January 1972

OPERATION RESOURCE

Rochester Engineering Society Organized to Utilize Research to Conserve Our Environment

REPORT

A Study of Solid Waste Disposal for MONROE COUNTY

Volume 2
Detail Study

SOLID WASTE DISPOSAL

PLANS FOR ROCHESTER

AND MONROE COUNTY

Rochester Engineering Society, Rochester, N.Y.

VOLUME II OF III

BASED ON OPERATION
"RESOURCE" STUDIES
OF THE ROCHESTER
ENGINEERING SOCIETY

FEBRUARY 1972

PREFACE

In March, 1971, the Rochester Engineering Society recognized the critical state of solid waste disposal in the Rochester area. In the belief that it could offer technical guidance leading to the establishment of a positive long range program for solid waste management, the Society established "OPERATION RESOURCE", a task force of more than seventy technically-trained volunteers with backgrounds in engineering, chemistry, physics and the biological sciences. The Society directed the task force to (1) study all known methods of solid waste disposal, (2) evaluate their efficiency in terms which reflect local conditions, requirements and priorities, and finally, (3) recommend the specific steps to be taken by municipal officials.

The task force consisted of several sub-committees each dealing with different methods of solid waste disposal. In addition to the technological factors, each sub-committee considered the associated economics, reliability, and ecological impact. An evaluation committee analyzed the reports of the various sub-committees and generated the recommendations which appear in this volume.

Early in the research and study period, the task force realized that they were developing technical detail information which could be of value to municipal functional and planning agencies, ecologically-oriented groups and, in fact, the general public. To disseminate this information, the task force conducted three day-long symposia on incineration, recycling and landfill methods, and in addition, presented several evening lectures on specific proprietary methods of waste disposal. Furthermore, Operation RESOURCE transmitted interim reports to the Environmental Management Council who in turn informed the Monroe County Legislature of our progress

and the trend of our investigations.

Operation RESOURCE has completed its mission with the publication of a three volume report as follows:

Volume I - Contains recommendations based on an evaluation of the detail studies and also specific plans for both the short and long term.

Volume II - Contains the detail engineering study reports associated with the various processes and systems for solid waste disposal.

Volume III - Contains the appendices of the reports presented in Volume II.

The Rochester Engineering Society wishes to express its gratitude to the members of Operation RESOURCE for the many hours of research they devoted to the Study. Their accomplishments should serve as a model to be followed by technical organizations throughout the Country.

Copies of all reports are available from the Society. Persons interested only in the Operation RESOURCE Summary and Recommendations should request Volume I. However, those persons interested in the engineering details which supported the Summary and Recommendations of Volume I should request only Volumes II and III, since the entire contents of Volume I are included in Volume II.

THE ROCHESTER ENGINEERING SOCIETY
55 ST. PAUL STREET
ROCHESTER, NEW YORK 14604

January, 1972

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THE SALE OF ENERGY

The sale of steam energy produced by a solid waste incinerator can materially reduce the operating cost of any municipal incinerator.

The City of Rochester is uniquely fortunate in having the fifth largest, district steam utility (in annual sales) in the country as a prospective steam customer. In this respect, Rochester Gas and Electric Corporation has indicated an interest in purchasing the steam produced by a solid waste, steam generating, incinerator assuming that it is of the pressure and temperature the RG&E Corporation can use (per Mr. F. E. Drake, Jr., chairman of the board, letter dated 3/16/70). Since the cost of installing underground steam transmission and distribution mains is high (greater than $100 per foot) the location of any new steam generating incinerator plant is critical. It must of necessity, be located near the load.

In order to arrive at the possible revenue which can be obtained from selling steam produced by a solid waste incinerator, the local utility was approached and asked to make a comprehensive study of their steam requirements with the aim of providing a realistic revenue figure for the steam produced.

Since the primary objection of any solid waste energy plant is to incinerate refuse, steam generation cannot be arbitrarily increased or reduced to coincide with changes in demand. This fact meant that the RG&E study must take in not only average winter and summer demands but also daily highs and lows in these periods. See figures 1 and 2. Figure 1 graphically compares typical (not Rochester)

monthly peak and average demands for a district heating system with steam production from a typical solid waste energy producing incinerator. Demand is high in winter months and low in the summer, while winter differences in demand are typically much higher than summers.

