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6280
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31 JAN 1986

From: Commander, Atlantic Division, Naval Facilities Engineering Command
To: Commanding General, Marine Corps Base, Camp Lejeune

Subj: MCON PROJECT P-822, REFUSE-BURNING SUPPLEMENTAL STEAM PLANT, MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Ref: (a) MARCORB Camp Lejeune ltr 11000 PWO of 3 Sep 85
(b) LANTNAVFACENGCOM memo 6280 1142DPG of 5 Dec 84

Encl: (1) Cost/Benefit Analysis of the HRI

1. In view of your need for a refuse-burning steam plant expressed by reference (a) and the cost analysis issues reflected by reference (b), we forward the NCEL prepared study on Cost/Benefit Analysis of the Heat Recovery Incinerator (HRI), September 1985, which can be of further assistance in providing detailed and accurate economic justification of MCON Project P-822.

J. R. Bailey
J. R. BAILEY
By direction

N-1735

NCEL
Technical Note

September 1985

R. M. Roberts & K. T. C. Swanson

Sponsored By Naval Facilities
Engineering Command

COST/BENEFIT ANALYSIS OF THE HEAT RECOVERY INCINERATOR (HRI)

This report discusses the sensitivity of heat recovery incinerator (HRI) cost/benefits to various techno-economic parameters associated with the HRI computer model. These sensitivity data are presented in a form to aid in the conceptual design of the optimum HRI facility for a given Navy activity. The following techno-economic parameters are listed in order of their expected importance, considering both variance and sensitivity, to cost/benefit criteria of the HRI computer model: solid waste heating value, boiler thermal efficiency, energy inflation rate with respect to general inflation, cost of conventionally generated steam, solid waste disposal cost, differential landfill inflation of disposal cost, capital cost, and ratio of ash to waste input. Naval Facilities Engineering Command policy regarding HRI construction at Navy activities is to seek alternative waste management opportunities such as the use of nearby resource recovery facilities that have been financed and erected by private operators or civic entities.

NAVAL CIVIL ENGINEERING LABORATORY PORT HUENEME, CALIFORNIA 93043

METRIC CONVERSION FACTORS

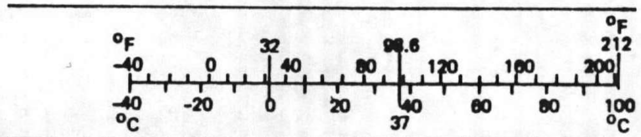
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
^oF	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	^oC

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
^oC	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	^oF



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This report discusses the sensitivity of heat recovery incinerator (HRI) cost/benefits to various techno-economic parameters associated with the HRI computer model. These sensitivity data are presented in a form to aid in the conceptual design of the optimum HRI facility for a given Navy activity. The following techno-economic parameters are listed in order of their expected importance, considering both variance and sensitivity, to cost/benefit criteria of the HRI computer model: solid waste heating value, boiler thermal efficiency,

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CONTENTS

INTRODUCTION

The Naval Facilities Engineering Command (NAVFAC) has tasked the Naval Civil Engineering Laboratory (NCEL) to evaluate the heat recovery incinerator (HRI) technology for application to Navy shore activities. NCEL has developed criteria to be used as guidance in determining whether a Navy activity can benefit economically from the use of an HRI in disposing of solid wastes. These decision criteria have been incorporated into a publication titled "Heat Recovery Incinerator (HRI) Application Guide" (Ref 1).

The HRI model was one of the tools developed by NCEL to facilitate the use of the HRI Application Guide. The model determines the economic liability or profitability of conceptual candidate HRI plant designs for a given Navy activity. The model also dimensions the influence of the various techno-economic factors on the cost/benefit results for the conceptual HRI facility when it is operational. This analysis will be used in the decision-to-construct process.

This report presents data on the correlations (and their sensitivities) that exist between the major design techno-economic parameters and a conceptual plant's economic viability. These data result from systematic exercising of the model. These sensitivity data are presented so that, in conceptually designing the optimum candidate HRI facility sought for a given Navy activity, the responsible design engineer will fully appreciate and take advantage of the way individual techno-economic factors impact the ultimate cost/benefit pay-offs. In this way, the ultimate decision to construct or abandon an HRI project will be made only after faulty system designs have been identified and corrected. Some Navy HRI projects have been approved and others rejected on the basis of questionable system designs. The study reported here provides a more logical and consistent approach.

BACKGROUND

The HRI Application Guide was specifically developed to provide a logical approach whether to install an HRI plant. The HRI Application Guide tells the user how to proceed systematically through a diagrammed decision matrix wherein data requirements that must be input for the decision process are developed at three progressively refined levels of iteration. In this data development and analysis process, the HRI Model is a tool that serves to determine as to whether a conceptual HRI candidate project would be cost beneficial relative to the processes already in place for waste disposal and steam generation.

Use of the HRI Model on a microcomputer is explained in the NCEL terminal-handbook, "User's Manual for the Heat Recovery Incinerator (HRI) Model" (Ref 2). The model assumes that solid waste is disposed of in a

landfill and that some kind of fossil fuel is being burned to generate steam for use at the Navy activity; either of these processes may be internal or contracted services. The model does not consider the HRI as being coupled to a turboelectric generator since, in order to be cost effective, the solid waste throughput would have to be considerably more than the typical large Navy activity generates. The model also assumes that the HRI has been selected for the primary function of disposing of sorted (possibly) but otherwise unprocessed solid waste (although cofiring of other waste and conventional fuels is permitted) and not as a system that has been designed primarily for fossil fuel firing with a secondary capability of firing specially prepared refuse derived fuels (RDF). Although not considered here, the latter scenario is now being studied at NCEL and should later lead to documentationt to: (1) identify any Navy-qualifiable RDF materials that are found to be reasonably marketable, and (2) define optimum usage of such materials in existing Navy boilers or in multiple-fuel-capable boiler designs now being considered by the Navy for future construction.

The various terms used in this report are defined in Appendix A. The techno-economic inputs called by the model will be discussed in some detail later but for immediate reference purposes are shown in Appendix B. The information format used in Appendix B actually comprises the input data screens presented to the user by the program. It can be seen in Appendix B that consideration is given to every aspect of facility design, construction, operation, reliability/availability/maintenance (RAM), and financing. As pointed out later, the values appearing on the screens are considered to be about what are average for an HRI plant installed at an average sized, typical Navy activity.

The outputs of the model are all tabulated on a single sheet, titled "The HRI Cost and Performance Report." This is presented as the last page of Appendix B. The program generates six categories of information, all of which are important to consider in deciding whether to install an HRI or to stay with the status quo. In the first category, the life cycle cost of the proposed system is computed by combining user inputs for the cost of capital, operation and maintenance, and system downtime due to failures. This cost is then compared to the sum of the costs of (1) using a conventional fossil fuel fired steam generator to produce the equivalent steam energy output for the HRI life cycle, and (2) disposal at a landfill of the solid waste that would be eliminated by operating the HRI.

The second category of model output information is the amount of limited-resource, prime (not reclaimed) fuel, such as petroleum fuels and natural gas, that is saved annually, as barrels of oil equivalent (BOE), by firing solid and possibly other wastes.

A third output category addressed by the model is the landfill capacity that is annually conserved by using the HRI. Because no practical disposal technique can completely eliminate the need for some landfill availability, conservation of landfills through maximum reduction of the waste volume is often economically important in the long term. However, if there are ample nearby landfill sites, an HRI project probably cannot be justified from the start.

This report also includes as a fourth category of information-output: the discounted life cycle costs and savings provided by the modelled HRI per ton of solid waste fired and per million Btus of steam generated. These data are very useful in making comparisons with other systems whether their function is basically one of waste disposal or of energy generation or both.

The two final output categories of the model are by far the most important. These are: Savings-to-Investment Ratio (SIR) and the HRI total payback period (including project lead-time). These, of course, are ultimate considerations in driving the decision process to the proper conclusion. Additionally, 13 other figures of merit are generated as outputs by the model that can be categorized together with one or the other of these two key parameters.

In the section following, the software of the HRI model is briefly described and introduced for optional study as an appendix. In the subsequent section of this report, the results of the sensitivity analyses performed are presented. The empirical functions describing the relationships of the techno-economic input variables with respect to selected parameters from each of the six output categories just discussed are tabulated and graphically presented. Comments on the significance of these operators in considering preliminary plant designs, operating cycles, and future changes in disposal practices are included in the discussion.

THE HRI MODEL SOFTWARE

The computer program of the HRI model is listed in Appendix C. The language is BASIC and is assembled for use in CP/M mode on a floppy disk microcomputer equipped with two disk drives. The software was developed on an Apple II computer and has been debugged and extensively exercised on the same type microcomputer.

The costing practices observed in the development of the HRI Model software are in conformity with NAVFAC P-442 (Ref 3). A possible exception is the specification of a 15-year life expectancy for the HRI plant, but this is only provided as a default value. The user is free to input any project lifespan he wishes, including the 25-year facility life specified in P-442 for conventionally fueled steam generators.

The mathematical subroutines effected by the HRI Model in achieving output results are explained in Reference 2. Appendix C may be consulted if a more detailed study of the techno-economic functions is desired.

THE HRI BASE CASE EXERCISED IN THE ANALYSIS

In order to evaluate the interrelationships of the input/output (I/O) model parameters, it was necessary to select some base case to represent the typical HRI plant that would fit the requirements of the average Navy activity. The accuracy of the definition of this base case is actually not critically important since small deviations from true average values do not significantly affect the comparative relationships (functions) of the I/O parameters with respect to each other but only

offset to some varying degree the relative scaling of each. If these deviations from true averages assume larger proportions, then the parametric relationship can be affected, but only if the functions are nonlinear.

The values assigned for the model case are shown on the HRI Model input screens which, as mentioned earlier, are tabulated herein as Appendix B. A brief explanation of the use of the input data follows.

Screen 1--The inputs for current month and year represent the actual time the analysis is performed. Inflation rates are specified and reflect any differential rates that may operate between the factors considered in the analysis. Inflation rates are applied to the variously dated input costs until initial funding occurs when standard NAVFAC P-442 discounting is observed. Project lead time allows for distribution and discounting of the involved costs over the project lead time period. The economic life of the HRI is its expected term of beneficial occupancy. As noted earlier, this has been set at 15 years rather than the 25-year period specified for steam generators in NAVFAC P-442 because of the more deleterious stoking/combustion conditions that HRIs experience in comparison to fossil fuel fired boilers.

Screen 2--Capital costs shown on this screen are dated and broken down into discrete categories. This is an optional journal procedure since line item entrees are ignored by the model in favor of subtotals. Similarly, subtotals are ignored if an entry for Total Capital Costs is made at the top of Screen 3. Thus, in Appendix B the subtotals are entered while the line items are not journalized.

Screen 3--In addition to total capital costs, allowances are made for expected major modifications of the plant. These can be dated up through the entire economic life of the plant and will be accordingly discounted. The type of modifications can include both augmentative and restorative operations, for example, plant expansion through the addition of a new boiler or installation of new refractory in the HRIs, respectively.

Screen 4--Manpower requirements are broken down into operation and preventive/corrective maintenance. Wage rates are burdened to allow for fringe benefits and acceleration, which amounts to about 40% incrementation of pay scale. Full burdening as done at NIFI activities is not considered applicable since the inputs to the model itself consider the overhead charges normally going onto NIFI burdens. Assignment of operational personnel to maintenance procedures during outages is taken into account. The assumption is that the balance, if any, of their time will be reassigned to other duties and will not be assessed against HRI O&M.

Screen 5--Cost of consumables includes all requirements for the plant. Power consumption takes into account the plant mode of operation. Fuel usage, for auxiliary firing and operation of ancillary equipment such as front-end loaders, is broken down into "virgin" and other fuels. The former type fuels are those that the Navy seeks reduced usage of (fuel oils and natural gas), while the "other" category includes fuels that offset the virgin fuels and can include waste fuels (e.g., JP fuels rejected as being out of specification), other solid waste fuels (bagasse, wood chips, etc.) and fossil fuels that are domestically in potential long supply, such as coal, peat, shale oil, and the various coal derived fuels.

Screen 6--In addition to several more maintenance cost factors, costs are given for solid waste disposal. These costs are broken down into the three categories of waste that the HRI is involved with, which include nonburnable waste, ash, and as-received material. Disposal costs for the latter represent a saving when the HRI is operating but become a debit if the HRI is down and must divert waste.

Screen 7--Other costs are special entries that can include capital (C), energy (E), landfill (L), or other (O) costs. These may be input as fixed or conditional modifications after a model case has been developed. For the present exercise, Screen 7 was not used.

Screen 8--Many of the key design and operational factors are input to this screen and are largely self-explanatory. A possible exception is the specification of furnace type (refractory or water walled). This input implements a procedure for correcting for the differences in wall heat losses of the two furnace types when shut down during scheduled or unanticipated outages. Also the mathematical application of estimated maximum HRI downtime may not be obvious. The distribution of HRI downtimes is assumed to be log-normal and the user's estimate of the maximum duration of downtime is required to scale that function.

THE ANALYTICAL APPROACH

This section describes the approach used to determine how the various operating and cost factors (input parameters to the HRI model) affect the cost benefits of an HRI plant. The HRI cost benefit analysis program described above is essentially intended for the analysis of a specific HRI installation, which some user or user's consultant has developed as being appropriate to his particular activity. On the present undertaking, the specific conceptual HRI plant usually input to the model was replaced with the base case HRI. The program was then repetitively run with the selected parameters being varied over predetermined ranges at arbitrarily fixed intervals.

The summary report sheets obtained from these exercises were then plotted using the Tektronix 4052 ADP plotting system. Empirical equations were generated by polynomial regression by the same computer/plotter for each of the curves generated. These expressions were abbreviated to eliminate inconsequential terms and are tabulated here as Appendix D. These equations may be used to predict the behavior of the particular variable beyond the range examined in this study. The user should, however, be aware of the possibility of incurring significant error when empirical equations are exercised outside of the range in which they were developed.

The input data for the base HRI case were derived from existing HRI facilities costs and construction and operating conditions (e.g., Ref 4) and provide a reasonable reference point from which to execute variations in the input parameters. The independent variables were usually operated over rather broad ranges, ones that would not likely be exceeded in actual engineering practice. In most cases, the range of variation has been arbitrarily assigned and generally is not more then 50% above or below the base case value.

