OPERATING, MAINTENANCE, REPAIR AND COST EXPERIENCE FOR A CONTROLLED AIR MUNICIPAL INCINERATOR

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ABSTRACT:

The performance of a 12 ton per day solid waste incinerator over a four year period is described. A factory built controlled air incinerator was installed near the village of Lake Cowichan, B.C. in 1975 to burn the municipal refuse from a population of 7,000 persons. Information is presented on refuse quantities processed, operating methods developed by the owner, auxiliary fuel consumption, maintenance and repair experience, and annual and unit costs.

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1 SUMMARY

The Cowichan Valley Regional District is located on southern Vancouver Island in the Province of British Columbia. In 1975, the District constructed the Meade Creek plant and installed a controlled air incinerator to burn the municipal solid wastes from the Village of Lake Cowichan and the surrounding unorganized areas. The plant serves a population of 7,000 persons and has a capacity of 12 tons per day. The incinerator was manufactured by Consumat System Inc. of Richmond, Virginia, U.S.A.

The Solid Waste Management Branch of Environment Canada commissioned Allan M. McCrae, P. Eng. to survey the plant to determine its reduction efficiencies, the density of particulate contained in its emissions and the costs. Field studies were conducted after nine months of regular operation and the report "An Evaluation of a Controlled Air Municipal Incinerator" (1) was published in 1976. Copies were made available to municipal and institutional authorities and others interested in this type of solid waste treatment.

This present study was commissioned to supplement the previous study. The Owner has operated the plant for four years and has gained considerable operating experience and cost data. Because it is difficult to anticipate the continuing problems and benefits of operating an uncommon treatment system, this information should be of value to others considering installing this type of plant.

A review of the number of residences served and the total waste generated indicates a steady growth in population served and the quantity of waste processed. The quantity of wastes processed during the peak week in 1975 was 52.5 tons and in 1978 was 60 tons. The year average per week in 1975 was 37 tons and in 1978 was 46 tons.

The capacity of the incinerator according to the manufacturer (2) is 9.5 to 12.5 tons per 10 hour day. At 12 tons per day for a six day week the capacity is 72 tons per week. The summer weekly average quantity of waste treated in 1978 was 49 tons or 68 percent capacity. The peak week was 60 tons. If the plant can be operated for seven days per week for short periods, the peak week in 1978 represents 71 percent of capacity.

In order to achieve the best results from the plant at the least cost, the Regional District varies the operating mode daily to suit the ambient weather conditions and the characteristics and moisture content of the waste. Every effort is made to minimize the fuel oil consumption through versatile operating procedures.

Experience from the first year of operation and information from other authorities indicates that fuel consumption of over 7 gallons per ton of waste processed could be expected. Careful operation of the Meade Creek plant has significantly reduced this, the average for 1978 being 2.4 Imperial gallons per ton.

The operators of the plant regularly check, maintain and repair the incinerator and ancillary equipment. Major overhauls to the front end loaders and repairs to specialized parts such as motors and controls are carried out by others. During the four years of operation, wastes have never had to be diverted to alternative disposal systems. The burning of wastes on two occasions had to be delayed for short periods because of breakdowns of the plant or tractor loading equipment.

The repair of refractory is the most common non-routine maintenance task. This is not time consuming or expensive, however, it is considered important in extending the life expectancy of the plant.

The facility component requiring repairs the second most frequently was the older tractor loader. Repairs were required for both mechanical and tire failures.

The total capital cost of the waste treatment and disposal facility including initial construction and subsequent minor additions was $226,740.

The annual cost of operating the plant including capital financing, overhead, labour, energy, and miscellaneous costs over four years has averaged $81,200.

It is estimated that the annual weight of solid waste treated by the incinerator has averaged 2150 tons which indicates an average unit cost of $38 per ton. This cost includes the expenses of ancillary facilities such as derelict car storage and disposal and demolition waste disposal by landfilling. It is considered that, although these are important functions and if were operated independently would be expensive, they do not significantly add to the annual cost of the incinerator operation.

The wastes are collected by a private company under contract, the average costs to the Owner including administration costs has averaged $35.04 per ton.

The Cowichan Valley Regional District are satisfied with the operation of the incinerator and are proud of the installation from which a minimum of environmental degradation is achieved.

Two similar but larger plants are planned by the Regional District to serve other areas, a 20 ton per day plant and a 50 ton per day plant. These two facilities were constructed during summer of 1979. This major expansion plan is tangible proof of the Owners satisfaction with the treatment and disposal system.

2 INTRODUCTION

2.1 General

In British Columbia local governmental structure consists of incorporated municipalities, school districts, regional districts, improvement districts, and a number of special purpose districts. The jurisdictional area of a Regional District usually contains a number of municipalities and large unincorporated areas. Regional Districts provide and administer services for unincorporated areas and services transcending municipal boundaries.

The Regional District of Cowichan Valley is located on Vancouver Island north of Victoria. Its area contains four incorporated municipalities and large rural and uninhabited forested areas. In 1972 under letters patent from the Provincial Government the Regional District of Cowichan Valley assumed responsibility for solid waste disposal within its boundaries. The most urgent requirement at the time was to provide new municipal waste disposal facilities to serve the Village of Lake Cowichan and the surrounding small unincorporated communities and rural areas. The existing facility was a traditional 'dump' where the refuse was deposited at the top of a bank, burned, and the residue pushed down the slope. The lease for the property, containing the dump, was due to expire and could not be renewed.

The Regional District decided to provide a proper landfill facility and searched for a suitable site. The only site that could be found was not suitable for landfilling raw municipal wastes because of its visibility and limited capacity. Due to these conditions, it was decided to use the site and treat the wastes by incineration. This would reduce both visual impact and waste volume leading to an extended life for the facility.

Tenders were called in early 1974 for an incinerator plant. Five tenders were submitted, the lowest price was from Engineered Waste Control Systems Ltd. of Winnipeg for a Consumat Model C-760M with ML 525 loader.

The plant was installed and tested in February 1975.

Because this was the first installation of this type of municipal solid waste treatment system in Canada, the Solid Waste Management Branch of Environment Canada commissioned a study to determine the treatment efficiency, the particulate emission rates, and the operating costs.

The plant testing for this study was carried out from October 1975 to February 1976, and the results were published in the report by Allan M. McCrae, entitled "An Evaluation of a Controlled Air Municipal Incinerator." (1)

2.2 Purpose of the Present Study

The evaluation study carried out in 1976 was found to be of wide interest to those across Canada contemplating this type of solid waste treatment. The study however was limited because of the relatively short period of operating experience. The Regional District were still experimenting with alternative operating modes attempting to achieve maximum efficiency and economy. Also because the plant was new, there was little data available to assess the reliability and the repair and replacement costs.

The purpose of this supplementary study is to report on the Regional District's operating and maintenance experience and costs for the four years of plant operation.

2.3 Acknowledgements

The owner of the plant, the Cowichan Valley Regional District, have cooperated unreservedly in providing the data and information reported in this study. They are to be commended for freely making available to others the benefit of their experience. Particularly helpful at the Regional District have been Mr. Denis C. Leeman, Superintendent of Public Works and Mr. Mel C. H. Miller, Assistant Superintendent of Public Works, who provided the data and descriptions of operating experience and assisted in the field survey; Mr. Peter Hayward, Secretary-Treasurer, who provided cost details; and Mr. Ralph D. Kier, Administrator, who supported the study.

3 SUMMARY OF PREVIOUS STUDY

3.1 Collection Area

The area served by the incinerator contains one incorporated municipality, the Village of Lake Cowichan; three unorganized communities of Honeymoon Bay, Youbou, and Caycuse; and a large rural area. The collection area is shown on Figure 1. The principal industry of the area is forestry with three large lumber mills and timber harvesting for a pulp mill located outside the area.

The refuse from the area was collected by a private firm with one compactor truck operating under contract to the Regional District. The area was divided into five collection areas with each route serviced once per week. The customers served on each route are shown on Table 3.1.

TABLE 3.1

Refuse Collection in 1975[a]

Area	Residences	Commercial and Industrial Bins	Route Miles
1. Central and eastern part of Village	350	8	10.1
2. Southern part of Village and adjacent area	373		24.7
3. Honeymoon Bay and Caycuse	219	7	44.8
4. Northern part of Village and river bottom	314		24
5. Youbou	417		20.9
TOTALS	1,673	15	124.5

[a]See Figure 2, Reference 1.