If steam production available from a solid waste incinerator is as shown in figure 1, other sources of steam are required to get us by winter peaks, while excess steam would be available in the summer. Typical (not Rochester) weekday and weekend demands for the winter and summer are shown in figure 2. Demand variations are usually significant in the winter only when the capacity of the system is approached.

The ideal situation exists when incinerator steam can be used as the base load for a demand that is always greater than the steam supply. If this is the case, no condenser equipment with its attendant problems and costs is required at the incinerator installation. This ideal situation can exist here in Rochester if the incinerator is located adjacent to an RG&E facility where electric power is generated. Conversely, if it is located only where it can supply the Rochester Gas and Electric Corporation's district steam system there would be significant amounts of steam generated which could not be sold during periods of low system demands such as summer periods and weekends.

A detailed examination of Rochester Gas and Electric Corporation's steam distribution system shows one particular point where all steam generated from a 2,000 ton per day incinerator could be absorbed.

This is the area adjoining RG&E's Station #3 (Beebee Station) where the old central incinerator is presently located. This major RG&E facility not only uses high pressure steam to generate electric power but also supplies a significant amount of low pressure district steam to the downtown distribution network. If it is assumed that a maximum of 3 pounds of steam can be generated for each pound of waste incinerated, up to 500,000 pounds per hour could be produced by a 2,000 ton per day waste incinerator. In order to utilize this steam at Beebee Station, steam must be generated at high pressure conditions - 660 psig and 750°F. If these conditions were met, RG&E could absorb on a minimum demand day as much as 550,000 pounds per hour. This steam absorption capability is based on the following requirements:

450,000 lbs./hr. for Beebee Station power generation needs.

75,000 lbs./hr. for the high pressure steam transmission main to downtown Rochester.

25,000 lbs./hr. for the low pressure steam distribution system in the vicinity of Beebee Station. (Reduced from 660 psig)

However, if steam could only be supplied at low pressure conditions, (200 pounds per square inch, 500°F), RG&E could only guarantee to absorb 140,000 pounds per hour at this location based on a minimum day system demand. (25,000 #/hr. for the L.P. distribution system and 115,000 for a L.P. turbine).

The production of steam at 660 psig and 750°F requires approximately 250° of superheat. One major incinerator manufacturer states that the required superheater can be installed integral with the

incinerator boiler and fired with the primary fuel--solid waste.

Another major manufacturer recommends that a separate superheater be installed which would be fired with an auxiliary fuel such as #6 oil. This plan would result in an additional operating cost of approximately 14¢/1000 lbs. of steam generated. (For a fully operational 2000 ton/day incinerator, an auxiliary fired superheater would consume approximately 4,342,000 gallons of fuel oil per year.) The incinerator manufacturer recommending this plan believes that the decreased downtime and maintenance costs on the superheater will offset the increased operating cost due to the auxiliary fuel. However, it would appear advantageous, if possible, to try and eliminate a separate oil fired superheater since the price of fuel oil is expected to rise sharply in the next decade.

Two other factors favor the Beebee Station location. The RG&E Corporation would be able to supply all of the feed water required for a nominal treatment charge. This is important because some of the steam generated would be fed to the low pressure district steam network which distributes steam for cooking and baking purposes to downtown Rochester customers. This necessitates a high degree of steam purity.

Another factor is any necessary standby steam capability can always be provided by Beebee Station. This would eliminate any need for a standby boiler at the solid waste incinerator plant.

In regard to the value of this steam, RG&E concluded (based on the net cost of producing this steam with coal) that the corporation could pay approximately 50¢* per thousand pounds for steam supplied to Beebee Station at the State condition of 660 psig and 750°F. (*Exact

figure must be negotiated with RG&E.) At the present time, RG&E has installed boiler capacity which is adequate for the steam load growth in the foreseeable future. For this reason, the value of steam from the incinerator plant is limited to the fuel component cost.

If, in the future, the load growth should increase to a point beyond present plant capability, an adjustment could be negotiated to account for savings in fixed costs, labor, or other applicable costs.

Referring to Figure 3, if a 50¢ sales value is accorded the steam sold and a 4,000 BTU/# refuse heating value is used (as obtained in actual operating results at the new Chicago plant), a $2.50 figure for steam revenue per ton of refuse incinerated is arrived at. (For steam at 660 psig and 750°F. This figure should be adjusted to $2.20.)