The independent variables that are discussed in this section have been divided into the following four groups: (1) costs, (2) inflation rates, (3) plant performance, and (4) other design criteria. Each group is individually discussed, with particular emphasis being given the comparative impact on cost benefits each of the group members was found to exhibit.

HRI COSTS

The first group of independent variables comprises cost parameters which include: capital costs, disposal costs, and cost of producing steam from an existing fossil fuel boiler.

HRI Capital Costs

Heat recovery incinerator capital costs refer to the total equipment and construction expenses for erecting an HRI plant. In addition to entering the capital cost figures, the year in which the money is anticipated to be spent must also be entered into the computer model, since inflation factors need to be applied to such costs.

Capital costs are a major fraction of the total investment cost of an HRI facility. As shown in Figures 1 and 2, the discounted life cycle cost (LCC), discounted life cycle savings (LCS), and payback period (the number of years required for the savings to equal the costs) all vary linearly with varying capital costs. The savings-to-investment ratio (SIR) decreases exponentially with increasing capital cost, approximated by a second order function. Because the rate of change for a second order curve is dependent on the specific location of the point on the plot, the accuracy of the capital cost value used is important in estimating its effect on SIR (unlike LCC, LCS, or payback period). While the data used are indeed of reasonable accuracy, the variations are essentially manipulations that would not likely occur within a population of properly designed HRI plants. The competitive bidding process would likely ensure that the average (stabilized) dollar cost for a given HRI purchase specification package would not vary greatly from one CONUS activity to another. The key lesson that is to be learned from Figures 1 and 2 is that designers should avoid frills, excessive redundancy, overdesigned components, and other liberalities that can drive capital costs up and render the resultant facility cost-ineffective.

Solid Waste Disposal Costs

In contrast to the somewhat artificial variation in capital costs practiced above, a variation in disposal costs is a very real and expectable thing. The scale range used ($0-50) is not heavily exaggerated, since costs of landfill disposal may soon approach the $50/ton level in certain parts of the country. Landfill disposal costs are, in fact, one of the principal factors incentivizing solid waste managers towards the construction of waste-to-energy plants.

Fortunately, however, the sensitivity of payback and SIR to variations in disposal costs is not as acute as it is to capital costs. This is apparent from Figures 1 and 2. This is, of course, due to the predominant role capital costs play in the initial (lead time) investment term, which is the denominator in both of the above expressions. In contrast, LCC and LCS are more profoundly influenced by disposal costs (see Figure 2), since these cost benefit terms deal only with the discounted costs and savings which are accrued over the entire economic life of the plant.

The fact that the difference between LCS and LCC does not appear to change over the range of disposal costs observed merely results from the fact that disposal costs for ash, oversized, and noncombustibles are also increasing, assumedly at the same rate as the regular disposal costs. Since the solid wastes emanating from the HRI are a fixed fraction of what is received, the slopes of the LCS and LCC curves should thus be the same, if all other factors remain the same. It will be noted that the difference in LCC and LCS is less than the capital cost of the base case; this does not mean, however, that the plant will be unprofitable. The capital cost is not a discounted value and cannot therefore be directly compared. The magnitude of the difference does, however, point up the justification for recovering energy in the process of reducing disposal volume.

Cost of Producing Steam From an Existing Fossil Fuel Boiler

Another cost that is an input parameter to the HRI model is that for operating a pre-existing fossil fuel boiler to provide the same amount of steam energy that would result from the operation (zero downtime) of the HRI design selected for input to the model. The input includes the cost of steam produced by the fossil fuel boiler in units of dollars per million British thermal units (MBtu), and the year for which this cost was derived. This implies that the user knows what he is paying for steam, a cost easily determined only if the steam is bought from the outside. If it is produced by the PWD utility division, the cost will not be so easily fixed, since typically only fuel costs, unburdened operating labor costs, and repair bills are recorded. Some activities do maintain comprehensive steam cost data that include life cycle costs of plant, maintenance labor, labor burden, and many other cost items. Based on such data, the standard case value entered in the model was $9/MBtu and was varied ±33% in the HRI study.

Given a competitively acquired and efficiently run fossil-fuel boiler plant that exhibits a RAM reasonably near the median, the principal operator that will impact steam cost is the cost of fuel. This, of course, is volatile enough that one could expect a range of variation in steam costs of the magnitude employed here. Thus, as one examines the strong reactions of the dependent cost/benefit parameters to fossil-fuel-based steam costs, one can essentially predict how the attractiveness of an HRI steam plant will be enhanced as fuel costs rise.

The behavior of the four dependent cost variables to fossil-fuel-based steam is shown in Figures 3 and 4. As could be expected, the HRI LC Savings (Figure 3) are dramatically influenced by changes in costs of conventionally generated steam. This is because HRI LC Savings are

derived from energy, waste disposal, and other savings. The energy term, which contains the cost of steam conventionally generated and HRI total energy costs, is a dominant factor. Thus, the attractiveness of the HRI investment will hinge critically on what an activity is already paying to generate steam. A well-managed, coal-fired plant will likely prove hard competition, thus making the other HRI LC Savings factors (e.g., high solid waste disposal costs) prime movers in the decision-to-construct process.

Discounted Life Cycle Cost of the HRI proves much less sensitive (Figure 3) to cost of conventionally generated steam. This is because the steam term only enters the comprehensive cost-of-doing-business expression in the downtime cost. Thus, a 33% increase in cost of conventionally generated steam increases the HRI LC Cost by less than 7%. A similar situation is obtained when looking at SIR (Figure 4). Here, the HRI LC savings are essentially compared to inflation-normalized capital and engineering costs. Because the former term is dominated by the cost of conventionally generated steam and the HRI, in a right fit situation, is apparently an attractive investment otherwise, the SIR shows a strong response to steam cost variation. A 33% increase in the cost of generating steam from fossil fuel at a Navy activity will result in a 30% increase in the SIR for the modeled HRI plant displacing some of that production. The payback period is arithmetically more complicated than SIR even though the same economic expressions are involved. The discounting process exponentiates the function, giving the result shown in Figure 4. Here a 33% increase in conventional steam cost will decrease payback period by only about 10%, while a like steam cost decrease results in a 23% increase in payback time. Because of this peculiar sensitivity and the earlier mentioned dominance of fuel cost on the cost of generating steam with fossil fuels, investment in an HRI must involve a hard look at probable future trends in fuel costs.

COST OF MONEY

In the foregoing discussion, the sensitivity of HRI costs normalized for inflation was discussed. In this subsection, the influence of inflation rates themselves is considered. Because the impact of inflation on capital and engineering costs is well known, project lead times are typically held to a minimum. What is often not considered is the effect on costs that differences in inflation rates between commodities have. Such differences are particularly noteworthy in the case of fossil fuel and solid waste disposal costs and can influence the cost/benefits of a project over its entire economic life.

In the present model, inflation rates allow for both a differential energy inflation rate and differential landfill inflation rate. These differential inflation rates allow the user to inflate energy or landfill costs at a higher rate than general inflation that is applied to the balance of the HRI cost components. Based on trends that operated at the time (but which today may well no longer apply), the two differential inflation rates were set at twice that of the general rate of inflation, which was taken to be 5%. These energy and disposal cost inflation rates, each thus set at 10%, were actually considerably less than what prevailed a few years ago.

Energy Cost Inflation

The differential energy inflation rate affects both the cost of operating the fossil-fuel fired steam generator with which the HRI is compared and the various quantities (sometimes none) of auxiliary fuel burned during start-up and, perhaps, routine operation of the HRI. For the present analysis, variation of energy inflation rate about the default value of 10% was not attempted because a stabilization of fuel costs had occurred after the default value was set. The variation applied, therefore, was to start the range at the general inflation rate of 5% and then increase it 10 percentage points above that to 15%. Thus, the inflation rate of 10% for energy and landfill disposal costs used in the standard case locates midpoint in the differential range. The results are shown in Figures 5 and 6.

It can be seen that the HRI Life Cycle Savings (LCS) increase dramatically with energy inflation rate while the increases in HRI Life Cycle Cost (LCC), while much less, are nonetheless at about the same rate as the energy inflation rate. The results are entirely analogous with those obtained when steam costs are varied. HRI LCS derive from conventional energy, landfill disposal, and "other" costs savings. Energy dominates in this relationship and the cost of fuel dominates energy costs such that inflation of energy costs (through fuel price increases) results in a skyrocketing appeal developing for the waste-to-energy concept.

Landfill Disposal Cost Inflation

The economic impact of the landfill disposal cost inflation rate is similar in principal with that of energy costs but not as potent. For example, as energy cost inflation increases above general inflation from 0 to 10 percentage points, HRI LCS increases 197% while the same parameter is increased by "only" 30% when solid waste disposal costs are increased by the same amount. This is consistent with the analysis discussed earlier concerning Figures 1 and 2 where it was found that the relative (no inflation) cost of solid waste disposal did have a modest impact on cost/benefit parameters.

PLANT PERFORMANCE

Plant performance, which is the third group of independent variables to which cost/benefit parameters are sensitive, includes the following factors: (1) thermal efficiency, (2) ratio of wet ash to solid waste input, and (3) operating scenario.

Thermal Efficiency

As used in the model, thermal efficiency is simply expressed as the ratio of the design rates of steam energy output to thermal energy available from the combustion of the solid waste and any auxiliary fuel. The HRI thermal efficiency proved to be one of the more potent input parameters, with only capital cost and conventional steam costs exhibiting a greater influence on cost/benefit parameters. The potency of this

[illegible]

parameter results from the direct relationship of efficiency to the savings of producing steam conventionally. Discounted LCC, LCS, payback period, and SIR are plotted against thermal efficiency (Figures 7 and 8) as it is varied from 40 to 70%. This range is somewhat improbable on the low end, in a Navy context at least, but achievable at the high end. Refractory furnace HRI's equipped with waste heat boilers typically furnish efficiencies between 55 and 65%. Water wall units, which are intrinsically less susceptible to wall heat losses, provide efficiencies in the range of 60 to 70%.

Because of the direct relationship with offset conventional steam production, the LCS for response to efficiency improvement is impressive. The LCS increases 65% as the efficiency is increased 30% relative from the selected minimum of 40%. Definite benefits, although not as arithmetically prominent, are also seen in the LCC, SIR, and payback period. The obvious lesson presented by these data is that boiler efficiency should not be merely regarded as a casual system characteristic, that a premium should be placed on high, sustainable boiler efficiency, and that guarantees for boiler efficiency must be secured.

Ash Outhaul/Disposal Rate

Another factor that is a measure of plant performance is the tons of wet ash produced per ton of solid waste input. This output-to-input ratio provides the basis for quantifying the amount of ash that must be "landfilled" - hauled to a landfill. Typical output-to-input ratios resulting from the reduction of waste weight range from 0.2 to 0.6, depending on the degree of fuel burnout and the moisture content of the ash, which is wetted by an appropriate means. Either end of this range is attainable by the various ash handling processes that are available. Because of the relationship of ash disposal to solid waste disposal, which has been shown earlier to have only a modest effect on the cost/benefit parameters, variation of the ratio also has minor impact, assuming that the cost of disposal for ash is the same as that for solid waste.

Figures 7 and 8 illustrate the performance of LCC, LCS, payback period, and SIR versus the ratio of wet ash output to solid waste input. These data were generated, however, with the assumption that ash can be landfilled at the same cost as ordinary refuse. Present environmental law on this is not clear and local regulations may differ considerably. If ash is not permitted to be disposed of in a Class 2 landfill and a hazardous dump must be used, the unit disposal cost could be two to five times higher, depending on location. The data shown, therefore, are for a best case situation. In this case, the data would suggest to the potential HRI plant operator that ash disposal costs are not important factors in the choice between wet or dry ash handling systems. This conclusion should be avoided until after specific ash disposal requirements have been established. The model, incidentally, segregates costs of disposing of oversized reject, ash, and unprocessed refuse so that the model user can study the economic impact of having to haul these various forms of waste to different types of dumps.

Operating Scenario

This phrase refers to the number of hours per day and days per week the HRI facility is scheduled to operate. The HRI model provides the user with five operating scenarios with which the user may match his own planned operating schedule. The purpose of inputting this information is to calculate the boiler reheat losses associated with scheduled downtime under the different shift arrangements. It is assumed that when the capital costs for the plant were arrived at, the sizing of the plant was already based on the operating scenario selected. Thus, the model cannot be used to determine the comparative attributes (other than heat loss) of the various scenarios.

In the standard case (Option 2 in the HRI model), the operation was based on working three 8-hour shifts a day (24 hours), 5 days per week. The other four options include burning two shifts, 5 or 7 days per week or three shifts, 7 or 4 days per week (following receipt of 1 day's refuse collection). Other operating scenarios are employed in the trade but are rather uncommon.

While the model cannot determine the comparative attributes of the various operating scenarios given a fixed set of operational requirements, it can be used to consider the cost benefits available if it is decided to expand the throughput of an existing HRI. If an operator is somehow confronted with an increased load of solid waste to dispose of and the activity can utilize the additional steam generated, the operator may opt to change the operating scenario rather than seek funding for the erection of new facilities. The model can then demonstrate the benefits available from these scenario changes. This can be done for any incremental increase in refuse input. In the present study, however, the standard case only was exercised, thus fixing the firing rate. That is, the standard case requires a refuse input rate of 250 tons/wk; therefore, a shift to 7-day continuous firing would require inputting 350 tons/wk.

Given the operating assumptions just stated, the SIR and payback period behave in relation to the five operating scenarios as seen in Figures 9 and 10. As expected, the results indicate that the total duty time is almost directly proportional to the cost benefits realized.

OTHER ECONOMIC FACTORS

The fourth and final group of economic factors includes: (1) solid waste heating value, (2) plant economic life, and (3) discount rate.

Solid Waste Heating Value

The calorific value of the fuel is expressed as the higher heating value (HHV) and will vary considerably depending on the composition of the solid waste. A probable HHV range for randomly sampled, unprocessed Navy solid waste would be between 3,500 and 6,500 Btu/lb. Besides geographic peculiarities, considerable fluctuation in the composition and, thus, the HHV of Navy activity solid waste can be expected from seasonal and even diurnal factors, as well as from the exercise of the activity's

mission (e.g., variation in ship berthings). Nonetheless, the annual average HHV for a given Navy activity, if determined in accordance with Reference 1, should prove fairly reliable for HRI design purposes. What this value turns out to be, however, can be significantly influenced by the resource recovery policies in practice at the given activity. Source separation of refuse components, such as boxboard, aluminum cans, bottles, garbage, etc., can have a significant effect on heating value.