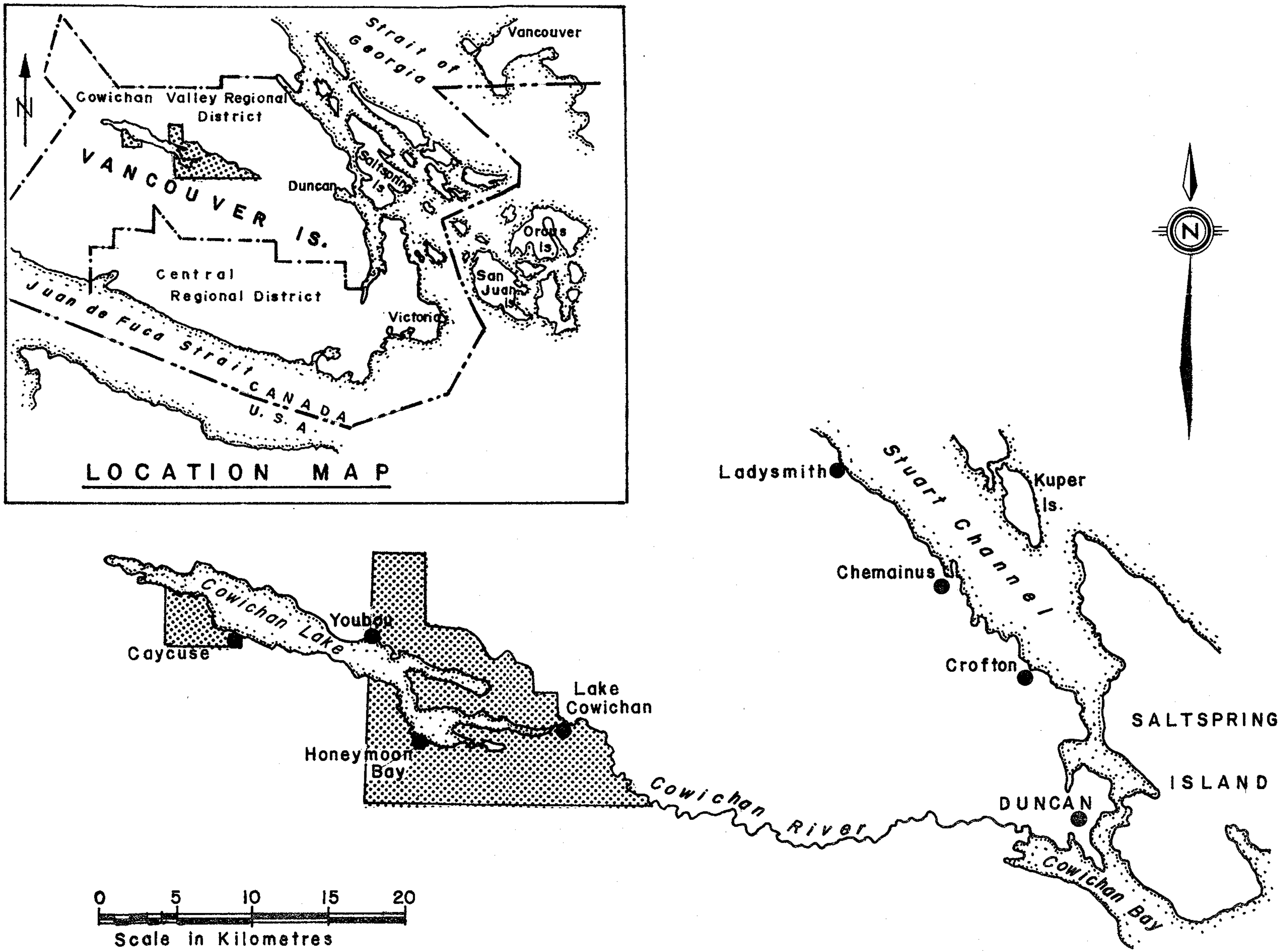


FIGURE I SERVICE AREA

Although most residences and businesses are served by the collection service, it was noted during the study that a number of individuals and businesses delivered wastes directly to the plant. Many of the individuals were delivering extra quantities of waste in excess of the prescribed limits allowed by the service.

The researchers at the time, noted a sense of community pride in the facility and an appreciation of the neat, well managed operation.

3.2 Refuse

The incinerator plant is not equipped with weigh scales so it was difficult to accurately measure the quantities being processed. During the periods of field testing the collection vehicle was diverted for weighing on the scales of a local asphalt plant owned by Duncan Paving Ltd. Because this plant is located 16.3 miles from the incinerator, weighing was expensive and time consuming.

The Regional District kept regular records of the number of loader charges made to the incinerator. The weighed quantities of wastes were used to develop average unit weights for each charge. This factor was used to estimate annual averages and seasonal variations. A summary of the various refuse quantity parameters determined is shown in Table 3.2.

The refuse processed at the plant is primarily from residential services with some contributed by stores and garages. No significant amounts of industrial waste are processed at the plant.

To measure the quality of the waste samples were sorted into standard classifications and weighed. Samples were taken by dividing the receiving floor area into a

TABLE 3.2

Refuse Quantities - 1975

Description	Measure
1. Number of Residences[a]	1,673
2. Service Population (assuming 3.5 persons per residence)[a]	5,860 persons
3. Quantity of waste processed[b]	
(a) summer	51.6 T per week
(b) winter	37.0 T per week
(c) year	42.2 T per week
4. Generation rate[b]	
(a) summer	2.07 lbs per cap per day
(b) winter	1.63 lbs per cap per day
(c) year	1.86 lbs per cap per day
5. Collection vehicle[c] (compactor truck)	
(a) volume	15 cu. yd.
(b) median load	7,700 lbs.
(c) density	513 lbs per cu. yd. 19 lbs per cu. ft.
6. Incinerator loader	
(a) volume	61 cu. ft.
(b) average load[d]	630 lbs.
(c) density	10.4 lbs per cu. ft.

[a]See Table 2, Ref. 1.

[b]See Table 3, Ref 1.

[c]From unpublished work notes for Ref 1.

[d]See Sec. 5.3 Ref 1.

number grid and selecting samples in accordance with a sequence of random numbers. The sample size averaged 150 lbs. with the largest sample being 224 lbs. and the smallest 66 lbs. A total of 32 samples were characterized during the field testing. Table 3.3 summarizes the results of this testing.

TABLE 3.3

Characterization of Wastes Processed - 1975[a]

Item	Categories	Mean Proportion by Weight Percent	95 Percent Confidence Interval Percent
1.	Paper Products	36.49	32.38-40.59
2.	Food Wastes	33.75	29.53-37.97
3.	Metals	9.65	8.22-11.07
4.	Glass, Ceramics	8.28	6.65-9.91
5.	Dirt, Rocks, Ash	1.15	0.19-2.12
6.	Rubber	0.32	0.15-0.49
7.	Leather	0.16	0.03-0.29
8.	Plastics	3.48	2.57-4.39
9.	Textiles	3.20	1.71-4.69
10.	Wood	0.89	0.46-1.32
11.	Garden Waste	0.31	0.02-0.60
12.	Fines, ½" minus	2.32	1.80-2.85
A	Non-combustibles (items 3, 4, 5)	19.08	16.63-21.53
B	Combustibles (items 1, 2, and 6-12 incl.)	80.92	78.47-83.37

[a]See Table 6, Ref. 1.

3.3 Incinerator Plant

The incinerator is a factory built Consumat Systems Inc. of Richmond, Virginia, U.S.A. model C-760M with a ML-525 loader manufactured in Houston, Texas. The plant consists of a loader mechanism, a primary chamber, a secondary chamber and a discharge stack.

The loader is a rectangular ram mechanism sealed off from the primary chamber by a fire door. The charging chamber is 3.5 feet wide by 7 feet long by 2.5 feet deep for a charge volume of 61 cubic feet. Charging is hydraulically powered and automatically sequenced. When the loader chamber is filled and the start button pressed the loading door closes, the fire door opens and the ram pushes the waste into the combustion chamber. The ram then withdraws and the fire door closes.

The primary combustion chamber is a steel cylinder 10 feet in diameter with 2 inches of insulation and 5 inches of refractory lining. The cylinder is 12 feet long giving a gross internal volume of 750 cubic feet. The primary chamber is equipped with two burners to initially ignite the charged solid waste. Normally these burners operate for about 15 minutes when the plant is first charged. With normal wastes, combustion is self sustaining after starting.

Air is metered into the primary chamber by a fan discharging through ports located at about 4 and 6 o'clock on the perimeter and in the front wall. During testing in 1975 the unburned combustibles in the residue were measured and averaged almost one percent of the original refuse quantity by weight. After the testing was completed, an additional air supply plenum was installed in the bottom of the primary combustion chamber to reduce this proportion.

The secondary chamber is a small chamber adjacent to the bottom of the stack. It is equipped with a burner and a forced air supply for incinerating combustibles driven off the refuse in the primary chamber.

Emissions from the secondary chamber are discharged to atmosphere through a stack approximately 15 feet above the secondary chamber. The stack is equipped with an anular orifice for the intake of diluting air. The stack is 31 inches outside diameter and is lined with 3 inches thick refractory.

3.4 Incinerator Process

The method of incineration of the wastes is known as a controlled air process. Waste is heated in the primary chamber and its combustion reaction is controlled by limiting the amount of air available to less than required for stoichiometric requirements. The controlled combustion releases heat to sustain the process and gasifies and volatizes the hydrocarbons. The conditions in the chamber are as quiescent and free of turbulence as possible.

These incinerating conditions produce volatile gasses containing combustible particulate but little inert fly ash. The combustible gasses and material in the smoke are burned in the secondary chamber. A blower injects forced air to sustain combustion and an auxillary burner supplies the heat necessary to maintain required temperatures.

Gasses from the secondary chamber are discharged to the stack for discharge to the atmosphere. An anular orifice located in the lower part of the stack admits air for diluting and cooling the gasses.

A schematic illustration of the controlled air incinerator process is shown in Figure 2.

3.5 Residue

During field testing the volume and average density of the residue was measured to obtain a total residue weight. The volume and weight were compared with the refuse processed to obtain process reduction efficiencies.

The average reductions in waste quantities obtained by the incineration process are shown in Table 3.4.

It is noted that on the average the weight of refuse was reduced by 72 percent and the volume by 93.4 percent. The non-combustibles in the refuse were measured to be 18.7 percent by weight. If it is assumed these are unchanged in the combustion process then the combustible portion was reduced by 89 percent.

Samples of the residue were characterized into metals; glass, ceramics and rocks; unburned combustibles; and fines passing a 1/2 inch screen. The average proportion of each characteristic is shown in Table 3.5.

One sample of the fines portion was analysed by spectograph to determine its chemical makeup. The results of this one test are shown in Table 3.6.

