 lbs compaction force. We actually had testing done on smaller scale systems starting at about 20 PSI force on up to 7100 PSI. We also had data supplied to us on other testing done on most foreign systems (see Tables VI and VII). Two (2) of the figures we generated for our evaluation were Volume Reduction vs. Compaction Force and Density (PCF) vs. Compaction Force (PSI). We then plotted on the figures data on the compactability of the various types of waste. We located on this figure a line which represented the compactor being evaluated and its compaction force. This showed us the relationship of the various systems and predicted the various volume reduction factors we were going to receive from each. We plotted five (5) different curves

TABLE V

Estimated Compactor Results Prior to /Bid Writing

	Expected Density	VFR	Cost of Equipment
	LB/FT^3		
Noncompacted DAW	7	-	-
Surplus Equipment Compactor (18,000 lbs)	26	3.7	$3,000
Stock Compactor (30,000 lbs)	35	5.7	$85,000
Box Compactor Alone (100,000 lbs)	25-35	3.5-5	$125,000 & up
Box Compactor and Shredder	45-55	6.4-7.9	$350,000
Supercompactor	70 & up	10 & up	$1,000,000 & up

TABLE VI

Volume Reduction Factor For Various Compaction Forces

Ram Force	Avg. lbs/cu.ft.	VR Factor
50 PSI	35	3.0:1
60 PSI	38.6	3.5:1
70 PSI*	41.9	4.0:1

Material used for testing was composed of 84.8% normally compactable type material with a density of 9 lbs/cu.ft. and 15.2% normally noncompactable material with a density of 50 lbs/cu.ft. The high density of the compacted waste was due to metal material that was mixed in with the noncompactables.

* TVA upgraded one of its existing drum compactors to a ram force of 70 PSI over the surface area of a 55 gallon drum. This represented a total ram force of about 31,000 lbs. This also equated to a total ram force of approximately 250,000 lbs. for a box compactor.

on the figure for steel pipe, plastics, sheeting and rubber, insulation material, glass and filter media.

From this we arrived at a VRF for each system. We took the initial volume of waste we had for both compactable and noncompactable and came up with a VRF for each separate waste component. We then totalled these to show the systems total VRF. From this we formulated the total operating and disposal cost per system. Our

TABLE VII

Volume Reduction Factors
For Various High Compaction Forces

Foreign data supplied on high compation force testing - Compaction force of 28,400 PSI

Material		Density
Steel pipe	300	30 lbs/cu. ft.
Plastic sheeting	50	10 lbs/cu. ft.
Insulation	66	10 lbs/cu. ft.
Cloth	80	10 lbs/cu. ft.
Paper	70	5 lbs/cu. ft.

No additional benefit with increased force

Material	Compaction Force
Cloth, rags and polyvinyl	1200 PSI
Concrete and glass	1500 PSI

Typical compacted material	(Precompacted)	Noncompactabl
1500 PSI	VRF = 2.96	VRF = 2.12
9750 PSI	VRF = 3.46	VRF = 2.68

bids ranged from around $140,000 to $2,000,000 for a compactor ranging from 30 PSI to 7000 PSI compaction force. For this paper we developed Fig. 1. This figure shows the VR Factors for both typical compactable and noncompactable material. Curve No. I represents the VR Factor you can expect to receive from normally compactable material. The number derived from this curve must be multiplied by a factor of two (2) to obtain the VR Factor. Curve No. II represents the VR Factor for normally noncompactable material. This shows how important it is that you know your initial input mix in order to do an adequate cost evaluation. All the compactor systems offered an improvement over a low pressure drum compactor. The high force or supercompactors all appeared to be able to be cost justified on the basis of noncompactables alone if a large percent of the waste to be processed is noncompactable or there is a large backlog. As the volumes of the noncompactables decreases the cost effectiveness of the system decreases.

Some of the systems that we were looking at had shredders associated with them. They generally were lower compactor pressure systems but because of the shredding ability they received some additional VR credit. We evaluated the effectiveness of preshredding trash both as a volume reduction technique and as an improved method of handling large items. We used a value of 25% additional reduction in volume at lower compaction forces and gave no credit at higher compaction forces. Since our evaluation additional data has become available which indicates a large VRF might be obtainable by preshredding (see Table VIII). As the compaction pressure increased the benefit of shredding decreased from a VRF standpoint. However, we did feel we would receive an additional benefit from shredding since it homongenized the waste feed stream. It also eleminates or reduces the handling of material by reducing the need to cut material to fit into 55 gallon drums or boxes.