Changes in solid waste management practices or any other factors that affect the annual average HHV of solid waste will have a pronounced effect on the economics of an HRI facility. This sensitivity results simply from the HHV's direct relationship to the quantity of steam generated from a given amount of solid waste. Shown on Figures 11 and 12 are the LCC, LCS, payback period, and SIR versus Btu per pound of solid waste input. The HHV range plotted has been limited to between 4,000 and 6,000 Btu/lb, since the annual average range will be much narrower than the range for randomly sampled values mentioned above.

It can be seen that the LCS and SIR increase at almost the same rate as HHV. LCC is much less influenced since HHV enters the HRI cost base only when downtime costs are computed. The richer the waste fuel, the more energy that must be generated by a standby fossil-fuel-fired boiler per unit of downtime. The lesson available from these data is that some caution should be exercised in resource recovery if an HRI is to be operated. Source removal of valuable inerts (aluminum and glass containers, nonferrous junk, etc.) beneficiates the fuel and is certainly commendable if the separation process otherwise pays for itself. Removal of combustible fractions, such as IBM cards, boxboard, newspapers, etc., is another matter and should be given some thought. Boxboard now sells for about $80/ton if you can find a nearby salvor. For steam production, however, it will produce about $65/ton, assuming an HHV of 6000 Btu/lb, 60% boiler efficiency, and a steam value of $9/MBtu. Can you separate the boxboard and deliver it to the salvor for less than the differential of $15/ton? Also, you know that the value of steam will doubtless continue to increase, but what about the price of reclaimed boxboard, which has always been very volatile?

Economic Life of the HRI Plant

Useful economic life of the HRI plant was specified as 15 years for the standard case HRI model that was exercised on this study. This differs from the 25-year lifespan specified in P-442 for steam generators in fossil fuel fired systems, which inherently offer better longevity. The HRI life period was selected based on the experience operators have had in the field with a variety of HRI configurations. Some have been surveyed in a few years (e.g., Naval Air Station, Jacksonville) while others have been steaming well in excess of 15 years.

Because the HRI Application Guide (Ref 1) sets out design guidelines for an optimally configured HRI, it can be assumed that considerably extended plant life expectancies will result for those in the Navy availing themselves of this technology. For that reason it was felt justifiable to exercise the standard case assuming an economic life of 25 years. The results are shown in Figures 11 and 12. As expected, extending the economic life had essentially no effect on payback period

but almost commensurately increased the SIR and the (SIR-related) LCS by the same fractional amount of the life extension. The effect on LCC was considerably lower (about half) because, while O&M costs were extended another 10 years, capital costs did not change.

Discount Rate

The discount rate is the minimum attractive rate of return that the Government expects on their money spent on a project. Per P-442, 10% has been used for several years, but recent trends are towards the use of 7%. In view of this possible change, the HRI model was executed at both 7 and 10% discount rates. The sensitivity of the discount rate was found to be rather small in the case of payback period but increased SIR by 24% when the lower discount rate was applied. These data are shown in Figure 13.

FINDINGS AND CONCLUSIONS

General Findings

The 11 parameters selected to determine their degree of influence on the cost/benefits of an HRI plant are presented in Table 1. The expectable range of variation these parameters may operate over (corrected for general inflation) is shown together with the degree of sensitivity SIR will experience when these variations occur.

Key Parameters

The three parameters expected to vary and thereby affect the economic characteristics of an HRI plant the most are: (1) heating value, (2) boiler thermal efficiency available from design, and (3) differential of energy inflation rate with respect to general inflation. These parameters can be expected to have both a moderate to high degree of variation and a high impact on SIR. Although other parameters may exhibit greater influence on SIR per unit of change, the overall effect of these parameters on the cost/benefits of the HRI plant is greater.

Capital Costs

Capital costs and the cost of conventionally generated steam both have the potential for significantly altering the cost/benefits of an HRI plant. Any trends that may result in the technological lowering of the former (corrected for inflation) or inflating the latter will markedly enhance the economic attractiveness of the HRI.

Disposal Costs

Both the cost of solid waste disposal and the differential inflation rate of that service with respect to general inflation proved to be less influential in the HRI cost/benefit picture than was expected.

Similarly, SIR exhibited relatively low sensitivity to HRI ash outhaul cost variations, but this is based on treating the ash as a nonhazardous material, a categorization that may prove faulty.

Uncertainties

Assignment of appropriate values for the money discount rate and the facility economic life was an uncertain process. Both can have very strong effects on the economic attractiveness of an HRI plant and should be better defined.

RECOMMENDATIONS

Capital Costs

Because of the powerful effect capital costs have on the economic viability of an HRI plant, they should not be allowed to vary upward through the inclusion of unnecessary features, redundancy, control sophistication, structural overdesign, etc. Protect your investment through the inclusion of component performance guarantees so that fix-money need not be applied. Be sure your bidders represent the competitive field of good technology purveyors and that your purchase specification package faithfully follows the guidelines in Reference 1.

Disposal Costs

There is no magic breakpoint in the costs for solid waste outhaul/disposal at which one should turn to the HRI Model Users' Manual. Rates can be expected to increase as they follow general inflation and rise sharply when new landfills come on line. Anticipate these relocations, preferably by several years, by running the HRI Model based on expected disposal costs.

Cost of Conventionally Generated Steam

This will go up as fossil fuel costs increase or if new plant (replacement or add-on) capacity is in MCON planning. If the latter is the case, determine if an HRI would satisfy the service required and, if so, at what comparative cost. Fossil fuel other than coal will certainly increase in cost enough to warrant the annual exercise of the HRI Model.

HRI Thermal Efficiency

Because of lack of development in small waterwall HRI's, the HRI Application Guide necessarily recommends a specific configuration of the refractory-furnace HRI, a device considerably lower in thermal efficiency than the waterwall system. With this design penalty considered, it becomes very important to specify a system that is very well insulated and that furnishes average residual carbon values not exceeding 3 wt-%. A minimum thermal efficiency of 60% must be guaranteed for a suitable operating term (at least 1 year) based on testing procedures that conform to ASTM Committee E38.10 standards.

Ash Production

Given efficient HRI combustion (low residual carbon), the quantity of ash output by an HRI will largely be determined by the composition of the fuel and the degree of wetting the ash experiences. The HRI Application Guide does not recommend the use of a dry ash handling system but instead promotes the use of quench tanks for handling bottom residues. Wet ash handling results in the leaching of metals from the ash and this can be a significant economic factor when considering landfill costs. Disposal of bottom/fly ash is variously regulated and, in some states, the material is treated as hazardous waste (high cost disposal) unless the leachable heavy metals are below certain limits. It will therefore be important to learn local disposal requirements and expected future requirements. If ash leaching becomes important, the ash handling system design should promote it.

Heating Value of the Fuel

Because the HRI Application Guide recommends mass firing of the received solid waste, beneficiation of the fuel should be done by source separation and a minimum amount of hand culling at the HRI plant. Source separation specifications should encourage removal of valuable inerts but leave combustibles that demonstrably will provide a better financial return when fired than when recycled. Upgrading the calorific value of the fuel will develop the economic viability of the HRI system significantly.

Operating Scenario

The HRI Application Guide recommends designing an HRI that will be operated continuously over a 5-day work week.

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2. ______________. Contract Report CR 84.029: User's manual for the heat recovery incinerator (HRI) model, by J.M. Ertman. Port Hueneme, Calif., L.I. Dimmick Corp., Jun 1984.

3. Naval Facilities Engineering Command. NAVFAC P-442: Economic analysis handbook, Washington, D.C., Jun 1980.

4. Naval Civil Engineering Laboratory. Contract Report CR 84.013: Field examination of heat recovery incinerator (HRI) facilities of up to 50-tpd capacity; Comparison of ten HRI facilities, by R. Frounfelker, B.A. Hausfeld, and R.A. Haverland. Xenia, Ohio, Systech Corporation, Feb 1984.

Table 1. The Degree of Variation of and Sensitivity of SIR to 11 Techno-Economic Parameters

Parameter	Expected Degree of Variation	SIR Sensitivity
Capital Cost	Low	Very High
Solid Waste Disposal Cost	High	Moderate
Cost of Conventionally Generated Steam	Moderate	High
Differential Energy Inflation	High	Moderate
Differential Landfill Disposal Cost	High	Moderate
Boiler Thermal Efficiency	Moderate	High
Ratio of Ash to Waste Input	High	Low
Heating Value	High	High
Economic Plant Life	Fixed Value	High
Operating Scenario	As Required	N/A
Money Discount Rate	Fixed Value	Moderate

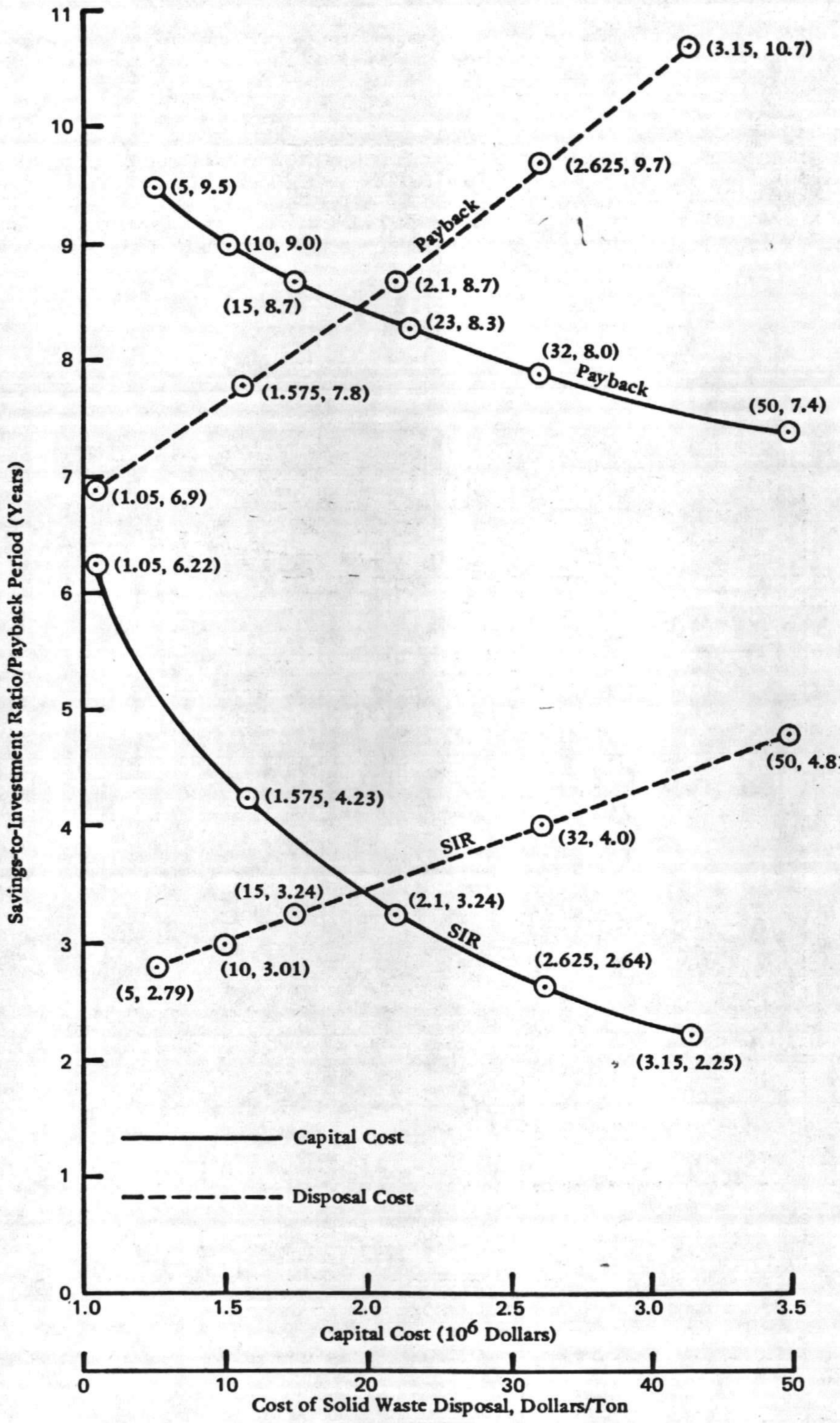

Figure 1. Savings to investment ratio (SIR) and payback period versus capital cost and solid waste disposal cost by landfilling.

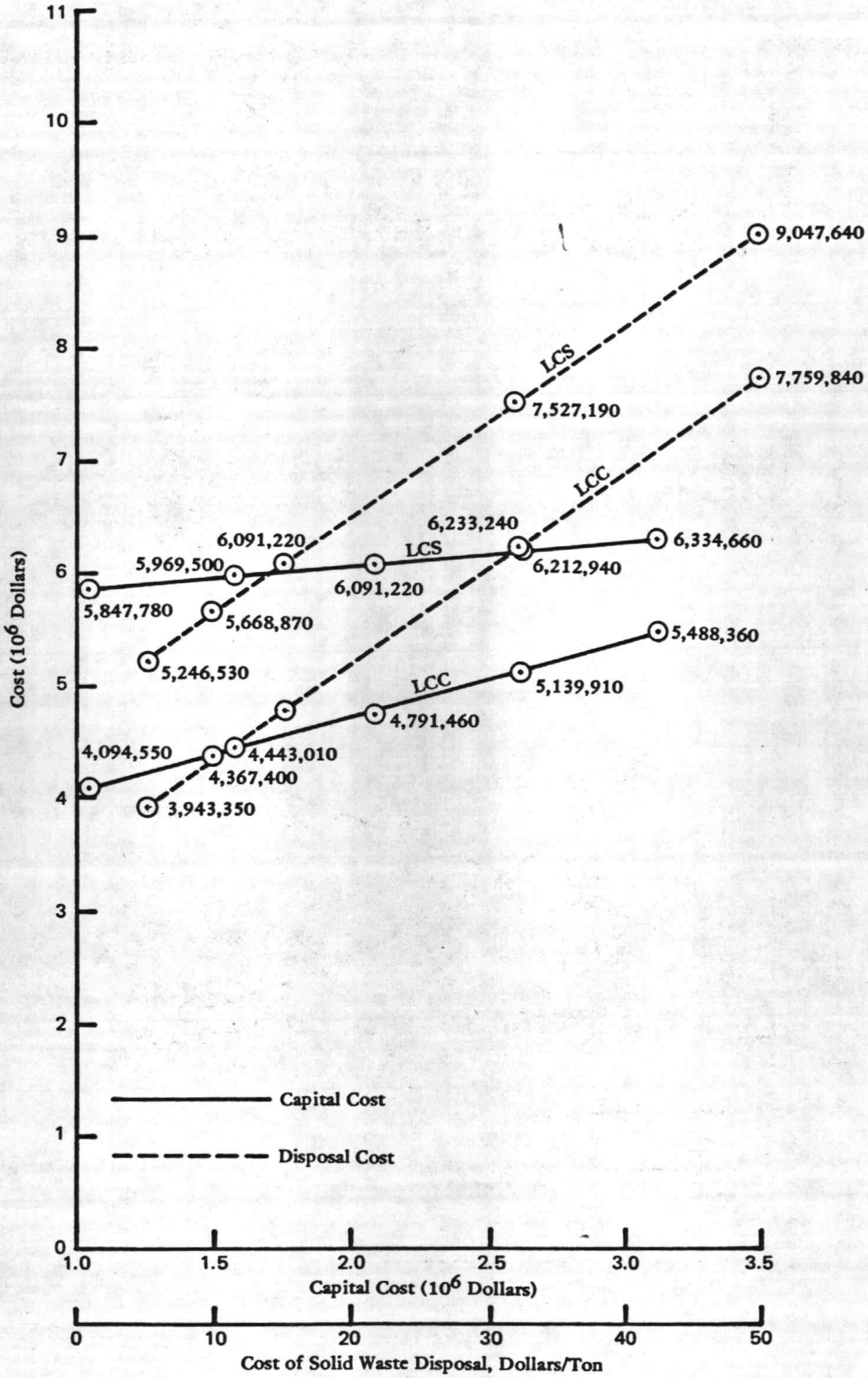

Figure 2. HRI discounted life cycle cost (LCC) and savings (LCS) versus HRI capital cost and solid waste disposal cost by landfilling.