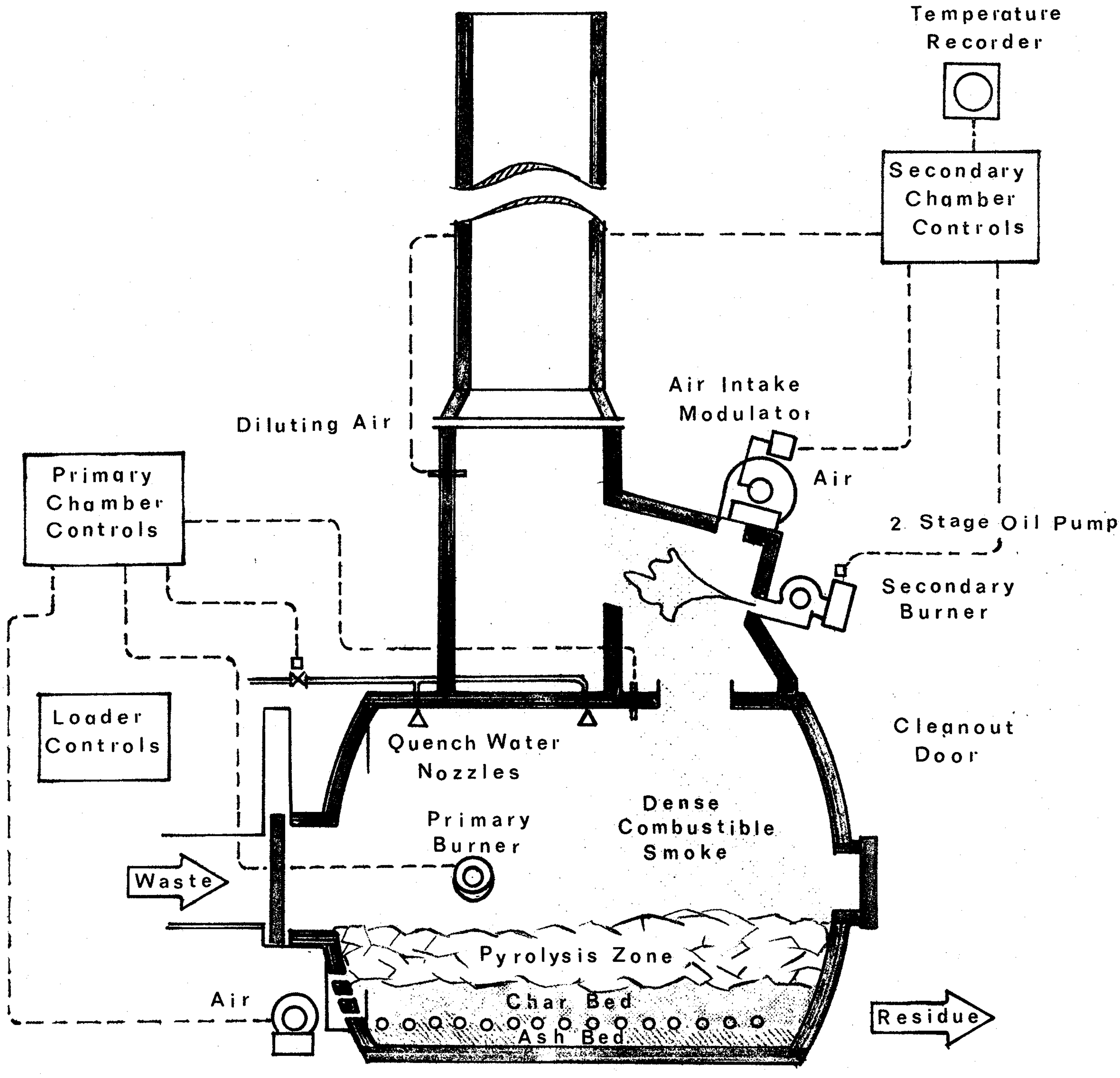


Fig.2 CONTROLLED AIR INCINERATION PROCESS

TABLE 3.4

Solid Waste to Residue Reduction Ratios[a] - 1975

Parameter	Value
1. Number of Test Days	7
2. Refuse Processed:	
average volume	2,436 cu. ft. per day
average weight	22,784 lbs per day[c]
3. Average refuse density	9.46 lbs per cu. ft. (SD[d] 1.45)
4. Residue:	
average volume	163 cu. ft. per day
average density[b]	28.03 lbs per cu. ft. (SD 7.20)
average weight	6,386 lbs per day
5. Ratio of Residue to Refuse:	
by volume average	6.85 percent (SD 1.39)
by weight average	28.03 percent (SD 5.77)
6. Ratio of non-combustible in refuse by weight	19.01 percent (SD 4.37)

[a]Data from Ref. 1, Table 9, p. 44.

[b]Density is taken after cleanout but before land filling.

[c]Plant is rated at 10 to 12.5 T per day so testing was carried out within the design operating range.

[d]SD is standard deviation.

TABLE 3.5

Residue Characteristics[a] - 1975

Constituent	Proportion[b] %
Metals	18.3
Glass, Ceramic, Rocks, etc.	46.4
Unburned Combustibles	0.96
Fines Passing 1/2 inch screen	34.4

[a]Data from Ref. 1, Table 35, p. 45.

[b]Proportions are averages of four samples.

TABLE 3.6

Chemical Composition of Fines Portion of Residue[a] - 1975

Element	Proportion Percent
1. Iron and Silicon combined	83
2. Calcium	5
3. Aluminum	4
4. Magnesium, Sodium, and Titanium each	2
5. Manganese, Potassium, Barium and Tin	$\geq$ .3 $\leq$ 1.0
6. Chromium, Copper, Zinc each	$\leq$ 0.1
7. Strontium, Lead, Molybdenum, Vanadium each	0.10

[a]Data is from Ref. 1, Table 11, p. 47, based on spectrographic analysis of one sample.

3.6 Summary of Solid Waste Reduction to Residue

The reduction of the constituents of the solid waste by the Meade Creek incinerator are summarized in Figure 3.

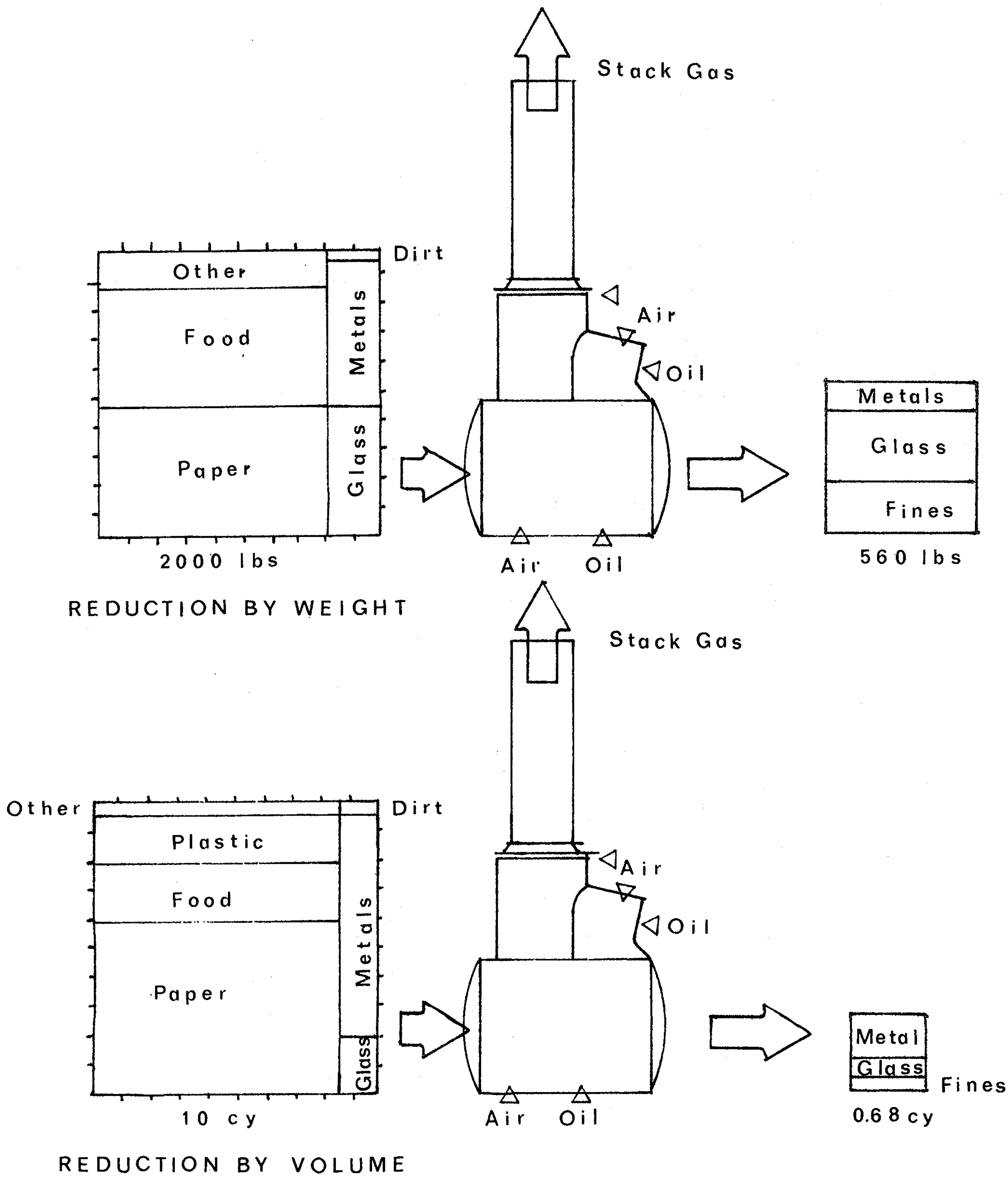


Fig 3 WASTE REDUCTION RATIOS 1975

3.7 Emissions

At the time of implementation of this project the Provincial Government authorities were in the process of developing standards for emission contaminants. In an attempt to anticipate the standards, tenders were based on two alternative particulate emission criteria, a maximum of 0.15 and 0.10 grains per standard cubic foot adjusted to 12 percent carbon dioxide. Five tenders were received, the lowest price was for equipment meeting the more stringent standard.

The permit for operation of the station granted by the Pollution Control Branch did not specify particulate emissions as anticipated but rather a minimum stack gas temperature of 1800°F and opacity standards. About six months later when the Provincial Government issued their objective for Municipal Type Waste Discharges in British Columbia[4] the maximum particulate emissions were specified as 0.100 grains per standard cubic foot corrected to 12 percent carbon dioxide.