To determine the estimated annual revenue (E.A.R.) which could be derived from the sale of steam, a conservative energy ratio of 2.2 lbs. of steam generated (at 660 psig and 750°F.) from 1 lb. of waste should be used. If it is assumed that 15% of any steam generated will be used for such in-house purposes as feed water pumps, feed water heaters and blowers, a total of 2,730,000 M lbs./yr. of steam would be available for sale from a 2,000 ton per day incinerator once it has reached full operational status. At $.50 per M lbs. this would amount to a total E.A.R. of $1,365,000 which could be derived from sale of steam to the Rochester Gas and Electric Corporation.

If steam is produced at 660 psig and 500°F. (saturated condition) and superheated with fuel oil to 750°F., the quantity of steam available for sale would be increased to 3,102,000 M lbs. This would yield $1,551,000 revenue @ $.50 per 1,000 lbs. of steam. On the assumption that No. 6 oil

costs 10¢ per gallon and 4,342,000 gallons are required annually for superheating purposes, the financial effect will be a reduction in the net steam revenue to $1,116,000 annually.

Since the sale of energy (steam) is an important factor in reducing operating costs of an incinerator, it is imperative that the sale of this steam be firmly contracted for before construction of the incinerator is started.

If this is not done, a situation similar to what happened in Montreal could develop.

There, the proposed customer, an existing chocolate factory, moved out of the district before the plant was opened. This meant that all steam generated had to be condensed by the cooling towers located on the roof. This in turn limited the burning capacity of the incinerator since sufficient condenser capacity was not available.

Addendum:

Two other potential sites (Culver Road and the Station 9 area) were investigated and abandoned as impractical. At each of these sites the absence of cooling water for condensing turbines rules out the possible use of incinerator-produced steam for electric generation. For this reason the steam use would be limited to commercial district steam use only. This would not be sufficient load to absorb the steam output of a 2,000 ton/day incinerator during the summer months. A further obstacle was found in the length of pipe which would be required to tie into the RG&E system and transmit the steam to existing RG&E steam customers in the downtown area. This was estimated at 6,000 feet from the Culver Road site and 11,000 feet

from the Station 9 area. The cost to RG&E was estimated at $750,000 and $1,400,000 respectively.

There would be some potential growth in the Culver Road area but not enough to make it a logical location for locating a large steam generating incinerator.

Two separate incinerator plants:

If it was decided that two 1,000 ton per day incinerator plants should be built because of the traffic and haulage problems involved with one central 2,000 ton per day plant, a second site where steam might be sold would be near the northwest boundary of the City adjacent to the outer loop.

A large industrial complex located in this area could probably absorb a significant amount of the steam produced by a 1,000 ton per day waste incinerator. If a plant was located in this area, steam would have to be produced at 300 psi and 475°F. in order for it to be used for the process, space heating and refrigeration requirements of this industrial complex.

Estimated annual revenue from steam sold to any industrial complex would have to be determined after direct negotiation with the potential customer.

Recycling Metals and Minerals from Incinerator Residue:

The U.S. Bureau of Mines has recently completed a research program on the economics of recycling metals and minerals from incinerator residue. (U.S. Technical Progress Report 33 - April, 1971.)

By use of conventional equipment such as magnetic separators,

tumblers, and crushers, a recycling plant can be economically constructed which will segregate aluminum from ferrous metal and then separate out and crush the glass fraction of the residue. This process reduces the amount of residue which has to be landfilled from 25% to 5% of the original trash volume. Depending upon the market price for aluminum and glass, the recycling plant can be a profitable scheme. The ferrous material, often contaminated by alloys, may or may not be marketable.

Stamford, Connecticut (population - 110,000) expects to have such a plant in operation in 1973. A modern incinerator rated at 360 tons per day is being planned along with a recycling residue system. From the sale of glass and aluminum, the City of Stamford expects to net $300,000 a year, $100,000 a year more than the recycling unit's annual operating cost.

If the above scheme proves technologically and economically feasible, the recycling plant could be adopted for use in conjunction with the incinerator proposed for Rochester.