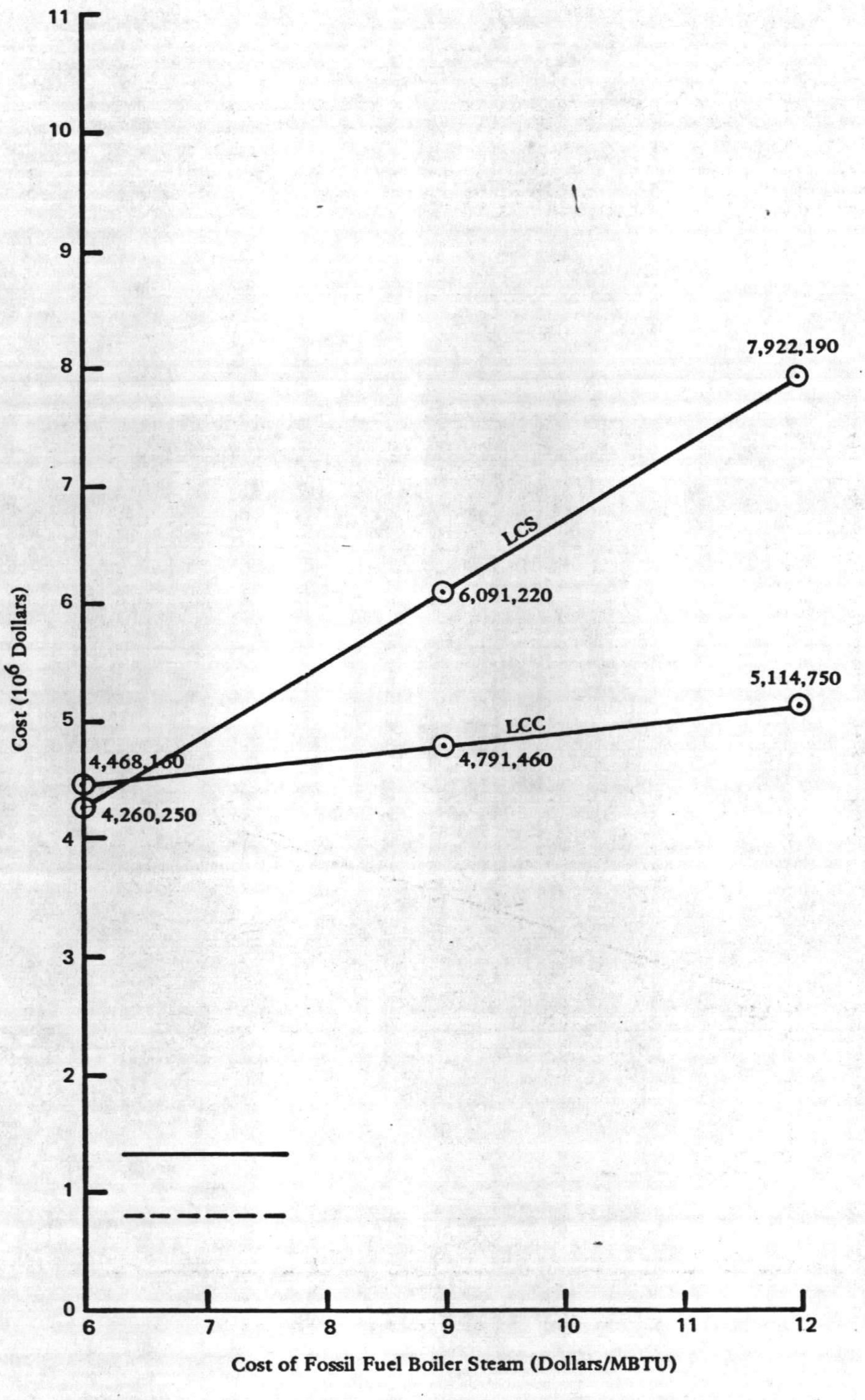

Figure 3. HRI life cycle cost (LCC) and savings (LCS) versus cost of fossil fuel boiler steam.

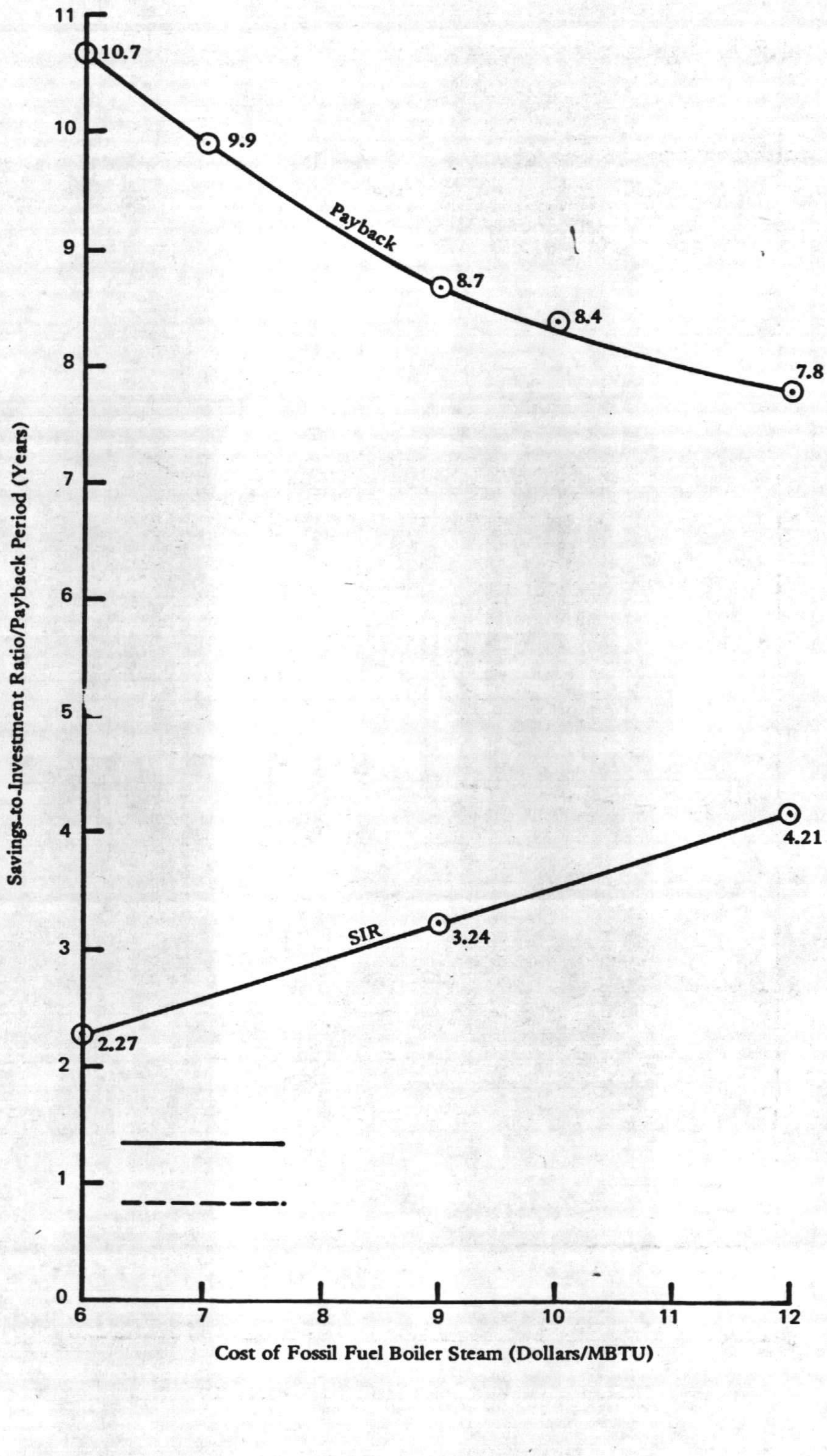

Figure 4. Savings to investment ratio (SIR) and payback period versus cost of fossil fuel boiler steam.

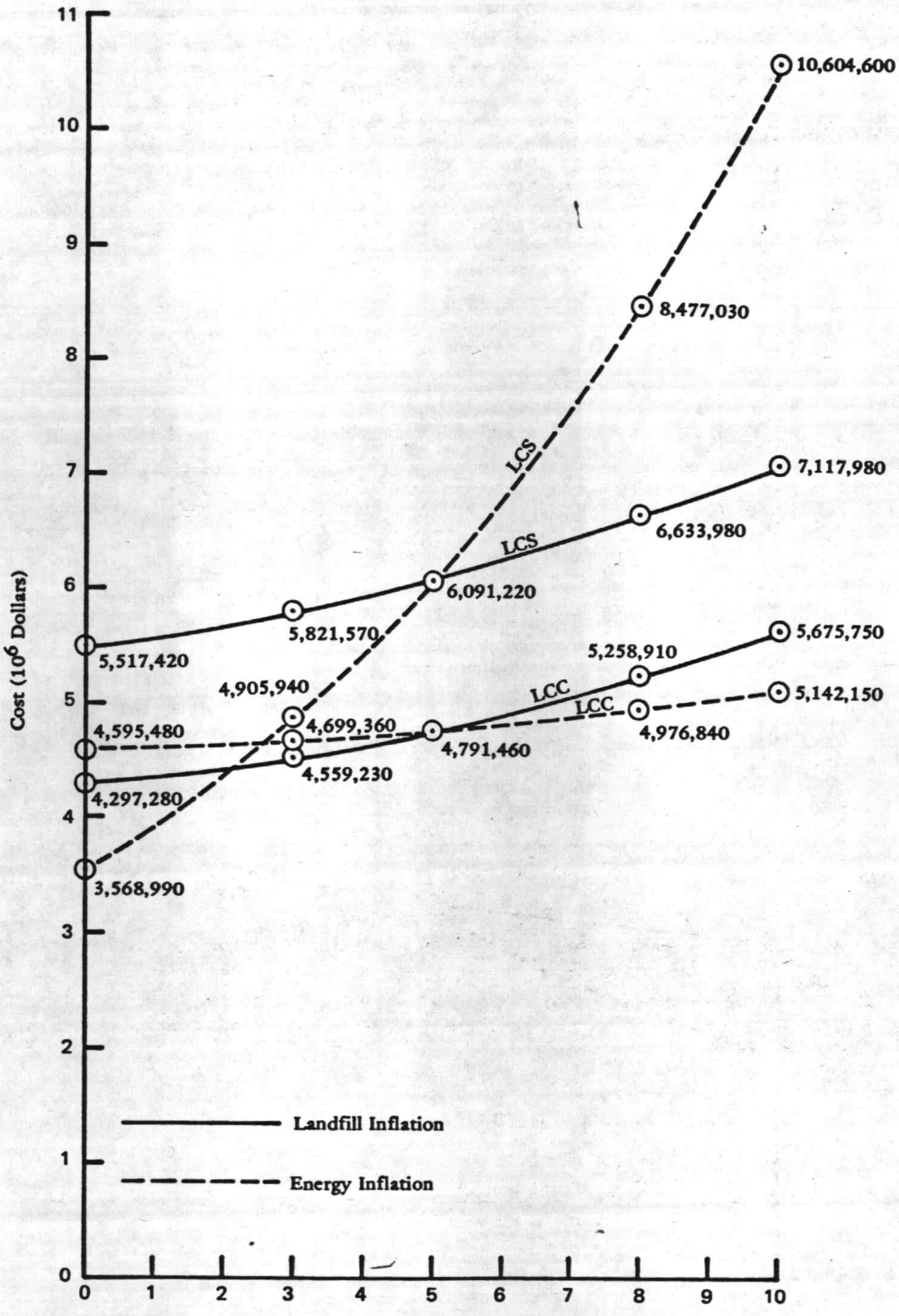

Figure 5. Discounted life cycle cost (LCC) and savings (LCS) versus differential energy and landfill inflation rates.