Under the Contract specifications acceptance of the plant was contingent on the particulate discharge rate being less than the standard during normal operation. Four tests were carried out in April 1975 with the test results being 0.47, 0.057, 0.090, and 0.063 grains per SCFC 12% CO_2.

One of the principal objectives of the 1976 evaluation study was to test the emission performance of the plant after it had operated for a period and was no longer in new, factory condition.

Unfortunately the emission testing program for the study encountered a series of difficulties both with faults in the plant and failures of the testing equipment.

Testing equipment problems were caused by the high gas temperature breaking and accelerating corrosion of the material used to construct the nozzle and probe. Average temperatures at the sampling location for each week were 1139°F, 1156°F, 1137°F, 1070°F, and 1124°F. The maximum average temperature for a test series was 1286°F and the minimum 793°F.

For the first week a stainless steel water cooled probe was used with a stainless steel nozzle. For the second week the stainless steel nozzle was replaced with one of inconel. It was suspected and verified by spectrographic analysis that the particulate being measured contained quantities of corrosion products from the probe. The degree of interference was assessed and the results adjusted.

For the third and fourth week test series a ceramic nozzle with a pyrex probe liner was used. Because pyrex begins to soften and quartz becomes fragile at temperatures over 800°F, extreme care had to be taken; even with care a number of breakages occurred. Prior to the fifth and last week the quartz nozzle fractured and an inconel nozzle had to be used.

The first week of particulate testing gave results two and one half times the maximum standard. The fuel burner nozzles were thought to be "lacquered" restricting the fuel oil injection. The nozzles were cleaned for the second test week, however the test results did not improve. The nozzles were replaced which significantly improved the emission tests for the third and fourth weeks, however, readings were still greater than the required standard of 0.100 grains per SCF @ 12 percent carbon dioxide.

The manufacturer's representative considered the particulate test results to be non-representative of the plant's normal capability. A specialist from their factory carried out a detailed inspection of the plant and discovered that the secondary burner was not equipped with a choke ring. This part directs the air required through the air diffuser for proper combustion.

A choke ring was installed and other suspect parts were replaced. A final series of particulate tests were conducted with the results shown in Table 3.7.

TABLE 3.7
Emission Test Results after Incinerator was Repaired[a] - 1976

Test	Particulate Emissions: gr/SCF @ 12% CO_2	Particulate Emissions: lbs/Ton of Refuse	Av Temp Test pt °F	Av Vol Flow SCFM
Feb. 20, 1976				
Day 9 #1	0.125	1.61	990	3897
#2	0.090	1.20	1196	4248
Feb. 21, 1976				
Day 10 #1[b]	0.055	0.53	1150	4525
#2[b]	0.062	0.60	1160	4531
#3[b]	0.083	0.79	1124	4507
Average	0.083	0.95	1124	4342

[a]Data from Table 23, Ref. 1, p. 76.

[b]Paint cans, aerosol tins and potentially explosive objects were removed from waste stream.

4 REFUSE QUANTITY AND QUALITY

4.1 Collection Areas and Methods

The capital and operating costs for the Meade Creek Thermal Reduction Plant are financed from property taxes from the Village of Lake Cowichan and adjacent Unorganized areas.

Collection of refuse from the areas is carried out by a private company under contract to the Cowichan Valley Regional District. Refuse is collected by the Contractor only from those parts of the unorganized areas where development densities permit economical operation. Principally the services are located in the Valley of Lake Cowichan and the unorganized communities of Mesachie Lake, Honeymoon Bay, Caycuse and Youbou. The boundaries of collection have not changed since the previous study and are shown on Figure 1. Refuse is collected on a weekly frequency. The number of customers serviced by the collection contractor are as shown in Table 4.1.

TABLE 4.1

Customers Serviced by Collection Contractor

Location	1976		1977		1978	
	Res.	Comm.	Res.	Comm.	Res.	Comm.
Lake Cowichan			759	87	780	91
Outside Lake Cowichan	1140	N/a	397	17	417	15
Mesachie Lake			80	8	82	8
Honeymoon Bay	219	N/A	182	2	192	2
Caycuse			97	5	97	5
Youbou	417	N/A	429	7	431	9
Totals	1776	N/A	1944	126	1999	130
Growth	Base		+9.5%		+12.6%	

All residences of the area taxed for the facility can individually deliver their domestic refuse to the plant for disposal free of direct charge.

Under the terms of the collective contract each residence is entitled to the curbside pickup of two standard garbage cans of waste each week. It was noted during the previous study that many individuals and some businesses personally deliver wastes for disposal. It is surmised that individually delivered wastes is refuse which was in excess of the collection specifications allowance, refuse that was missed in the weekly collection schedule, or refuse originating outside the collection area.

The operators estimate that about 15 tons per week or 25 percent of the total refuse is delivered on an individual basis.

4.2 Refuse Quantity

Because convenient scales are still not available the weight of refuse being processed can only be inferred from other records. The plant operator keeps an accurate record of the number of charges processed daily. The loader chamber is 7 feet by 3.5 feet by 2.5 feet for a volume of 61 cubic feet.

In the 1976 study, by comparing the number of charges with the weight of delivered refuse it was determined that each charge weighed 640 pounds giving a refuse density in the loader of 10.5 pounds per cubic foot. On the advice of a factory representative operational procedures were subsequently revised to charge the incinerator with smaller and less dense loads.

As part of this supplementary study one collection truck load of typical refuse was diverted to the Duncan Paving Limited scales for weighing and the number of incinerator charges making up this load was observed. The net weight of the load was 7,220 pounds and the refuse made up 18 loads for a weight of 401 pounds per load and density of 6.6 pounds per cubic foot. The weather for the preceding week was dry.

It is probable that the density of refuse is greater in the winter than summer with the higher moisture content and that the weight of charges will vary to some degree depending on the habits of a particular operator. The overall variability however, it is thought, is not large because most of the refuse is protected by plastic bags and the operators are efficiently supervised to conform to standard procedures.

The operator's records for the plant have been analyzed to determine the quantities of wastes processed by the incinerator. The quantities are shown in Table 4.2.

4.3 Refuse Quality

The character of the collection area has not changed significantly since the previous study carried out in winter of 1975 to 1976. It is not expected that the characteristics of the waste as previously measured have changed. These results are summarized in Table 3.3.

Since the previous study, two interesting developments have occurred related to specific waste types. The Regional District, as an adjunct to the incineration operation, collects and stores at a separate location on the site, derelict automobiles and large manufactured goods such as household appliances. When quantities warrant, a portable compactor operated by the Provincial Government compresses these goods for future transportation to a recycling plant in Vancouver. Recently, a private company has been negotiating with the Regional District for the right to dispose of these materials. This indicates that the commercial value of this salvage metal is now high enough to make recovery commercially feasible.

TABLE 4.2

Quantity of Refuse Processed[a]

Description	1976		1977		1978	
	Charges	Weight tons	Charges	Weight tons	Charges	Weight tons
Season and Annual Quantities:						
Summer, Apr.-Sept., 26 wks.	5210	1044	5364	1075	6281	1259
Winter, Jan.-Mar.+ Oct.-Dec., 26 wks.	N/A	-	5019	1006	5561	1115
Total Annual	N/A		10383	2082	11842	2374
Average Quantity per Week:						
Summer	200	40	206	41	242	49
Winter	N/A	-	193	39	214	43
Annual	N/A	-	200	40	228	46
Peak Week	245	49	249	50	300	60
Minimum Week	151	30	142	28	190	38
Growth from Previous Year:						
Summer %	N/A		2.95		17.10	
Winter %	N/A		N/A		10.80	
Annual	N/A		N/A		14.05	
Estimated Population[c]	6220		6800		7000	
Generation Rates in Pounds per Capita per Day:						
Summer	1.84		1.72		2.00	
Winter	N/A		1.64		1.76	
Annual	N/A		1.68		1.87	

[a] Based on daily operating records of the number of charges processed. One charge contains 61 cubic feet or 2.26 cubic yards.

[b] Assumes a constant index of 401 pounds per charge.

[c] Based on 3.5 persons per household served, see Table 4.1.

The following number of cars have been compressed and shipped from the site:

1975 - 175 cars
1976 - 177
1977 - 80
1978 - 245
Average 170 cars

In the past year 195 tons of white goods were also shipped.

In September 1978 a private disposal company, Oceangard Waste Management Systems Ltd., which collect solid wastes from international ocean going vessels, submitted a proposal requesting that the Regional District dispose of these wastes.[5] The 'International Garbage' will be transported to the incinerator from the Vancouver Island ports of Port Alberni, Nanaimo, Harmac, Crofton, Chemainus, Cowichan Bay, and Victoria. Under the terms of the agreement the Regional District will charge $50.00 per ton for disposing of this potentially hazardous material. Although the waste quantities that will be processed are expected to be small, the incinerator will be performing an important service to the southern Vancouver Island region.

5 PLANT OPERATION

5.1 General

The operators manual supplied by the manufacturer describes in a general way the normal operating sequence of the controlled air incinerator. The operators of the Meade Creek plant report that although these operating instructions are a useful guide, they have found that to obtain the best results at the least cost it is necessary to alter the procedures from day to day. The method of operation adopted at any time is dependent on the weather, the constituent makeup of the waste and its moisture content.

In controlling the incineration process the following operations can be regulated:

5.1.1 Loading - the loading sequence is automatically controlled. The loader door is opened and the chamber filled with refuse. On pushing the load button, the loader door closes, the fire door opens, the ram pushes the waste into the primary chamber, the ram withdraws and the fire door closes. Control of the incinerator operation can be achieved by altering the amount of waste inserted with each charge and the rate at which charges are inserted.