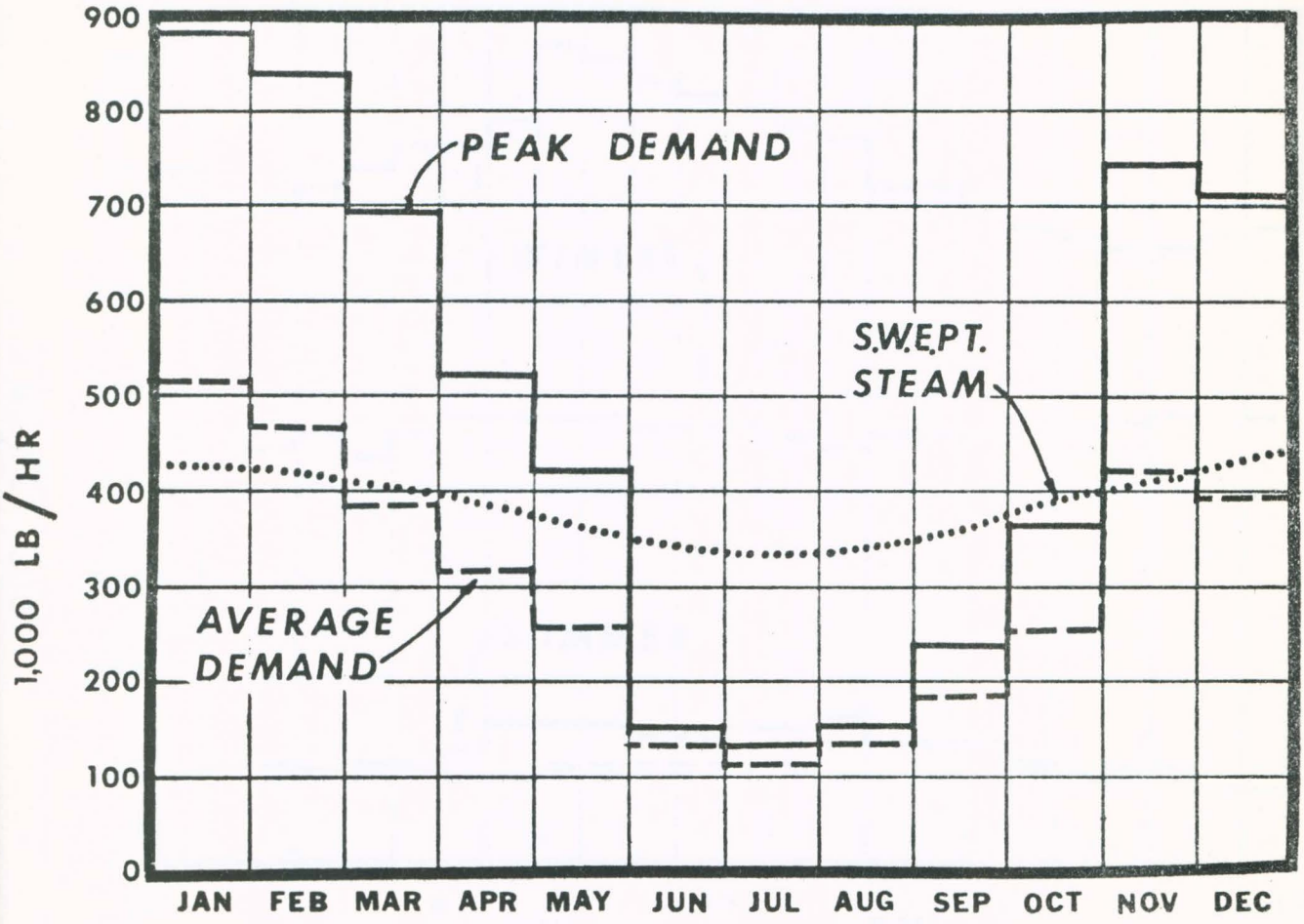


FIG. 1 TYPICAL MONTHLY DISTRICT HEATING DEMANDS AND S.W.E.P.T. STEAM AVAILABLE.