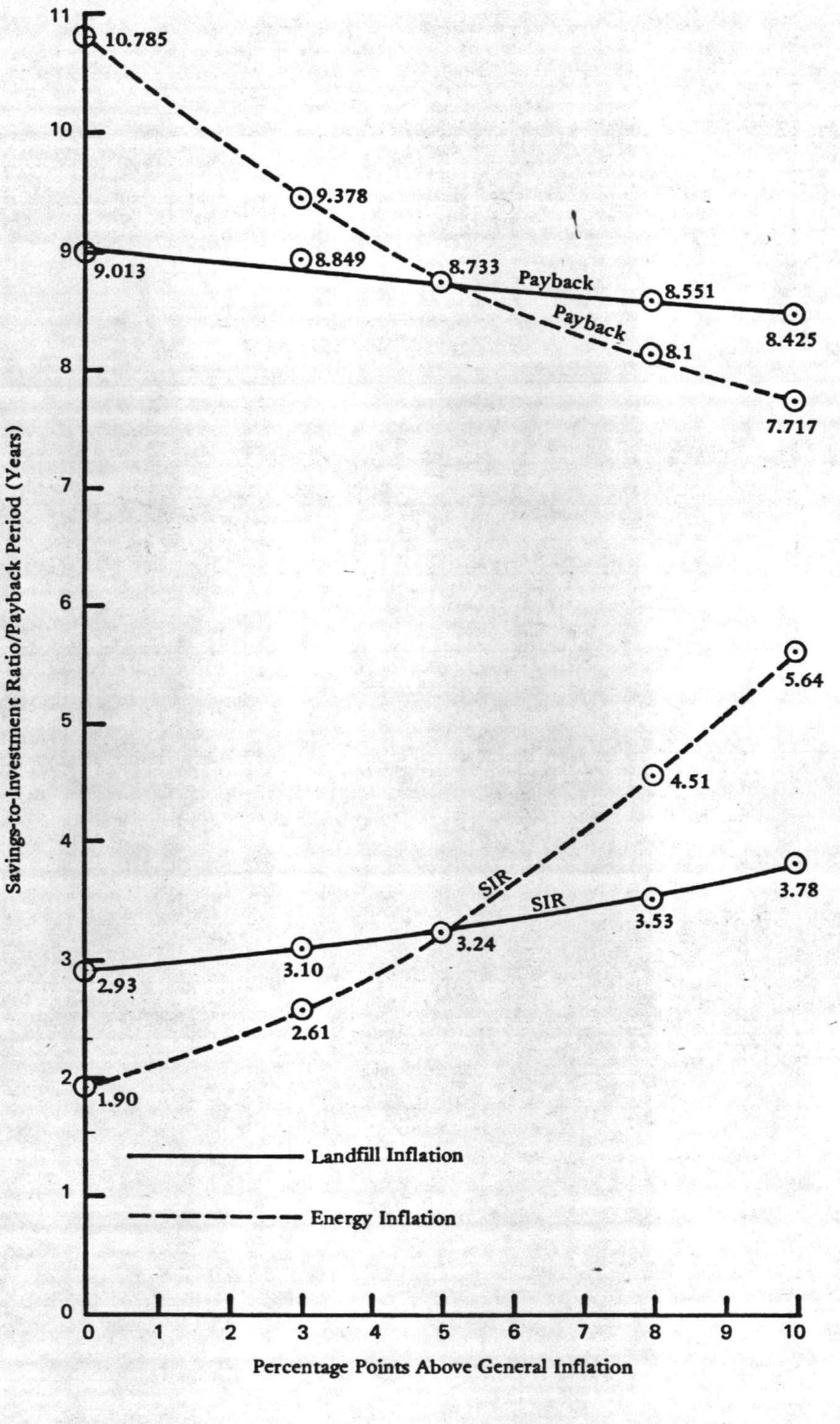

Figure 6. Savings to investment ratio (SIR) and payback period versus differential energy and landfill inflation rates.

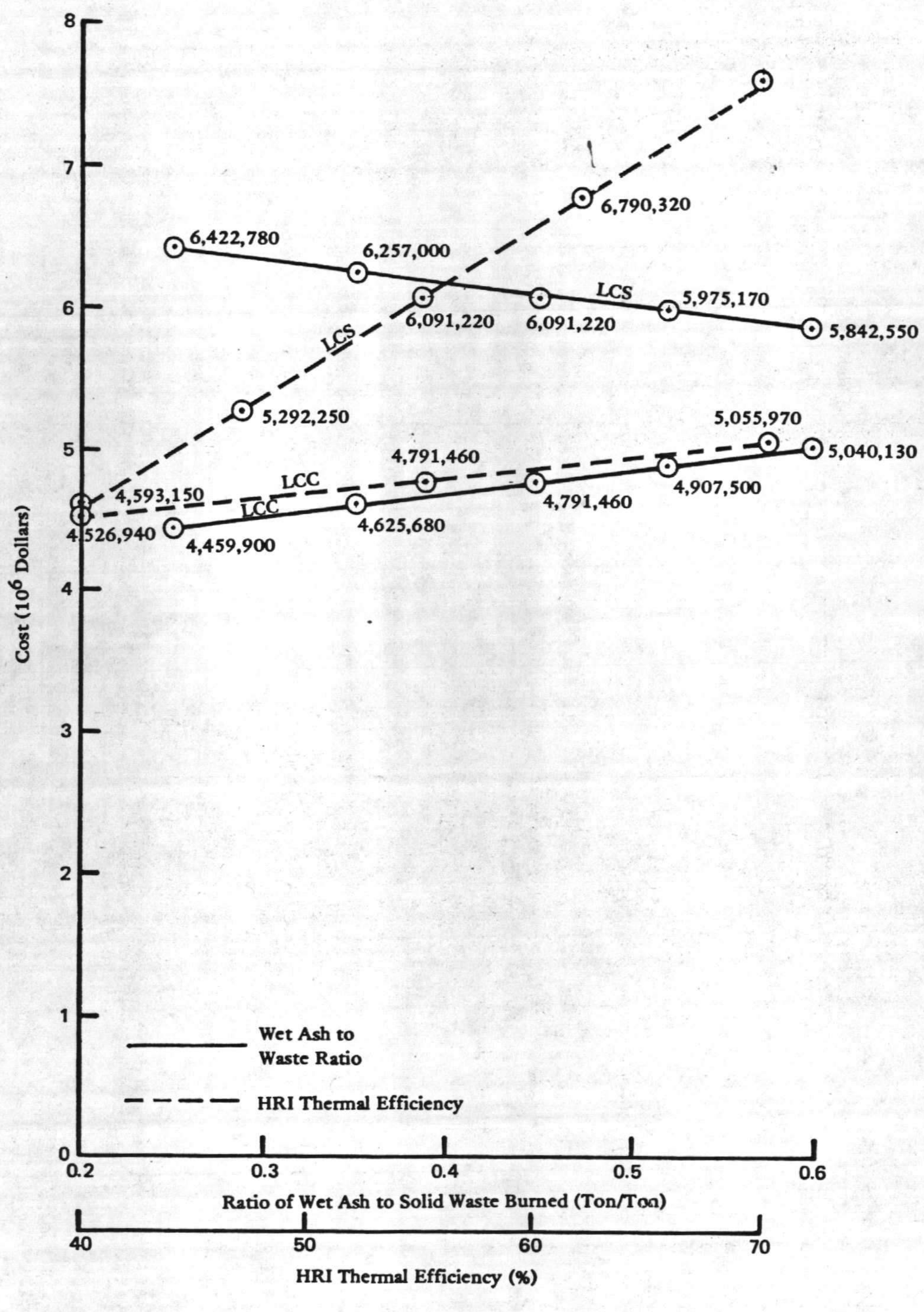

Figure 7. Discounted life cycle cost (LCC) and savings (LCS) versus ratio of wet ash to solid waste and HRI thermal efficiency.

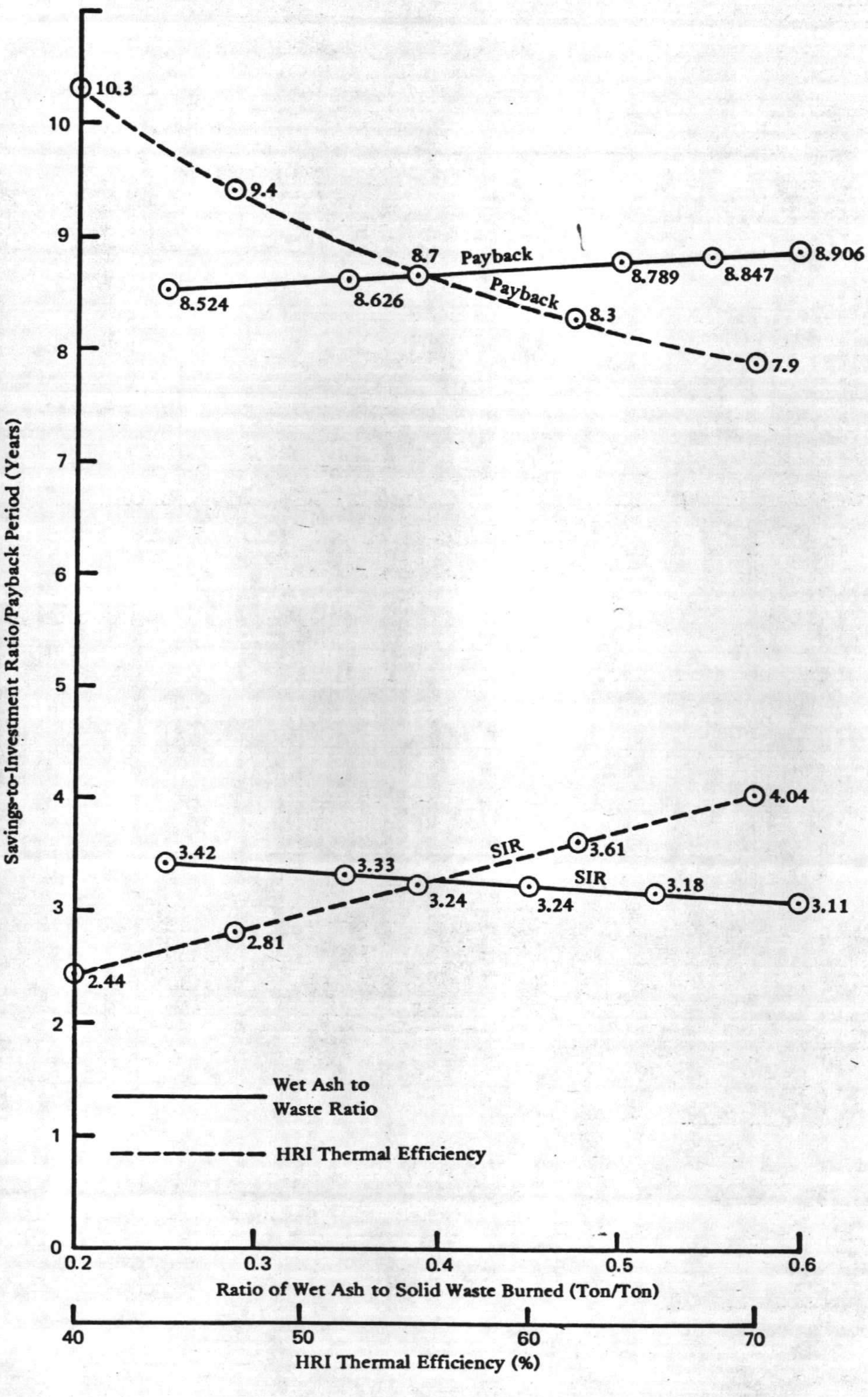

Figure 8. Savings to investment ratio (SIR) and payback period versus ratio of wet ash to solid waste and HRI thermal efficiency.

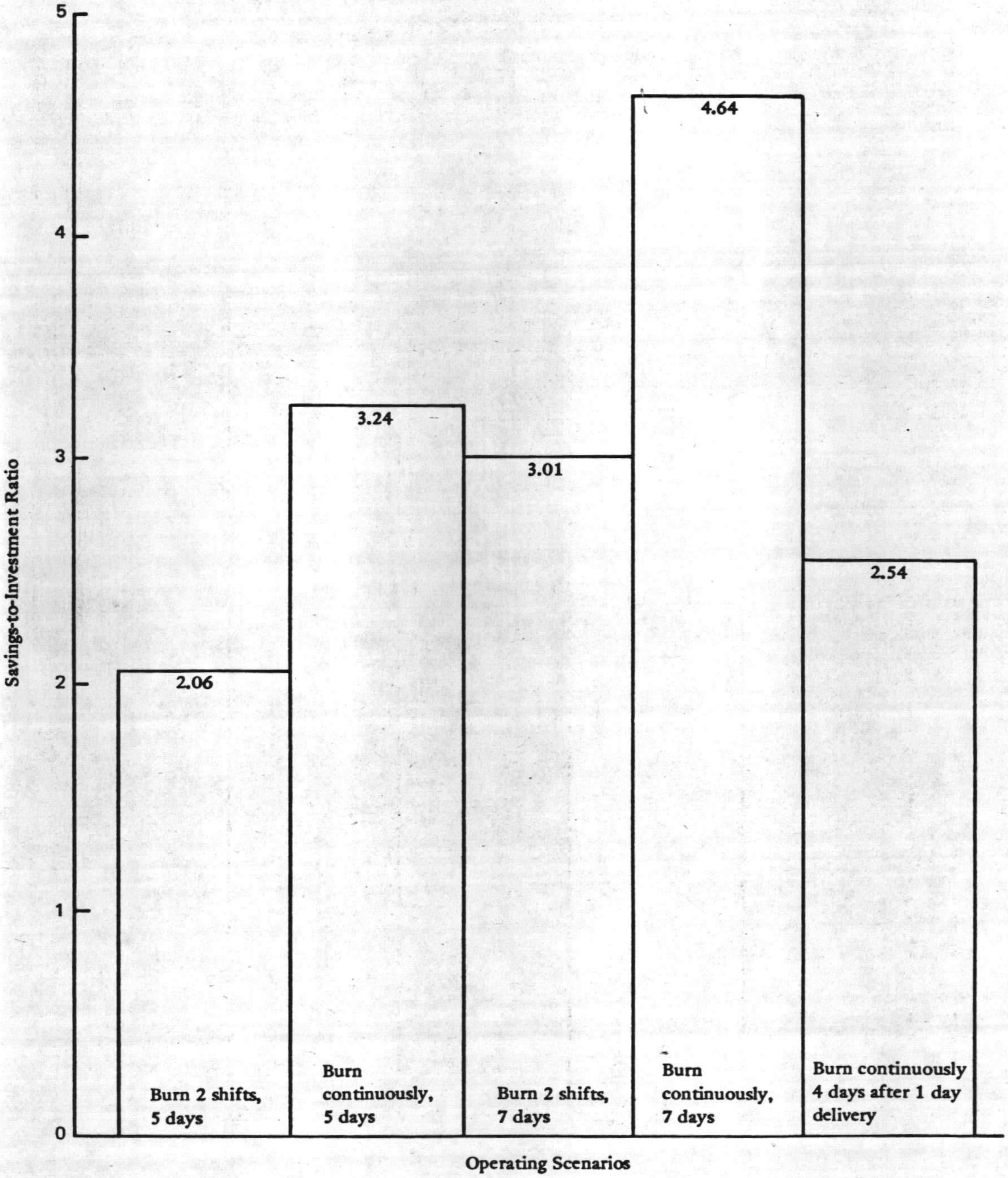

Figure 9. Savings to investment ratio versus operating scenario.