5.1.2 Lower Chamber - for proper operation of the process the wastes in the lower chamber should oxidize at a rate that will convert the organic components into volatile gasses. Turbulence should be minimized so that incombustible particulates are not carried off in the gaseous emissions. Conditions can be regulated in this chamber by controlling the rate of air input and the temperature. The temperature is monitored with a thermocouple; if the temperature is too low, two burners one on each side are started and additional air is provided. If the temperature is too high the chamber is quenched with water from a spray nozzle in the roof.

5.1.3 Upper Chamber - the volatile gasses and combustible particulates produced in the lower chamber are burned in the upper chamber. Excess air and supplementary heat are provided for complete combustion. Conditions in the chamber are monitored by a thermocouple located near the outlet of the secondary chamber. To provide optimum conditions the secondary burner and blower are regulated by a three position, proportioning controller directed by the thermocouple. If the temperature is less than a preset minimum fuel oil is pumped to the burner nozzle at 300 psi pressure to burn at a rate of about 18 gallons per hour. Above the minimum temperature, a solenoid valve opens on a bypass fuel oil line with a pressure controller and the pressure at the nozzle is reduced to 100 psi. The burning rate is then reduced to about 12 gallons per hour. When the volatile gasses distilled in the primary chamber are of a rate and concentration to burn in the upper chamber unaided by auxillary heat, the temperature rise shuts off the main oil line valve and the burner. Under the conditions of unaided combustion the temperature is controlled by varying the rate of air injected by the secondary blower. The proportioning controller regulates a modulating motor that opens the intake damper on the fan allowing a greater air flow to cool the chamber.

5.2 Operating Mode

As noted above the operation of the plant is adjusted regularly to achieve the best results considering ambient condition and the characteristics of the wastes. The operation can be divided into four stages: start-up, loading and operating, burndown, and cooldown and cleaning.

5.2.1 Startup - the manufacturers suggest the burners in the upper and lower chamber be operated for 15 minutes to warm up the plant prior to loading. The lower chamber burners are operated then to ignite the waste and are shut off when the desired temperature is reached.

The operators of the Meade Creek plant normally operate the plant without the lower burners. Easily combustible wastes such as cardboard and paper are selected for the first charges. These wastes are manually ignited within the loader chamber before charging. Fuel consumption is reduced and it is found that better burning of the first charges is achieved. By selecting light easily combustible materials for the first loads, the temperature can quickly be raised in the chamber to the normal operating range of 1400 to 1500°F.

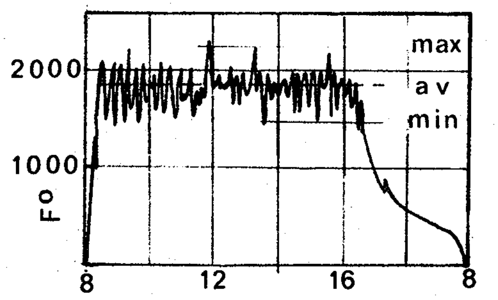
5.2.2 Loading and Operating - in accordance with the Provincial Government requirement a temperature of 1800°F is maintained above the secondary chamber. If conditions are adequately controlled in the primary chamber, sufficient combustible gasses will be produced to maintain the required temperature in the secondary chamber without operating the secondary burners. At Lake Cowichan, this operation is closely controlled to achieve maximum volatilation and minimize auxiliary fuel consumption. The plant superintendent reports "Through close observation and adjustment of primary air and water, we find that the secondary burner can be shut off after the unit is up to operating temperature of 1800°F. I must stress that this procedure cannot be learned from a book. It is knowing your machine and type of material to be burned, plus having the incinerator tuned and balanced to perfection." (6)

Typical temperatures measured above the secondary chamber are shown in Figure 4. It will be noted that the average operating temperature is greater than 1770°F for 50 percent of the time.

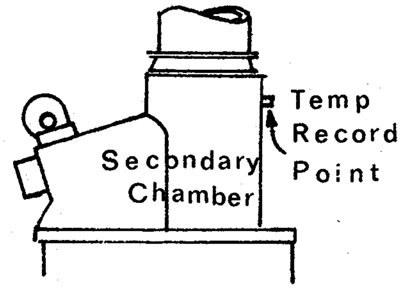
5.2.3 Burndown - after the last charge has been inserted the incinerator enters its burndown phase. The upper burner is set at the factory to operate for a five hour period, however at Lake Cowichan the period is reduced. A post purge blower operates for a further three hours to prevent burner heat damage. (7)

As with the loading operating phase, the operators at Meade Creek find they can usually maintain temperatures for a sufficient period during the burndown phase without using the secondary burner.

5.2.4 Cooldown and Cleaning - the plant is allowed to cool down overnight and the residue is cleaned out in the morning. The front end loader machines are equipped with a hoe attachment for removing the residue. A lance attachment has been constructed for the removal of slagging.



Typical Temperature Record



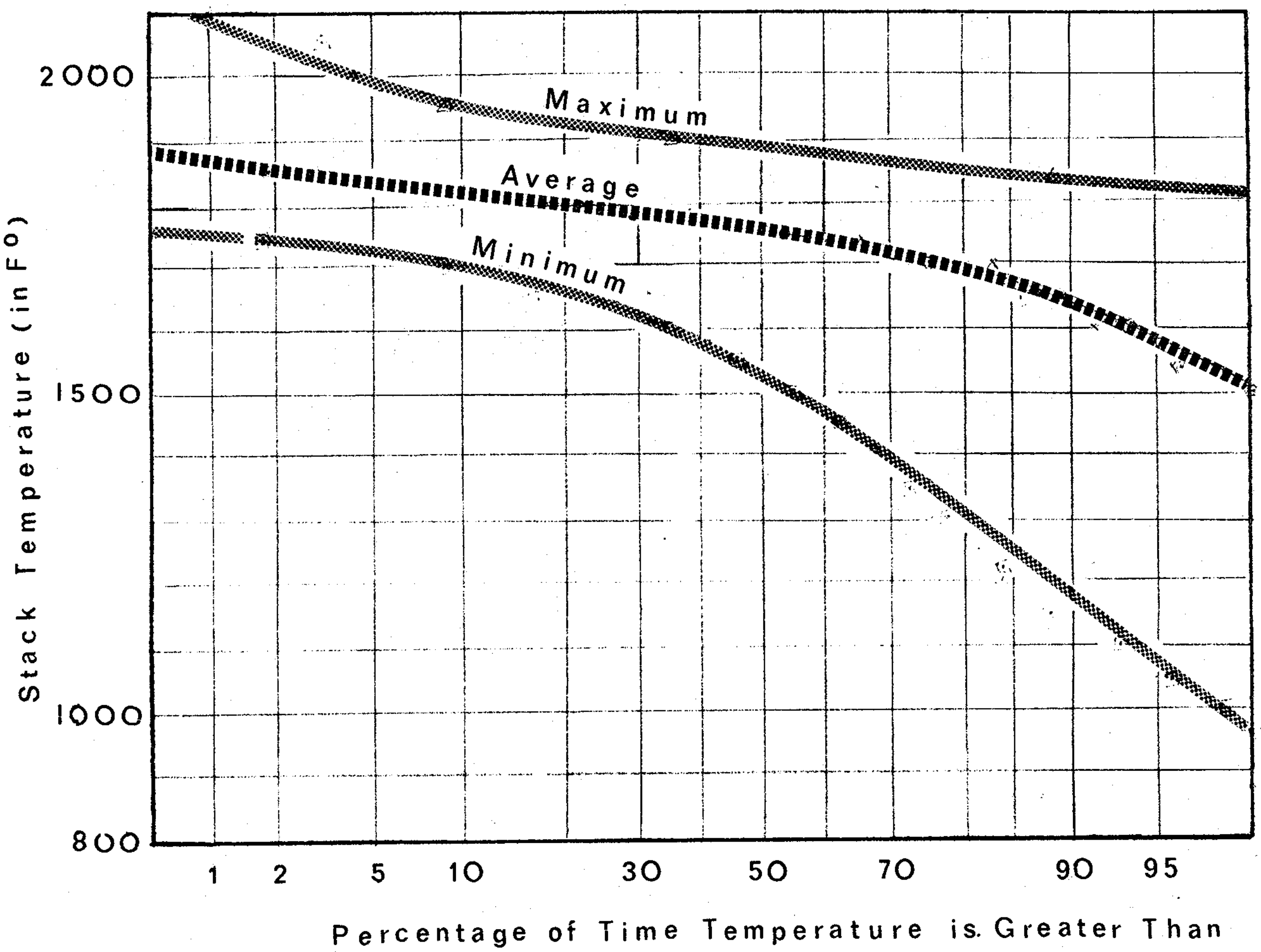


Fig 4 STACK TEMPERATURES

allan m. mccrae
consulting civil engineer

5.3 Operating Schedule

The plant when purchased in 1975 was expected to operate at 60 percent capacity and with the projected growth in the service area was expected to operate at capacity in 8 years or 1984 (see Ref 1, Figure 5).

Because municipal waste cannot be stored for an extended period it must be disposed of within several days after being received at the plant. The incinerator therefore must have adequate capacity to process the quantity of wastes received during the peak week. Some quantity of waste can be carried over from daily fluctuations during the peak week.

The manufacturers of this incinerator rate the model at from 1900 to 2500 pounds per hour (Ref 2). Based on a 10 hour day its capacity is from 9.5 to 12.5 tons per day. If it is assumed the plant could operate at 12 tons per day for seven days during the peak week and for six days per week for longer periods, its maximum capacity is:

Peak week	84 tons per week
Peak period	72 tons per week

As shown in Table 4.2 the peak week in 1978 was 60 tons and the summer average was 49 tons per week. The plant at present during peak periods is operating at 71 percent of the rated capacity and over the summer period at 68 percent.

Under the present schedule of operation of the plant, refuse is incinerated on Tuesday, Wednesday, Thursday, and Saturday. The plant is operated on Fridays when waste quantities warrant extra burning time. This is an infrequent occurrence. The plant is closed to the delivery of wastes on Mondays.

The operating records have been analysed to determine the length of time the plant operates. The results are shown in Table 5.1.