"Feasibility of Refuse Fuel for District Heating" - The Rust Engineering Co. June 24, 1971

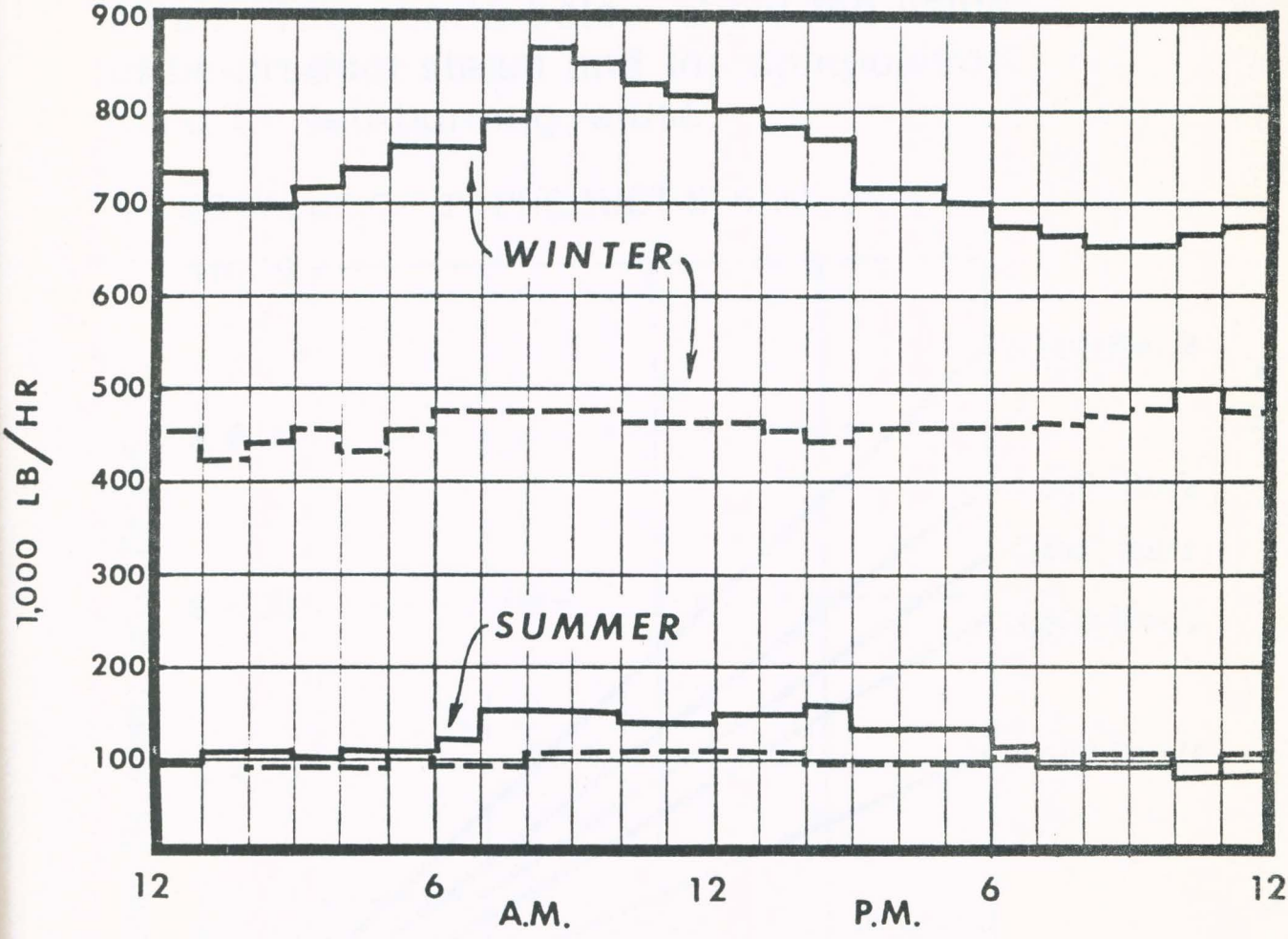


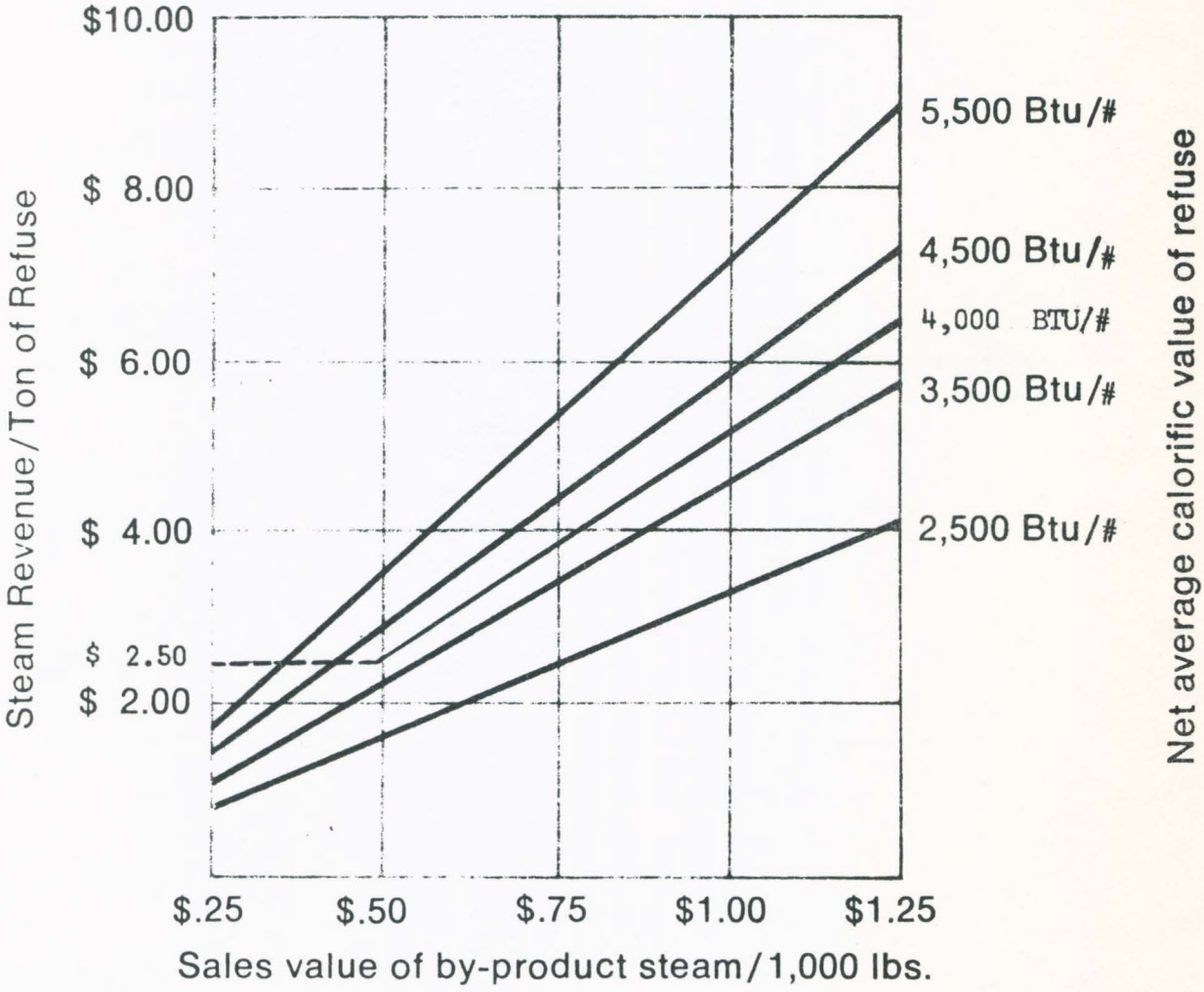
FIG. 2 TYPICAL WEEKDAY —— AND WEEKEND ---
DISTRICT HEATING DEMANDS.

"Feasibility of Refuse Fuel for District Heating" - The Rust Engineering Co. June 24, 1971

BY-PRODUCT STEAM HELPS AMORTIZE THE COST OF INCINERATION

Most Von Roll incinerators help reduce their net operating cost by using the heat of incineration to generate by-product steam. The charts below show the value of by-product steam and the composition limits for self-burning refuse.

SALES VALUE OF BY-PRODUCT STEAM



Based on:
100% condensate return
200 psig saturated steam
65% overall efficiency
Btu values are low heating value
Higher pressures and
temperatures can be generated

FIG. 3

"Feasibility of Refuse Fuel for District Heating"-The Rust Engineering Co. June 24, 1971