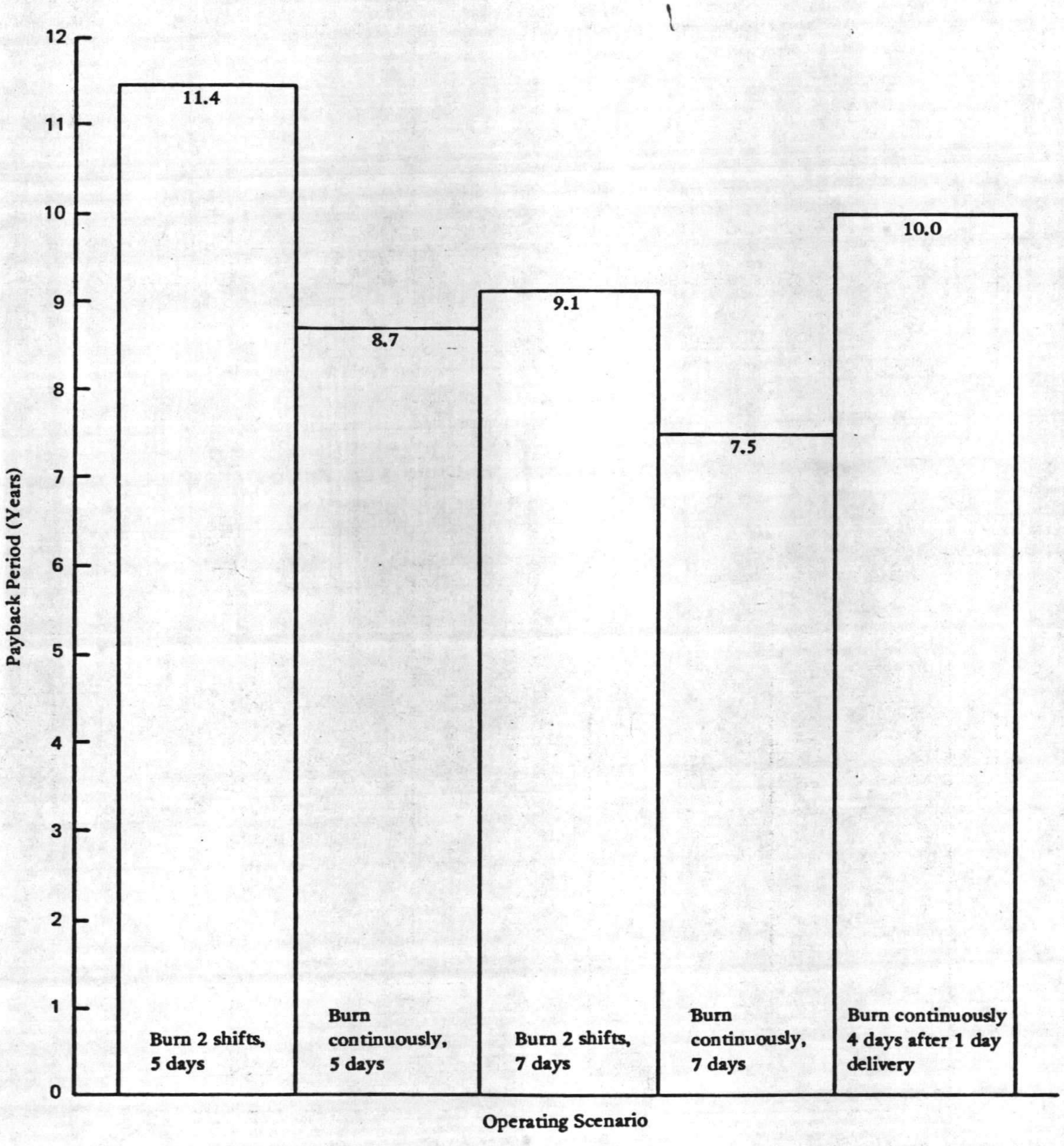

Figure 10. Payback period versus operating scenario.

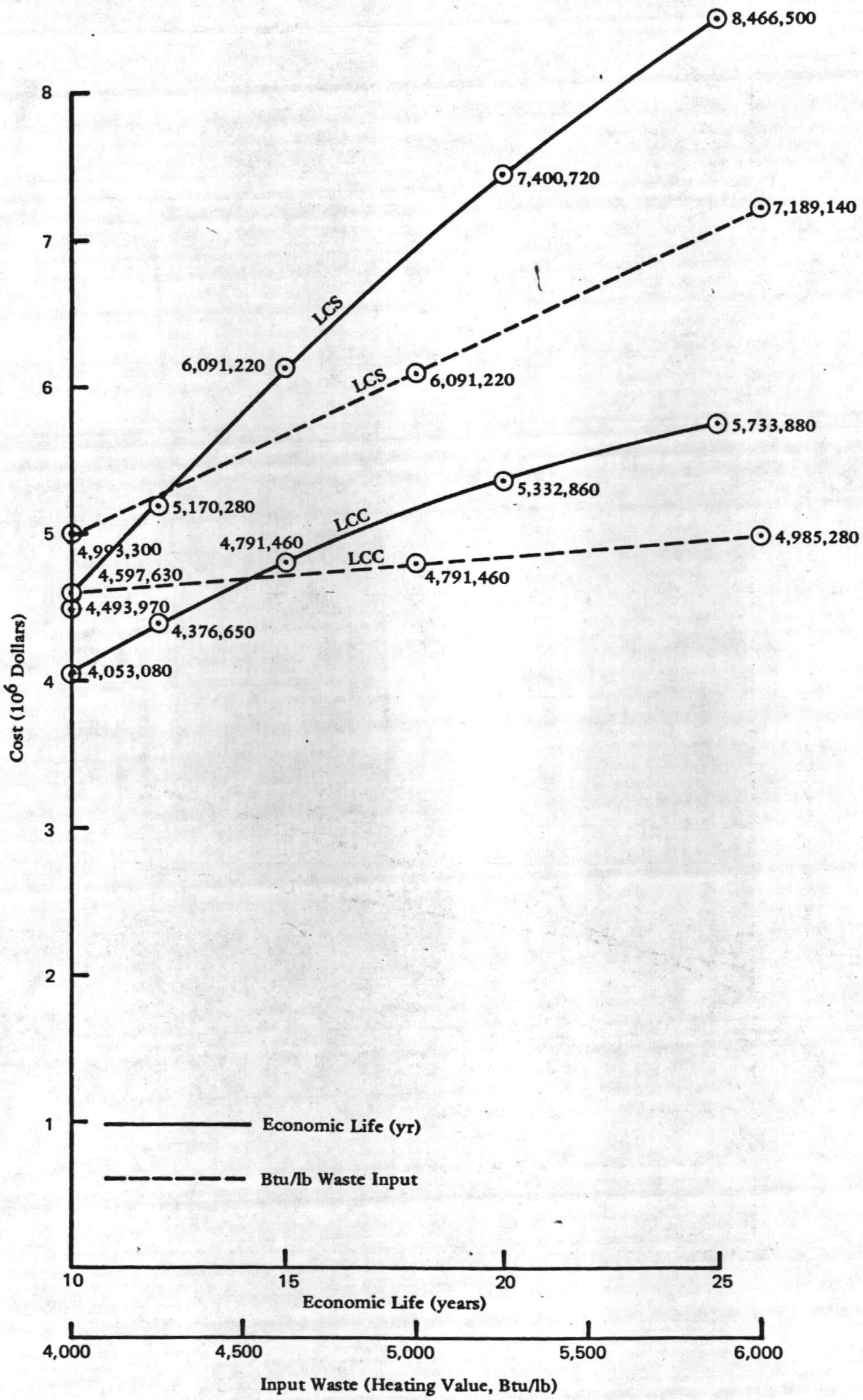

Figure 11. Discounted life cycle cost (LCC) and savings (LCS) versus economic life and input waste heating value.

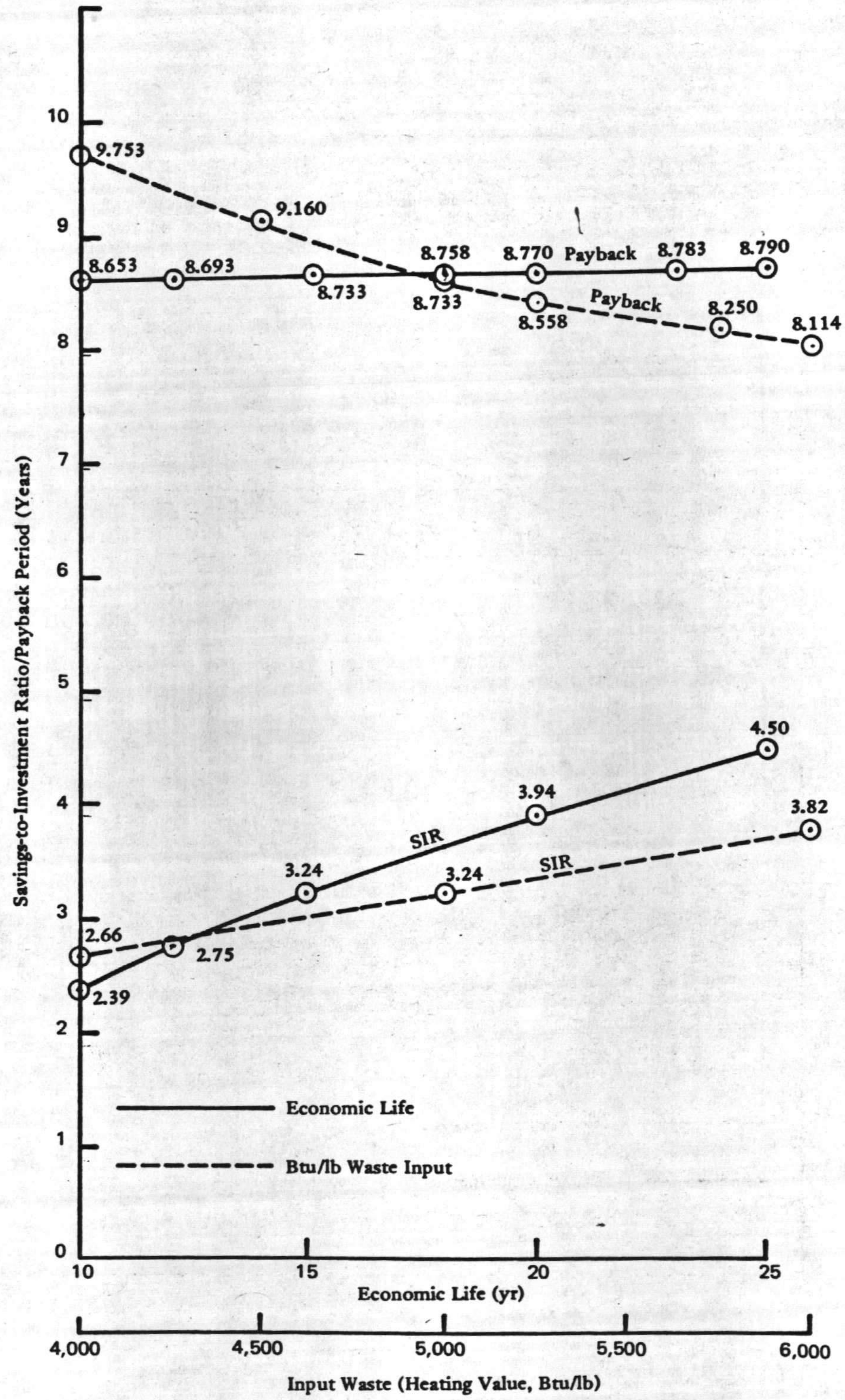

Figure 12. Savings to investment ratio (SIR) and payback period versus economic life and Btu/lb waste input.

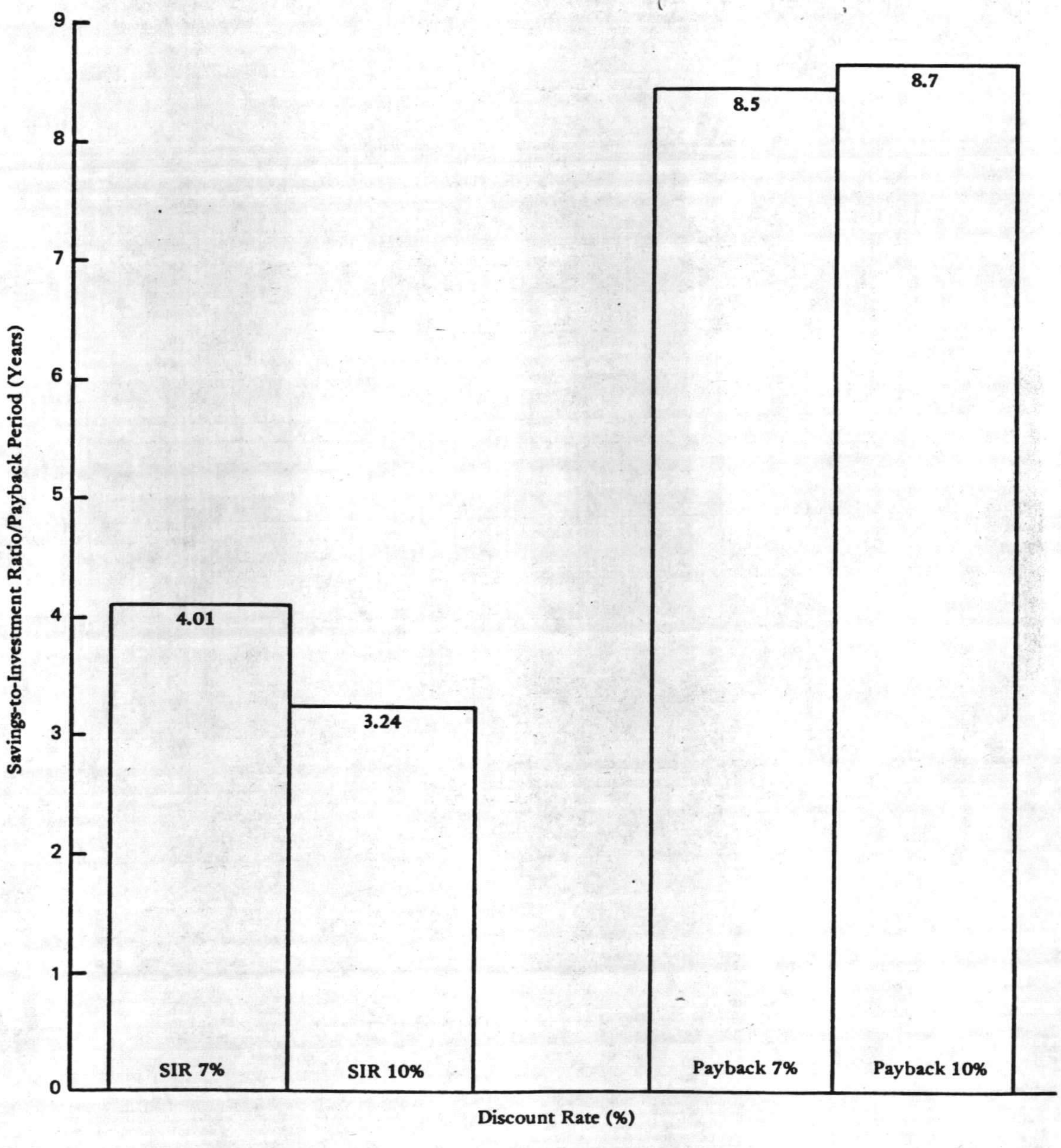

Figure 13. Savings to investment ratio (SIR) and payback versus discount rate.