The operating times shown in Table 5.1 are for the loading period and do not include burndown time. It will be noted that the plant is being loaded on average at a higher rate than suggested by the manufacturer. Although the quantities of waste processed can be incinerated in the four day week adopted, longer periods of loading daily would be necessary to conform with the rate suggested by the manufacturer.

With the present system of collection it is difficult to match the rate at which the wastes are picked up and transported to the plant with the processing rate. It is desirable to incinerate wastes as soon as possible after their delivery to the plant. If this is not done it is found the wastes settle and become more dense and difficult to handle. When stored in piles heat is generated internally and the anaerobic breakdown of organics quickly make the wastes offensive to handle.

It is also felt that if wastes are stored there is a greater risk of fires because the waste may contain ashes or other hot material.

Although the plant is not operated at capacity, the present level of operation is efficient with the normal staffing of two operators. During the periods the plant is not operating the plant and ancillary equipment can be serviced and repaired and the grounds maintained.

TABLE 5.1

Plant Operating Periods[a]

Description (1)	1976 (2)	1977 (3)	1978 (4)
Total Operating Time, Hrs.:			
Summer	584.75	703.00	782.50
Winter	N/A	654.25	736.00
Annual	N/A	1357.25	1518.50
Average Operating Time per Week, Hrs.:			
Summer	22.5	27.0	30.1
Winter	N/A	25.2	28.3
Annual	N/A	26.1	29.2
Average Quantity Processed[b] in Tons per Week T:			
Summer	40	41	49
Winter	N/A	39	43
Annual	N/A	40	46
Charging Rate in Tons per Hr.:			
Summer	1.78	1.52	1.63
Winter	N/A	1.55	1.52
Annual	N/A	1.53	1.58

[a]Operating periods are from operators records. Period is taken as the time the plant is charged and does not include burndown time.

[b]Quantities from Table 4.2.

6 ENERGY CONSUMPTION

6.1 Fuel Oil

In the 1975 evaluation study (Ref. 1, Sec. 12.11, p. 80) it was found that fuel consumption for the first year of operation averaged 7.6 Imperial gallons per ton. The consumption during summer months was 6.7 gallons per ton and during the winter 8.4 gallons per ton of waste burned.

Records for the subsequent three years of operation have been analysed and the results summarized in Table 6.1.

TABLE 6.1

Fuel Oil Consumption[a]

Description	1976	1977	1978
Oil Consumption: (in Imperial gallons)			
Summer, April-Sept., 26 wks.	2883	2159	3010
Winter, Jan.-Mar.+ Oct.-Dec., 26 wks.	N/A	3292	2741
Total Annual	N/A	5451	5751
Unit Oil Consumption[b] in gallons per ton:			
Summer, April-Sept., 26 wks.	2.76	2.01	2.39
Winter, Jan.-Mar. + Oct.-Dec., 26 wks.	N/A	3.27	2.46
Average Annual	N/A	2.62	2.42

[a]Based on daily operating records.

[b]For waste quantities, see Table 4.2.

The oil consumption for the years 1976 to 1978 is much less than the rate of usage of the first year of operation. In the original tender for the plant the supplier anticipated a consumption of 7 Imperial gallons per ton of refuse (Ref. 1, Table 1) which is close to the first year average consumption.

During emission testing of a similar incinerator at Pahokee, Florida fuel consumption of 15 Imperial gallons per ton was reported (Ref. 3, Table 21). The other two plants tested in this project consumed natural gas however if their measured fuel consumption is converted to No. 2 fuel oil on the basis of heat value, one plant would have consumed 7.46 Imperial gallons per ton and the other 2.65 Imperial gallons per ton. The plant with the low fuel consumption was noted as having "a newly developed air-fuel control system" (Ref. 3, footnote, Table 26).

It can be seen that the plant operators manage to operate the Meade Creek Plant extremely efficiently on the basis of fuel consumption without apparently significantly sacrificing reduction efficiency, a lowering of secondary chamber temperatures, or discharging visible emissions. This is important considering the large increases that have occurred in the cost of fuel. During the 1965 testing the No. 2 fuel oil costs was $0.38 per gallon and presently is $0.63 per gallon.

7 RESIDUE

7.1 Quantity

It had been hoped for this study to measure the volume of the residue landfill to obtain a total volume of residue for the three year operating period since the last study. The operators report however that the residue fill area is a convenient location for the disposal of wastes from ancillary operations. In addition to the municipal wastes, clearing wastes, demolition wastes and scrap metal including derelict automobiles and discarded appliances, are all disposed of at the site. The clearing and demolition wastes are periodically burned and the ashes and non combustibles buried with the incinerator residue in the disposal area. Rubber tires are removed from derelict cars prior to crushing; these are sometimes incinerated but often buried in the landfill.

The approximate increased volume of the residue tip area since 1975 is estimated to be 3130 cubic yards. The Public Works superintendent estimates 80 percent of this is residue with the balance being cover material and the added wastes described above. The total volume of wastes processed in the three years is 31,900 cubic yards projecting the data in Table 4.2. This indicates a long term average volume reduction ratio of 92.2 percent. In the previous study the reduction in volume was measured to be 93.5 percent (Ref. 1, Table 22).

7.2 Effects of Residue Disposal

During the 1975 study it was noted that leachate from the base of the residue fill area formed pools of rust coloured water. The operators report that neither the leachate or the residue fill have been known to cause any environmental degradation either on site, to Meade Creek located to the west of the site or to wells of residences located near the lake.

The water ponded at the base of the fill area during a site visit in March 1979 showed no discoloration.

8 EMISSIONS

8.1 Particulate Emission Tests

Subsequently to the particulate tests on the emissions of the incincerator carried out for the 1976 evaluation study,(+) the Provincial Pollution Control Branch carried out two series of emission tests on the plant. The results were inconclusive because it was suspected in both cases that corrosion products in the test probe contaminated the particulate catch.

The tests confirm the difficulty of carrying out the tests on this type of incinerator with the high temperature of the gasses and possibly corrosive components to normal test equipment materials. These difficulties are described in the original study (Ref. 1, Appendix A) and generally in Section 3.7 above.

8.2 Visible Emissions

The Regional District send the two employees who regularly operate the plant to courses held annually by the Provincial Government in the opacity testing of incinerators. As a requirement of the discharge permit, the opacity of the emission is to be regularly monitored and the average daily concentration based on the daily operating period shall be less than Ringelmann 1 and the concentration shall not exceed Ringelmann 2 for more than 10 percent of the operating period. The operators report that they "meet and better" this specification.

9 PLANT MAINTENANCE AND REPAIRS

9.1 Regular Maintenance Procedures

The equipment making up the disposal facility and requiring regular maintenance are: the incinerator including loader and controls; a 'Bob Cat' with front end loader bucket and rubber tires filled with solid filler; a 'J.D. 24' similarly equipped; and miscellaneous facilities including office, restroom, shop, and landscaping.

The Assistant Director of Public Works for the Regional District reports that "Routine maintenance is carried out daily by the plant operator. This includes: servicing of the skid steer loaders and the incinerator, plus clean up and general housekeeping."

"The chief operator oversees this daily servicing, plus cleans the plant, checks refractory, electrical controls, hydraulic system and the overall operation in general. He also does all welding, which involves a fair amount of pre-fabbing, i.e. safety railings, catwalks, building of cleanout lance, snowplow, Bob Cat wheels, etc. All the major and minor repairs to the plant have been carried out by the operators. The 610 Bob Cat has had a complete overhaul, motor hydraulics, chains, sprockets, seals and bearings."[6]

9.2 Repairs and Parts Replacement

The daily operating records were reviewed to determine the effort required to repair breakages and replace equipment. It is noted that the plant operator is required to have versatile experience and abilities. As well as being knowledgeable on the control of the incinerator process to achieve maximum performance at least cost, the operator carries out all but major mechanical and control system repairs. The operator also plans and constructs additions to the plant for operational ease and safety.

The notations on the daily reports related to non-routine maintenance and repairs are chronologically listed in Appendix A. The frequency of repair to various parts of the plant are shown on Table 9.1.

It can be seen generally from Table 9.1 that the frequency of non-regular repairs and replacements averages almost one per week. Patching of refractory material is the most frequent repair. This is not a difficult or expensive task, however, is regarded as important in extending the life of the plant.

Repairs to the wheeled equipment, the 'Bob Cat' and 'J.D. 24' used to load the refuse, clean out the residue and perform miscellaneous site works, make up 24 percent of all repairs.

The daily reports indicate few instances where the daily routine operating schedule was threatened by break-down:

- On Thursday March 17, 1977 the motor on the upper burner failed and burning could not resume till Saturday, March 19 when the motor was repaired and reinstalled.
- On Saturday, April 23, 1977 the 5 hp upper blower motor burnt out. A new motor was installed on Monday, April 25th in time for regular scheduling.
- On Thursday, July 29, 1978 both the Bob Cat and J.D. 24 were down and burning was postponed till Friday, July 30th.
- On Friday, November 24, 1978 the lower blower motor was removed, repaired and reinstalled for the regular Saturday burn.

It is concluded from the review of maintenance and repair experience at the Meade Creek incinerator that a continuing effort is required to sustain the plant in good operating order. Most of the repairs are of a minor nature and can be performed by the regular operator.

TABLE 9.1

Frequency of Repairs[a]

Order	Description	Repair Frequency				
		1976	1977	1978	Total	Percentage
1	Repair refractory	5	4	17	26	18
2	Repair bob cat mech tires	5 3	9 2	 2	14 7	14
3	Thermocouples, repair & replace	10	4	2	16	11
4	Controls minor major, outside technician	4 2	4 2	3 –	11 4	10
5	J.D. 24 repair minor major, outside mechanic tires	– – –	1 2 1	4 3 3	5 5 4	10
6	Repair air pipe	5	1	5	11	8
7	Oil burner repair, service lower upper Replace motor and burner	 2 – –	 1 – 1	 3 4 	 6 4 1	8
8	Water nozzle repair	–	2	6	8	6
9	Hopper door repaired	–	5	2	7	5
10	Loader repaired	1	2	3	6	4
11	Fire door repaired	3	1	–	4	3
12	Cleanout door repaired	1	1	1	3	2
13	Clean out secondary chamber	–	1	1	2	1
14	Upper blower motor 5 hp replaced	–	1	–	1	1
	Totals	41	45	59	145	

[a]From daily plant records. See Appendix A for descriptive summary.