We were also looking and trying to use larger containers. When you load a truck it may only take 10 to 12 boxes whereas it could take as many as 100 to 150

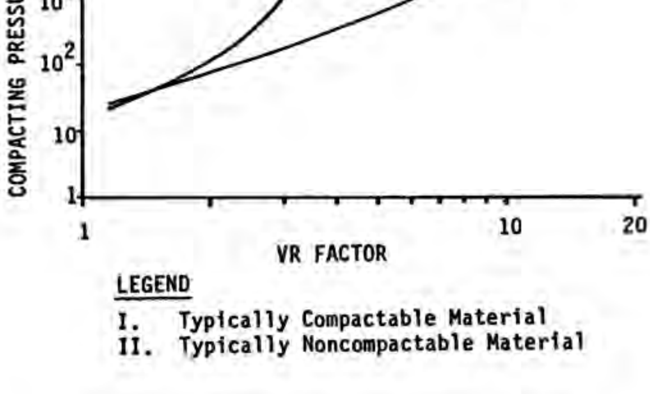

Fig. 1. Typical Volume Reduction Curves.

drums to load the same truck. A large labor savings can be realized not only from the loading of the truck but also from the labeling and documentation that is necessary to account for material being shipped and stored. So it is advantageous to increase the size of the container if possible, either with a shredder or a compactor option. Our evaluations left out labor cost even though we did feel there was a benefit in reduced man hours.

TABLE VIII

Volume Reduction Benefits Of Preshredding Waste Prior To Low Force Compaction

Uncompacted waste density (9 containers)		13.5 lbs/ft^3
Compacted waste density	1st Container	31.5 lbs/ft^3
	2nd Container	30.1 lbs/ft^3
Shredded/Compacted density	1st Container	47.2 lbs/ft^3
	2nd Container	44.7 lbs/ft^3
Box weights including containers & lids		
(656 lbs)		
Compacted	1st Container	3529 lbs
	2nd Container	3368 lbs
Shredded/Compacted	1st Container	4900 lbs
	2nd Container	4680 lbs
% Density increase Shredded/Compacted / Compacted	1st Container	49.8%
	2nd Container	48.3%

Data supplied by Impell Corp. from testing conducted at CP&L's Brunwick plant.

Based on Sequoyah's mix of compactables and noncompactables the most cost effective compaction force was chosen (see Table IX). A new type of design was decided on which differed from the typical high forced compactors in that no precompaction was required. Instead waste is shredded then compacted directly by the high forced compactor. The resultant billet is then forced into a cell of a large chambered DAW box. The use of high force compactor shredder thus allows the blending of DAW waste from different plant locations and waste forms to better meet new regulations and plant shipping needs. It also allows the plant to continue to use DAW boxes which the plant finds the least manpower intense and easiest to handle. Table IX shows the payback periods for several compactors that were evaluated. Base was the plants existing compactor. Venders 1, 3 and 4 were supercompactors of various compaction forces. Vendor 2 is the shredder and high forced compactor that was selected.

CONCLUSION

TVA awarded a contract to JGC (Vendor # 2 on Table IX). The JGC system includes a shredder high force box compactor, ventilation and radiation monitoring equipment. The current schedule is for the equipment to be delivered August, 1985.

TABLE IX

Payback Periods For Various Compactables And Noncompactables Ratios

COMPACTOR	COMP. VRF	NON-COMP. VRF	SYS. VRF	BURIAL COST	SAVING/YR.	PAYBACK MONTHS
80% COMPACTABLES - 20% NONCOMPACTABLES						
Base	2.5 : 1	1.0 : 1	2.2 : 1	$ 981,818	--------	-----------
*Shredder Comp.	3.0 : 1	1.0 : 1	2.6 : 1	$ 830,769	$151,049	25.8 months
Vendor # 1 (1770 psi)	6.4 : 1	7.5 : 1	6.62 : 1	$ 326,284	$655,534	17.2 months
*Vendor # 2 (3000 psi)	6.6 : 1	8.8 : 1	7.04 : 1	$ 306,818	$675,000	9.96 months
Vendor # 3 (4424 psi)	6.9 : 1	9.6 : 1	7.44 : 1	$ 290,322	$691,496	13.9 months
Vendor # 4 (6637 psi)	7.1 : 1	10.75 : 1	7.83 : 1	$ 275,862	$705,956	30.4 months
60% COMPACTABLES - 40% NONCOMPACTABLES						
Base	2.5 : 1	1.0 : 1	1.9 : 1	$1,136,842	--------	-----------
*Shredder Comp.	3.0 : 1	1.0 : 1	2.2 : 1	$ 981,818	$155,024	25.2 months
Vendor # 1	6.4 : 1	7.5 : 1	6.84 : 1	$ 315,789	$821,053	13.7 months
*Vendor # 2	6.6 : 1	8.8 : 1	7.48 : 1	$ 288,770	$848,072	7.9 months
Vendor # 3	6.9 : 1	9.6 : 1	7.98 : 1	$ 270,677	$866,165	11.1 months
Vendor # 4	7.1 : 1	10.75 : 1	8.56 : 1	$ 252,336	$884,506	24.3 months

* Additional benefit for labor saving due to handling of non-compactables (pre compaction, pre cutting and loading of trucks)

BASIS: $27.ft^3$ Burial Price
80,000 ft^3 unprocessed waste volume