Appendix A

DEFINITIONS FOR HRI COST AND PERFORMANCE REPORT

The cost and performance report presented by the HRI computer model prints out 22 parameters which may be useful in the design or economic evaluation of a Heat Recovery Incinerator. This appendix presents a discussion of how each output parameter is calculated and, where deemed necessary, what the output parameters represent as economic functions. The definitions are listed in the same order as they appear in the HRI Cost and Performance Report, which is shown at the end of Appendix B.

1. INFLATED PER TON COST OF DISPOSING WASTE OF THE TYPE GENERATED AT THE SITE TO THE LANDFILL--This is the cost of hauling (but not collecting) solid waste from the Navy activity to the landfill and disposing of it there. This cost is inflated at the specified landfill inflation rate called for on Screen 6.

2. INFLATED PER MBTU COST OF THE FOSSIL FUEL BOILER TO WHICH THE HRI IS BEING COMPARED--This is the cost of steam to the activity which an existing PWD boiler produces or which the activity may be paying for over-the-fence service from a commercial producer, whichever service is being partly or wholly displaced by the HRI plant. This value is inflated at the energy inflation rate input on Screen 8.

3. TONS OF TRASH BURNED ANNUALLY--This is the amount of solid waste collected annually and sent to the HRI plant less oversized trash and that trash that must be diverted to landfill during outages after the storage facility has filled.

4. MBTUS PRODUCED ANNUALLY BY THE HRI (CONSIDERING NO DOWNTIME)--This value is the sum of steady state steam production, calculated from the energy content of the trash and any other fuels burned and boiler thermal efficiency less heat losses incurred while cooling and reheating the furnace following scheduled maintenance.

5. VIRGIN FUEL OFFSET ANNUALLY BY THE HRI IN BARRELS-OF-OIL-EQUIVALENT--This is the amount of prime fossil fuel saved by generating the quantity of steam produced (Item 4 just preceding) in the HRI assuming no unscheduled downtime. The MBtus are then converted to the standard units of barrels-of-oil-equivalent (BOE).

6. LANDFILL SPACE CONSERVED ANNUALLY BY THE HRI IN TONS--This is (1) the amount of solid waste that would normally be hauled to landfill if there were no HRI less (2) that solid waste generated by the HRI (ash and oversized waste) or bypassing it due to outages.

7. COST OF USING A BOILER TO PRODUCE THE ANNUAL NO-DOWNTIME QUANTITY OF STEAM PRODUCED BY THE HRI AND LANDFILLING ALL WASTE--This is the sum of the inflated costs to the activity for generating the annual no-downtime quantity of steam produced by the HRI and the annual cost for disposing of all the activity's trash at a landfill without the benefits of an HRI.

8. INFLATED TOTAL CAPITAL COST OF THE HRI--This is the capital cost of the HRI plant (screen 2) inflated at the general inflation rate from the date these costs were estimated to the time the project is funded.

9. UNIFORM ANNUAL COST OF THE HRI--This is the sum of operating costs for the entire economic life of the facility divided by the years of economic life. These costs take into account the cost of consumables, repair parts, sewer, insurance, pest control, labor, project lead time costs, expected modifications, residue disposal, and downtime.

10. ANNUAL NO-DOWNTIME COST OF THE HRI--This cost is the same as the item just preceding except that downtime costs are excluded.

11. DISCOUNTED LIFE CYCLE COST OF USING A BOILER TO PRODUCE THE LIFE CYCLE NO-DOWNTIME QUANTITY OF STEAM PRODUCED BY THE HRI AND LANDFILLING ALL WASTE--This is the total cost of landfilling all waste and using a conventional boiler to produce the no-downtime steam generated by the HRI both over the entire economic life of the HRI facility. This combined cost is discounted per the rate input by the user on Screen 1.

12. DISCOUNTED LIFE CYCLE COST OF THE HRI--This is the Uniform Annual Cost of an HRI (Item 9 above) discounted over the economic life of the project at the rate specified on Screen 1.

13. DISCOUNTED LIFE CYCLE COST OF AUXILIARY FUELS USED BY THE HRI--This is the annual costs for auxiliary fuels that are burned in the HRI discounted over the economic life of the HRI.

14. DISCOUNTED LIFE CYCLE COST OF NONCOMBUSTIBLE WASTE, ASH, AND SCHEDULED DOWNTIME WASTE DISPOSAL--This is the annual cost of landfill disposal of oversized waste and ash from the HRI and ordinary waste diverted from the HRI during scheduled downtimes. This cost is discounted over the economic life of the project.

15. DISCOUNTED LIFE CYCLE COST OF HRI DOWNTIME--This is the discounted life cycle cost of the annual waste tonnage diverted to landfill because of unscheduled outages multiplied by the savings for no-downtime HRI operation realized per ton of waste fired. The latter is expressed as the annual no-downtime firing rate divided into the difference between Items 7 and 10.

16. DISCOUNTED LIFE CYCLE COST OF THE HRI PER TON OF WASTE FIRED--This is the life cycle cost of the HRI (Item 12) divided by the product of actual (all outages included) annual trash incinerated and the years of economic life of the HRI.

17. DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI PER TON OF WASTE FIRED--This is the discounted LC HRI savings (see Item 20 below) divided by the product of actual (all outages included) annual trash incinerated and the economic life of the HRI.

18. DISCOUNTED LIFE CYCLE COST OF THE HRI PER MBTU PRODUCED--This is the HRI life cycle cost (Item 12) divided by the total energy produced over the economic life of the HRI, including that for steady state steaming, reheating the furnace and while turned up above nameplate rating.

19. DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI PER MBTU PRODUCED--This is the Life Cycle Savings of the HRI (Item 20, next below) divided by the same energy term used in Item 18.

20. DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI--This is the energy, landfill costs, and other savings (or losses) accrued by the HRI over its economic life and discounted to furnish an annual rate.

21. HRI SAVINGS-TO-INVESTMENT RATIO--This is the ratio of Item 20 to the Discounted Cost of Lead Time Expenditures, including inflated capital costs and A&E charges.

22. PAYBACK PERIOD IN YEARS--This is the time elapsed wherein the cumulative savings just exceed the Discounted Cost of Lead Time Expenditures.

Appendix B

HRI COST MODEL DATA SCREENS FOR THE STANDARD CASE

```
                    DATA INPUT SCREENS FOR B:KTC
                       ***  GENERAL INFORMATION  ***              SCREEN 01
                  CURRENT MONTH:  6          CURRENT YEAR: 84

                         ***  NEAR-TERM FUTURE  ***
                NUMBER OF MONTHS BETWEEN ANALYSIS AND FUNDING: 12
                 ANNUAL INFLATION RATES FOR THE FOLLOWING:
                           CAPITAL EXPENDITURES:  5.0
                                        ENERGY: 10.0
                                LANDFILL COSTS: 10.0
                        ALL OTHER EXPENDITURES:  5.0

                        ***  PROJECT LEAD TIME  ***
                 ARCHITECT/ENGINEER(%)          CAPITAL COSTS(%)
           YEAR 1      33.3                        0.0
           YEAR 2      33.3                        0.0        (NOTE: PERCENTAGES
           YEAR 3      33.4                        0.0          MUST ADD TO 100)
           YEAR 4       0.0                       50.0
           YEAR 5       0.0                       50.0
                      ***  PROJECT ECONOMIC LIFE  ***
ECONOMIC LIFE OF HRI IN YEARS: 15                  DISCOUNT RATE (%): 10
DIFFERENTIAL INFLATION RATES (%) FOR ENERGY:  5         AND LANDFILL:  5

                      IS EVERYTHING CORRECT (Y/N)?
```

***** CAPITAL COST FOR EQUIPMENT ***** SCREEN 02

YEAR $: 81

ITEM	COST	ITEM	COST
RECEIVING:	50679	QUENCH TANK WATER TREATMENT:	0
PROCESSING:	0	BOILER WATER TREATMENT:	0
STORAGE:	0	INSTRUMENTATION:	0
RETRIEVAL:	36000	CONTROL SYSTEM:	0
INCINERATION:	387200	FIRE AND EXPLOSION SUPPRESSION EQUIPMENT:	0
BOILER:	156500	INITIAL SPARE PARTS INVENTORY:	0
ASH REMOVAL:	29734	OTHER:	28125
AIR POLLUTION:	0	TOTAL:	1500000

***** CAPITAL COST FOR SUPPORT FACILITIES *****

YEAR $: 81

ITEM	COST
BUILDING:	0
UTILITIES:	0
EARTHWORK AND ROAD CONSTRUCTION:	0
OTHER:	0
TOTAL:	400000

***** CAPITAL COST FOR CONSTRUCTION AND SETUP *****

YEAR$: 81 TOTAL: 200000

IS EVERYTHING CORRECT (Y/N)?

*** TOTAL CAPITAL COST *** SCREEN 03
YEAR $: 81 TOTAL: 2100000

*** CAPITAL COST FOR EXPECTED MODIFICATIONS ***
YEAR $: 81

DESCRIPTION OF MODIFICATION	MODIFICATION COST	ECONOMIC LIFE YEAR
STAK SCRUB	100000	5
REFRAC ETC	200000	10
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0

*** CAPITAL COST FOR ARCHITECT AND ENGINEER SERVICES ***
PERCENTAGE OF ALL CAPITAL COSTS IDENTIFIED ABOVE: 6.0

IS EVERYTHING CORRECT (Y/N)?

*** LABOR COSTS *** SCREEN 04

YEAR $: 81

OPERATION	NO DOWNTIME ANNUAL MANHOURS(MHR)	RATE($/HR)	TOTAL	ASSIGNED TO DOWNTIME(%)
SUPERVISORY	2000	21.00	42000	50
SKILLED	4000	18.00	72000	50
UNSKILLED	4000	9.00	36000	50
		TOTAL OPERATION LABOR COST:	150000	

PREVENTIVE MAINTENANCE	ANNUAL MANHOURS(MHR)	RATE($/HR)	TOTAL
SUPERVISORY	75	21.00	1575
SKILLED	150	18.00	2700
UNSKILLED	150	9.00	1350
	TOTAL PREVENTIVE MAINTENANCE LABOR COST:		5625

CORRECTIVE MAINTENANCE	MHR/CORRECT MAINT HR	RATE($/HR)	
SUPERVISORY	0.1	21.00	
SKILLED	0.2	18.00	
UNSKILLED	0.2	9.00	
	TOTAL CORRECTIVE MAINTENANCE LABOR COST:		0

IS EVERYTHING CORRECT (Y/N)?

```
                  ***  COST OF CONSUMABLES  ***                    SCREEN 05
                              YEAR $:    81
ELECTRICITY:           KWH/OPERATING HR:      50         $/KWH:  0.060
                            KWH/DOWNTIME HR (% OF KWH/OP HR):   20.0
                       KWH/SCHEDULED NON-OP HR (% OF KWH/OP HR):   10.0

WASTE AND OTHER FUELS THAT OFFSET                   VIRGIN GAS AND LIQUID FUELS
  USE OF VIRGIN FUELS
            GAL/TON     $/GAL        BTU/GAL          GAL/TON     $/GAL       BTU/GAL
LIQUID:       0.000      0.00              0            0.050      1.00        129600
       1000 CF/TON  $/1000 CF  BTU/1000 CF   1000 CF/TON  $/1000 CF  BTU/1000 CF
GAS:          0.00        0.00              0           0.00       0.00             0
            TON/TON     $/TON        BTU/TON
SOLID:       0.00        0.00              0
SOLID:       0.00        0.00              0

MAKEUP WATER:   GAL/TON:     0     $/1000 GAL:  0.00    OR ANNUAL TOTAL: 2100
CHEMICALS:
    CHEMICAL     UNITS/1000 GAL MAKEUP WATER    $/UNIT     OR    ANNUAL TOTAL
                        0.00                      0.00                   0
                        0.00                      0.00                   0
                              TOTAL ANNUAL COST OF CHEMICALS:  3500
                        IS EVERYTHING CORRECT (Y/N)?
```

```
                         ***  OTHER COSTS  ***                         SCREEN 06
  ITEM                  ANNUAL COST          YEAR $
REPAIR PARTS              20000                81
SEWER                       300                81
INSURANCE                     0                 0
PEST/VERMIN CONTROL        3000                81
RESIDUE DISPOSAL                       YEAR $: 81
    (ENTRIES MUST BE MADE FOR EACH OF THE FOLLOWING THREE GROUPS)
       TRANSPORTATION COST OF NON-BURNABLE WASTE ($/TON-MILE):    0.00
       NUMBER OF MILES TO NON-BURNABLE WASTE LANDFILL:              0
       TIPPING FEE AT NON-BURNABLE WASTE LANDFILL ($/TON):        0.00
    OR COST OF LANDFILL DISPOSAL OF NON-BURNABLE WASTE ($/TON):  15.00

       TRANSPORTATION COST OF ASH ($/TON-MILE):                   0.00
       NUMBER OF MILES TO ASH DISPOSAL LANDFILL:                    0
       TIPPING FEE AT ASH DISPOSAL LANDFILL ($/TON):              0.00
    OR COST OF LANDFILL DISPOSAL OF ASH ($/TON):                 15.00

       TRANSPORTATION COST OF ALL WASTE GENERATED ($/TON-MILE):   0.00
       NUMBER OF MILES TO LANDFILL:                                 0
       TIPPING FEE AT LANDFILL ($/TON):                           0.00
    OR COST OF LANDFILL DISPOSAL OF ALL WASTE ($/TON):           15.00
                      IS EVERYTHING CORRECT (Y/N)?
```