[b]Frequency is the number of instances repairs were carried out, data is not available for the costs of or the time required for each event.

10 DISPOSAL COSTS

10.1 Capital Costs

The principal capital costs were incurred for the initial development of the facility, these costs were detailed in the original study (Ref. 3), Table 18). Since that time minor capital expenditures have been made for site improvements and a new front end loader. It was found that a second machine was essential as a backup in loading refuse and to perform heavier miscellaneous tasks on the site.

The capital costs charged to the plant to date are shown in Table 10.1.

10.2 Annual and Unit Costs

The Cowichan Valley Regional District have generously provided annual account sheets showing in detail the costs charged to the incinerator. Although charge categories have changed from year to year, an attempt has been made to rearrange the listing to allow comparison from year to year. Details of the annual costs are shown in Table 10.2.

It appears from Table 10.2 that treatment and disposal costs increased significantly after the first year of operation. Increases in salaries and the maintenance costs appear to be the main contributors to the increased costs. Although the totals for fiscal costs increase, financing costs in the first year are contained in Item 15 'Transfer to Capital'.

As described in Section 4.3 in addition to incinerating and disposing of domestic and commercial wastes, derelict cars, white metals, demolition wastes and clearing wastes are stored and treated at the site and disposed of by different methods. The cost of these ancillary operations are included in the annual costs listed in Table 10.2. Data is not available to separate the cost of these functions from the main incineration operation. In calculating the unit costs of disposal, only the quantity of wastes incinerated is used, the unit cost would obviously be decreased if the cost of the ancillary operations could be deducted. Although it is thought that the added costs are small because the same personnel and equipment are used, if the ancillary disposal operations were carried out independently appreciable cost would be incurred by the Regional District.

10.3 Collection Costs

As described previously, the wastes are collected by a private company under contract to the Regional District.

TABLE 10.1

Incinerator Capital Costs[a]

Description	1975 $	1976 $	1977 $	1978 $
1. Incinerator, Plant and Installation	95,170			
2. Federal Sales Tax Rebate	(6,600)			
3. Receiving Building	44,081			
4. Site Grading (paving)	5,288			
5. Office and Garage	12,876			
6. Engineering and Legal	21,539			
7. Other General Construction	2,157			
8. Site Costs, Fencing, Power, Water, etc.	11,233			
9. Tractor (Bob Cat)	10,170			
10. Equipment	553			
11. Temporary Financing	5,526			
Total 1975	201,992			
Total 1976		201,992		
12. Equipment and Lighting			2,679	
Total to 1977			204,671	
13. Site Work - Fencing, Paving, Lighting and Equipment				9,062
14. Tractor (J.D. 24)				13,006
Total to 1978				226,739

[a]Capital costs provided by the Regional District of Cowichan Valley.

TABLE 10.2

Incinerator Annual and Unit Cost[a]

Description[b]	1975 $	1976 $	1977 $	1978 $
1. General Government Services	3,500	3,300	-	-
2. Administration - Regional Dist.	-	-	4,800	2,700
3. Advertising	150	50	-	170
4. Insurance - Building	470	660	780	910
5. Miscellaneous	650	480	280	320
6. Incinerator Operation	5,540	3,960	3,440	3,440
7. Power	720	1,710	1,660	1,860
8. Rental - Equipment	200	100	370	240
9. Repairs & Maintenance - Building	420	800	460	320
10. Repairs & Maintenance - Equipment	4,310	6,310	5,700	6,580
11. Repairs & Maintenance - Incinerator	-	1,620	290	1,220
12. Stationery	-	10	40	-
13. Telephone	290	380	370	430
14. Travel	720	1,020	880	-
15. Transfer to Capital	20,000	-	2,680	1,230
16. Works & Services - Maint & Sup	-	-	-	40,200
17. Works & Services - Travel	-	-	-	1,570
18. Works & Services - Other	-			3,310
19. Public Works	-	6,860	7,690	-
20. Salaries	18,370	29,470	30,470	-
21. Salary Benefits			2,620	-
22. Maintenance RD Labour	-	-	5,830	-
23. Maintenance R.D.T.	-	-	780	-
24. Services provided to others	-	-	(230)	-
Sub Total	55,340	56,750	68,910	64,490
25. Fiscal Services - Principal	6,010	24,330	5,290	5,350
26. Fiscal Services - Interest			19,140	19,240
Total Fiscal Services	6,010	24,330	24,430	24,590
TOTAL ANNUAL COST	61,350	81,080	93,350	89,080

TABLE 10.2, Continued

Description[b]	1975	1976	1977	1978
Refuse Processed Tons[c]	2,194	1,940	2,080	2,374
UNIT COST INCINERATION & DISPOSAL $ Per Ton	27.96	41.79	44.88	37.52

[a]Cost data from Cowichan Valley Regional Districts Operating Reports.

[b]Accounting categorization changed from year to year for items 16 to 24.

[c]Refuse quantities from Table 4.2 for 1977 and 1978, extrapolated for 1976 and from Ref. 1 for 1975. Only the wastes incinerated are included, quantities of wastes disposed of by ancillary operations are not included.

Because of the customers being widely dispersed, costs are high. The collection costs are financed by a mill rate charge against the assessed value of properties in the service area.

The annual costs of collection are summarized in Table 10.3.

TABLE 10.3

Collection Costs[a]

Description	1975 $	1976 $	1977 $	1978 $
General Government Services	1,800	1,900	-	-
Administration - Regional District	-	-	1,800	3,500
Contract	47,280	54,770	55,860	58,700
Miscellaneous	340	90	-	-
Total for year	49,420	56,760	57,660	62,200
Refuse Processed[b]	2,194	1,940	2,080	2,374
Refuse Collected by Contract, est.75%	1,650	1,460	1,560	1,780
UNIT COLLECTION COST $ Per Ton	29.95	38.90	37.00	34.90

[a]Costs from Cowichan Valley Regional District annual statements for Cowichan Lake Garbage Collection.

[b]Refuse quantities from Table 4.2 for 1977 and 1978, extrapolated for 1976 and from Ref. 1 for 1975. Quantities incluce wastes personally delivered to plant. It is estimated this quantity could be up to 25% of the total, see Sec. 4.1.

11 REGIONAL DISPOSAL PLANNING

11.1 Present and Proposed Solid Waste Disposal Facilities

As noted above the incinerator located at Meade Creek is owned and operated by the Cowichan Valley Regional District and forms part of a regional disposal system. Other areas of the Regional District are served by sanitary landfill facilities except the municipality of North Cowichan which owns and operates its own pit type incinerator.

The sanitary landfill areas are approaching their capacity and new disposal facilities are required. After investigating a number of alternatives, the Regional District plans to install two new plants similar to the Lake Cowichan plant. One facility with a capacity of 20 tons per day (2 modular units)will be installed at a site south of the Town of Ladysmith to serve northern areas. A larger plant with a capacity of 50 tons per day (4 modular units) will be installed south of the City of Duncan at the present landfill site. This plant will serve the City of Duncan and unorganized areas to the south.

12 STUDY RESULTS

Following are the principal details and findings of this study.

12.1 The Meade Creek Thermal Reduction Plant serving the Village of Lake Cowichan and surrounding unorganized areas was installed during the winter of 1975-1976. The Owner is the Cowichan Valley Regional District.

12.2 The incinerator is a factory built controlled air type manufactured by Consumat Systems Inc. in Houston, Texas, U.S.A.

12.3 There was wide interest in the plant from other municipalities and institutions with solid waste disposal problems. The Solid Waste Management Branch of Environment Canada commissioned Allan M. McCrae, P.Eng. to carry out an evaluation study of the plant. The field testing began about nine months after the plant began operation. The report was published in September 1976 (Ref. 1). The study included an analyses of the quantity and quality of the waste, the waste reduction efficiencies, the residue characteristics, the particulate emission densities, and the costs.

12.4 The purpose of the present study is to supplement the original study with an updating of operating costs and to detail the Owner's experiences in maintenance and repair and operating procedures.

12.5 According to the counts made by the collection contractor, the number of residences served are as follows:

Year	Residences Served	Inc. over Prev. Yr.
1975	1,673	-
1976	1,776	6.5%
1977	1,944	9.5%
1978	1,999	12.6%

12.6 The plant is not equipped with scales to measure the weight of refuse processed. Daily records are kept of the number of charges burned. For this survey a typical truck load of waste was weighed and the number of charges recorded. The sample indicated that each loader charge weighs 401 pounds. On this basis the following parameters were estimated for 1978:

Total weight burned for the year	2,374 tons
Average weight processed weekly	46 tons
Average weight processed weekly - summer	49 tons
Maximum weight processed in one week	60 tons

12.7 Assuming the plant operated at its capacity of 12 tons per day for 6 days per week, the weekly capacity would be 72 tons. The present peak week is 83 percent of this capacity.

12.8 Estimating population served on the basis of 3.5 persons per residence the generation rates for 1978 were:

Summer 2.00 lb per capita per day
Winter 1.76 lb per capita per day
Annual 1.87 lb per capita per day

12.9 In conjunction with the incinerator operation derelict cars and manufactured goods (chiefly discarded appliances) are stored at the site and periodically compressed and shipped for metal recycling. On the average 170 cars per year are shipped and in 1978 manufactured goods shipped totalled 195 tons. Demolition and clearing wastes are also disposed of at the site.

12.10 The Regional District have entered into a Contract with a private firm to process 'International Wastes' collected from ships docked at Ports on southern Vancouver Island.

12.11 The operators of the Meade Creek incinerator are flexible in their operating mode. Procedures are changed in accordance with ambient weather conditions and the character and moisture content of the waste. Because of the large increases in fuel costs care is taken to maintain optimum conditions in the upper and lower chambers to achieve the best results with a minimum fuel consumption.

12.12 The incinerator is normally started by selecting light paper or cardboard, igniting this in the loader chamber and building up a fire in the primary chamber by inserting easily burnable material for the first charges. The primary burners are seldom used.

12.13 With careful operation the secondary burners can be shut off for most of the operating cycle.

12.14 The incinerator plant is open every day except Monday for the delivery of refuse. Wastes normally are burned on Tuesday, Wednesday, Thursday and Saturday. A review of operating records for 1978 indicates the plant now is loaded for an average of 29.2 hours per week. The average loading rate is 1.58 tons per hour. This is greater than the rate suggested by the manufacturer of from 0.95 to 1.25 tons.

12.15 As noted the plant is operated as carefully as possible to minimize fuel consumption. The average unit fuel consumptions are as follows:

1975	7.56 gal per ton
1976	2.76 gal per ton
1977	2.01 gal per ton
1978	2.39 gal per ton

By altering operating modes after 1975 significant savings in fuel oil have been achieved. In 1975 the fuel oil price was $0.38 per gallon for a unit cost of $2.87 per ton of refuse. In 1978 the fuel oil price was $0.63 per gallon for a unit cost of $1.51 per ton.

12.16 It is estimated the volume of the residue disposal for the period 1976 to 1978 is 3,130 cubic yards. Approximately 80 percent of this is residue, the other is building wastes, cover and miscellaneous. The volume of residue in the fill indicates the average reduction in volume from the refuse was 92.2 percent.

12.17 The incinerator is maintained in accordance with a daily and weekly routine. The operating reports indicate the following frequency of repair to various parts for the years 1976 to 1978:

		No.	Percentage Total
Repair refractory		28	18
Repair Bob Cat		21	14
Repair & replace thermocouples		16	11
Repair controls	minor	11	10
	major	4	
Repair J.D. 24		14	10
Repair & Service burners		11	8
Repair water nozzles		8	6

12.18 During the four years of operation waste has never had to be diverted for disposal by other means because of breakdowns. Two minor instances occurred when waste burning had to be delayed one day.

12.19 The total capital cost of the plant is $226,739.

12.20 The total annual cost of the facility including financing, overhead, operation and materials from 1975 to 1978 has averaged $81,200. Using the quantity of waste incinerated during the period the average unit cost of disposal has been $37.83 per ton. The annual costs include the expense of operating ancillary systems to dispose of derelict cars, white metal and demolition wastes. If the cost of these were not included the unit cost of the incineration function alone would be less.

12.21 The collection costs for residential refuse for the period 1975 to 1978 has averaged $35.04 per ton.

12.22 The Regional District plans to install two additional incinerator plants to replace existing landfill operations. One plant will have a capacity of 20 tons per day, one a capacity of 50 tons per day.

Respectfully submitted,

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APPENDIX A

NOTES ON SERVICING AND REPAIRS FROM OPERATIONS JOURNAL

1976

March 18 - New cutting edge on bobcat
26 - Replace rubber drive on left oil burner pump (third time)
31 - Bob tach welded

April 1 - Welded ram stop block of bobcat bucket
11 - New Thermocouple - lower
20 - Breaker blown, bus bar burned on hydraulic pump

May 13 - New points of condenser in bobcat
15 - Top thermocouple burnt, moved to lower port below air induction ring
19 - New thermocouple in lower chamber

June 8 - Screen on stack fell down
17 - Thermocouple out in lower

July 20 - Jam - 127 cars
21 - New thermocouple in lower chamber
28 - End of air pipe broke off
31 - Changed thermocouple jacket in upper chamber
Changed tires on bobcat

Aug 3 - New thermocouple core on air modulator
6 - Fix drive on side burner (left)
10 - Patch refractory, top
14 - Clean top chamber, check refractory (fair)
15 - Adjust fire door
21 - Change tires on bobcat - tread coming off, on for 3 weeks
31 - Air tube is burned off in lower chamber

Sept 2 - Repair refractory on door
3 - Fix end of air tube
8 - Replace upper thermocouple jacket
17 - Major maintenance on bobcat
22 - Change thermocouple jacket, fire door broke weld same

1976 (Continued)

Sept 25 - Bill plug working on Honeywell control
27 - Install temp control, adjust same
30 - Welded loader cover door, put refractory on bottom of incinerator door

Oct 5 - Adjust controller, not working good
8 - New chain on bobcat (drive)
12 - Bill plug replaces Honeywell controller
18 - Put refractory in seem of back wall
19 - Made air tube for garb
22 - Replace air tube in lower burner chamber, weld doors, paint doors

Nov 16 - Limit switch out, loader won't work, fixed same
17 - controller acting up
19 - SAM crushing cars

Dec 3 - Change tires on left side bobcat
15 - Refractory off door, welding on fan
16 - Put refractory on door
23 - Change air tube in garburator
Also change lower thermocouple
24 - Change upper thermocouple, pump shorted out, fix same

1977

Jan 4 - Loader switch goofing off, fix same, points are burned
7 - Change tires on bobcat, no tread recapped smooth, 100 mile service on bobcat new motor
18 - New points, condenser, rotor in bobcat
29 - Bill plug out. New switch on loader close, new dead rand pot, adjust air modulator

Feb 1 - Adjust Honeywell control
3 - Clean out upper chamber
5 - Fell in hopper with bobcat, broke bob thach. weld same
9 - Piece of wood of skel hooked one corner of hopper door and broke it loose
10 - Fix hopper door, 2 hours welding
12 - Broke cutting edge on bobcat
15 - Change upper thermocouple
24 - Back water nozzle plug, repair and replace it
25 - Fixed hopper door, fixed hinges on big door, welding 2 hours
26 - Working on hopper door, welding 3 hours

March	3	- Repair refractory on door and in burner
	4	- Replace cutting edge on bobcat bucket welding 7 hrs
	16	- Light quit working on water control
	17	- Broke down
	19	- Motor for upper burner is fixed
	30	- Controller is acting up
April	1	- Work on hopper door
	22	- Change tires on bobcat
	23	- Burnt 5 h.p. upper blower motor
	25	- Replace new 5 h.p.
May	13	- Patching refractory around upper burner
	18	- Upper blower running wrong way, reverse same
June	11	- Change thermocouple
	21	- Bobcat leaking oil
	23	- Gone to Nanaimo for backup machine J.D. 24
	29	- anging over attachments for J.D. 24
	29	- Welding on attachment for J.D. 24
July	7	- Mash in lower yard crushing cars
	27	- Change thermocouple in upper chamber
	28	- Refractory fell out of exp. seam
	29	- Replace refractory
Aug	10	- Return J.D. 24.
	12	- Change plugs, points, condenser, in bobcat
	24	- Pushed in dead bear 350 pounds
Sept	7	- Fix hydraulic cini on loader
	9	- Change tires on J.D. 24
	13	- Island Equipment out to work on J.D. 24
	15	- Change upper thermocouple
	16	- Welding on clean out attachment
	27	- J.D. 24 broken down
Oct	18	- Work on fire door, welding on clean out attachment
Nov	4	- Repair refractory approximately 100 lbs
	23	- New starter on bobcat
Dec	3	- Bill plug working on controls
	10	- Bolts missing on loader replace same

1978

Jan 5 - Change hydraulic lines on loader
24 - Change tires on J.D. 24, new recap perma fill

Feb 7 - J.D. 24 A broke down, took it to Nanaimo for repairs
10 - Moved OTC and OFTC controllers
11 - Service top burner, clean out nozzel
15 - Fix water nozzle, made new one
22 - Working on upper thermocouple

Mar 3 - Put in refractory
10 - Fix water nozzle lower chamber
24 - Patch refractory on door and exp seam

April 1 - Water nozzles burned out, made new ones
7 - Service both lower burners, replace water nozzles
15 - Replace fuel guage on upper burner
19 - Welding on cleanout attachment
27 - Change tires on J.D. 24
28 - Install Honeywell controller O.T.C.
30 - J.D. 24 down bucket pin weld broke

June 6 - Island Equipment replace head gasket and Bendix drive on J.D. 24
14 - Asco valve on upper burner fell off down 1 hr
22 - Replace plate on upper burner
30 - Island Equipment to fix J.D. 24

July 4 - Replace starter on J.D. 24
11 - Weld on J.D. 24 bucket replace cutting edge
17 - Clean fly ask build up in upper chamber approx 6", removed center air tube and cleaned out
21 - Change air tube

Aug 4 - Repair refractory
11 - New tires on bobcat
14 - Hydraulic line broken on loader repair
17 - Replace ring gear on J.D. 24

Sept 3 - Remove air tube and clean. Replace damaged refractory
13 - Water nozzle fell out, weld
20 - Welding on centre tube
22 - Repair refractory
23 - Change water nozzle in lower chamber
29 - Patch refractory

Oct 6 - Repair refractory
8 - Repair refractory
20 - Repair refractory
27 - Weld air tube and clean, repair refractory around air holes. Minor repairs to hopper lid and ram

Nov 3 - Repair refractory in door
10 - Fasi refractory
16 - Flooded thermocouple burned off and replaced
24 - Repair refractory capansion scam, remove lower blower motor for repairs
25 - Re-install blower motor, replace both bearings on loader rams
26 - Change water nozzle

Dec 1 - Repair refractory and plate at clean out door, change centre tube
2 - Start in loader switch
5 - Repair refractory on floor
8 - Lower burner motor to Duncan. Repress refractory on door and around air holes
9 - Remount lower burner unit
10 - Patch refractory in lower chamber
16 - Change tires on bobcat
20 - Repair ram on hopper door
27 - Change tires on J.D. 24