*** OTHER COSTS ***

SCREEN 07

ITEM	ANNUAL COST	ECONOMIC LIFE YEAR	AND COST	TYPE COST (C,E,L, OR O)	YEAR $
	0	0	0		0
	0	0	0		0
	0	0	0		0
	0	0	0		0
	0	0	0		0
	0	0	0		0
	0	0	0		0
	0	0	0		0
	0	0	0		0
	0	0	0		0

IS EVERYTHING CORRECT (Y/N)?

```
                    ***   OPERATING DATA  ***                              SCREEN 08

TONS OF NON-BURNABLE WASTE/TON OF WASTE:                            0.030
ESTIMATE OF HRI COMBUSTION RATE (TONS/HOUR):                        2.10
HRI TURN-UP CAPABILITY (PERCENT ABOVE NORMAL FIRING RATE):           0.0
TONS OF ASH (BOTTOM OR FLY)/TON OF BURNED WASTE:                    0.45
$/MBTU OUTPUT OF FOSSIL FUEL BOILER AND YEAR $:                      9.00  83
THERMAL EFFICIENCY OF FOSSIL FUEL BOILER (%):                       80.0
HEATING VALUE OF BURNABLE WASTE (BTU/TON):                          10000000
HRI FURNACE TYPE (R=REFRACTORY, W=WATER WALL):                      R
THERMAL EFFICIENCY OF THE HRI (%):                                  55.0
ESTIMATE OF HRI TOTAL ANNUAL DOWNTIME DUE TO FAILURE (%):           15
ESTIMATE OF HRI ANNUAL NUMBER OF FAILURES:                           20
ESTIMATE OF MAXIMUM HRI DOWNTIME (HOURS):                           120
TIME REQUIRED TO COMPLETE A DAYS DELIVERY (HOURS):                   6
STORAGE SPACE AVAILABLE AT HRI (TONS):                              150
HRI OPERATING SCENARIO:
   1=BURN 2 SHIFTS, 5 DAYS   2=BURN CONTINUOUSLY, 5 DAYS            2
   3=BURN 2 SHIFTS, 7 DAYS   4=BURN CONTINUOUSLY, 7 DAYS
   5=BURN CONTINUOUSLY, 4 DAYS, FOLLOWING DAY 1 RECEIPT
HRI PLANNED ANNUAL OPERATING WEEKS:                                 50

                    IS EVERYTHING CORRECT (Y/N)?
```

HRI COST AND PERFORMANCE REPORT

INFLATED PER TON COST OF DISPOSING WASTE OF THE TYPE GENERATED AT THE SITE TO THE LANDFILL:	$21.96
INFLATED PER MBTU COST OF THE FOSSIL FUEL BOILER TO WHICH THE HRI IS BEING COMPARED:	$10.89
TONS OF TRASH BURNED ANNUALLY BY THE HRI:	10,710.
MBTUS PRODUCED ANNUALLY BY THE HRI (CONSIDERING NO DOWNTIME):	6.93E+04
VIRGIN FUEL OFFSET ANNUALLY BY THE HRI IN BARRELS-OF-OIL-EQUIVALENT:	12,135.
LANDFILL SPACE CONSERVED ANNUALLY BY THE HRI IN TONS:	5,891.
COST OF USING A BOILER TO PRODUCE THE ANNUAL NO-DOWNTIME QUANTITY OF STEAM PRODUCED BY THE HRI AND LANDFILLING ALL WASTE:	$1,051,810.
INFLATED TOTAL CAPITAL COST OF THE HRI (INCLUDES EQUIPMENT, SUPPORT FACILITIES, AND CONSTRUCTION AND SETUP):	$2,552,560.
UNIFORM ANNUAL COST OF THE HRI (THE COST OF CAPITAL, MODIFICATIONS, LABOR, CONSUMABLES, RESIDUE DISPOSAL, DOWNTIME, AND OTHER COSTS SPREAD OVER THE ECONOMIC LIFE OF THE HRI):	$827,056.
ANNUAL NO-DOWNTIME COST OF THE HRI (THE TOTAL OF NO-DOWNTIME COSTS SPREAD OVER THE ECONOMIC LIFE OF THE HRI):	$780,701.
DISCOUNTED LIFE CYCLE COST OF USING A BOILER TO PRODUCE THE LIFE CYCLE NO-DOWNTIME QUANTITY OF STEAM PRODUCED BY THE HRI AND LANDFILLING ALL WASTE (COSTS DISCOUNTED TO THE POINT OF INITIAL FUNDING):	$9,001,990.
DISCOUNTED LIFE CYCLE COST OF THE HRI:	$4,791,460.
DISCOUNTED LIFE CYCLE COST OF AUXILIARY FUELS USED BY THE HRI:	$6,710.
DISCOUNTED LIFE CYCLE COST OF NONCOMBUSTIBLE WASTE, ASH, AND SCHEDULED DOWNTIME WASTE DISPOSAL:	$1,076,780.
DISCOUNTED LIFE CYCLE COST OF HRI DOWNTIME:	$348,042.
DISCOUNTED LIFE CYCLE COST OF THE HRI PER TON OF WASTE FIRED:	$29.83
DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI PER TON OF WASTE FIRED:	$37.92
DISCOUNTED LIFE CYCLE COST OF THE HRI PER MBTU PRODUCED:	$5.42
DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI PER MBTU PRODUCED:	$6.89
DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI:	$6,091,220.
HRI SAVINGS-TO-INVESTMENT RATIO:	+3.24
PAYBACK PERIOD IN YEARS (INCLUDES PROJECT LEAD TIME):	8.7

Appendix C

SYSTEM MANUAL FOR THE HEAT RECOVERY INCINERATOR (HRI) MODEL

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5 PRINT "THE FOUR MAIN PROGRAMS COMPRISING THE HRI MODEL WILL NOW SUCCESSIVELY BE"
6 PRINT "LOADED INTO THE COMPUTER AND RUN.  PLEASE DO NOT TOUCH THE KEYBOARD."
10 DIM LEAD.AE.PCT(5),  LEAD.CAP.PCT(5)
20 DIM COST.MOD(10),  COST.MOD.INF(10),  YEAR.MOD(10), COST.MOD.AE.INF(10), COST.MOD.TOT.INF(10)
30 DIM CHEM$(6),  CHEM.UNITS.PER.GAL(6),  CHEM.COST.PER.UNIT(6), CHEM.COST.PER.UNIT.INF(6),  CHEM.COST.TOT(6),  CHEM.COST.TOT.INF(6)
40 DIM  OTHER$(12),  COST.OTHER.ANNUAL(12),  COST.OTHER.ANNUAL.INF(12),  OTHER.COST.PROJ.YR(12),  COST.OTHER.ONETIME(12),  COST.OTHE
R.ONETIME.INF(12),  OTHER.TYPE.COST$(12),  OTHER.YR.DOLL%(12)
41 DIM SINGLE(30),  CUM(30)
42 DIM SINGLE.ENERGY.DIFF(30),  CUM.ENERGY.DIFF(30)
43 DIM SINGLE.LANDFILL.DIFF(30), CUM.LANDFILL.DIFF(30)
44 DIM COST.OTHER.INF(12), DIS.LC.COST.OTHER(12)
45 DIM SIR.COST.HRI.ENERGY(30), SIR.COST.HRI.LANDFILL(30), SIR.COST.HRI.OTHER(30)
46 DIM DIS.ENERGY.SAVINGS(30), DIS.LANDFILL.SAVINGS(30), DIS.OTHER.SAVINGS(30), DIS.TOT.SAVINGS(30)
47 DIM EQ(15), SUPP(4), OP.HR(3), OP.RATE(3), OP.TOT(3), PMAINT.HR(3), PMAINT.RATE(3), PMAINT.TOT(3), TRASH.IN.STORAGE.NORMAL(7)
50 OPEN "I",#1,"B:WORKFILE.TXT"
55 INPUT#1,X,ANALYSIS.MONTH%,X$,X,ANALYSIS.YEAR%,X$,X,NEAR.TERM.MONTHS%,X$,X,CAP.INF.RATE,X$,X,ENERGY.INF.RATE,X$,X,LANDFILL.INF.RAT
E,X$,X,OTHER.INF.RATE,X$
60 FOR I=1 TO 5
65 INPUT#1,X,LEAD.AE.PCT(I),X$
70 NEXT I
72 FOR I=1 TO 5
73 INPUT#1,X,LEAD.CAP.PCT(I),X$
74 NEXT I
75 INPUT#1,X,ECON.LIFE,X$,X,ENERGY.DIFF.INF.PCT,X$,X,LANDFILL.DIFF.INF.PCT,X$,X,EQP.YR.DOLL%,X$
80 FOR I=1 TO 15
85 INPUT#1,X,EQ(I),X$
90 NEXT I
95 INPUT#1,X,COST.EQP.TOT,X$
100 IF COST.EQP.TOT <> 0 THEN GOTO 120
105 FOR I=1 TO 15
110 COST.EQP.TOT=COST.EQP.TOT + EQ(I)
115 NEXT I
120 INPUT#1,X,SUPP.YR.DOLL%,X$
125 FOR I=1 TO 4
130 INPUT#1,X,SUPP(I),X$
135 NEXT I
140 INPUT#1,X,COST.SUPP.TOT,X$
145 IF COST.SUPP.TOT <> 0 THEN GOTO 165
150 FOR I=1 TO 4
155 COST.SUPP.TOT=COST.SUPP.TOT + SUPP(I)
160 NEXT I
165 INPUT#1,X,CONST.YR.DOLL%,X$,X,COST.CONST.TOT,X$,X,MOD.YR.DOLL%,X$
168 FOR I=1 TO 10
170 INPUT#1,X,X,X$,X,COST.MOD(I),X$,X,YEAR.MOD(I),X$
172 NEXT I
174 INPUT#1,X,AE.SERVICES.PCT,X$,X,LABOR.YR.DOLL%,X$
176 FOR I=1 TO 3
178 INPUT#1,X,OP.HR(I),X$,X,OP.RATE(I),X$,X,OP.TOT(I),X$
180 NEXT I
182 INPUT#1,X,COST.OP.LABOR.TOT,X$
184 IF COST.OP.LABOR.TOT <> 0 THEN GOTO 196
186 FOR I=1 TO 3
188 IF OP.TOT(I) <> 0 THEN GOTO 192
190 OP.TOT(I) = OP.HR(I) * OP.RATE(I)
192 COST.OP.LABOR.TOT = COST.OP.LABOR.TOT + OP.TOT(I)
194 NEXT I
195 GOTO 200
196 COST.DOWN.OP.LABOR.TOT = COST.OP.LABOR.TOT
200 FOR I=1 TO 3
210 INPUT#1,X,PMAINT.HR(I),X$,X,PMAINT.RATE(I),X$,X,PMAINT.TOT(I),X$
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220 NEXT I
230 INPUT#1,X,COST.PMAINT.LABOR.TOT,X$
240 IF COST.PMAINT.LABOR.TOT <> 0 THEN GOTO 300
250 FOR I=1 TO 3
260 IF PMAINT.TOT(I) <> 0 THEN GOTO 280
270 PMAINT.TOT(I) = PMAINT.HR(I) * PMAINT.RATE(I)
280 COST.PMAINT.LABOR.TOT = COST.PMAINT.LABOR.TOT + PMAINT.TOT(I)
290 NEXT I
300 INPUT#1,X,SUPER.CMAINT.MHR,X$,X,SUPER.CMAINT.LABOR.RATE,X$,X,SKILL.CMAINT.MHR,X$,X,SKILL.CMAINT.LABOR.RATE,X$,X,UNSKIL.CMAINT.MH
R,X$,X,UNSKIL.CMAINT.LABOR.RATE,X$
310 INPUT#1,X,CONSUM.YR.DOLL%,X$,X,KWH.PER.OP.HR,X$,X,COST.PER.KWH,X$,X,KWH.PER.DOWN.HR.PCT,X$,X,KWH.PER.SCHED.NONOP.HR.PCT,X$
320 INPUT#1,X,OFFSET.LIQ.GAL.TON,X$,X,OFFSET.LIQ.COST.GAL,X$,X,OFFSET.LIQ.BTU.GAL,X$,X,LIQ.GAL.TON,X$,X,LIQ.COST.GAL,X$,X,LIQ.BTU.GA
L,X$,X,OFFSET.GAS.CF.TON,X$,X,OFFSET.GAS.COST.CF,X$,X,OFFSET.GAS.BTU.CF,X$,X,GAS.CF.TON,X$,X,GAS.COST.CF,X$
330 INPUT#1,X,GAS.BTU.CF,X$,X,WATER.GAL.PER.TON,X$,X,WATER.COST.PER.GAL,X$,X,COST.WATER.TOT,X$
340 INPUT#1,X,OFFSET.SOL1.TON.TON,X$,X,OFFSET.SOL1.COST.TON,X$,X,OFFSET.SOL1.BTU.TON,X$,X,SOL1.TON.TON,X$,X,SOL1.COST.TON,X$,X,SOL1.
BTU.TON,X$,X,OFFSET.SOL2.TON.TON,X$,X,OFFSET.SOL2.COST.TON,X$,X,OFFSET.SOL2.BTU.TON,X$,X.SOL2.TON.TON,X$
350 INPUT#1,X,SOL2.COST.TON,X$,X,SOL2.BTU.TON,X$
360 FOR I=1 TO 2
370 INPUT#1,X,X,X$,X,CHEM.UNITS.PER.GAL(I),X$,X,CHEM.COST.PER.UNIT(I),X$,X,CHEM.COST.TOT(I),X$
380 NEXT I
390 INPUT#1,X,COST.CHEMICALS.TOT,X$,X,COST.REPAIRPARTS.TOT,X$,X,REPAIRPARTS.YR.DOLL%,X$,X,COST.SEWER.TOT,X$,X,SEWER.YR.DOLL%,X$,X,CO
ST.INSUR.TOT,X$,X,INSUR.YR.DOLL%,X$,X,COST.PEST.TOT,X$,X,PEST.YR.DOLL%,X$
400 INPUT#1,X,RESIDUEDISP.YR.DOLL%,X$,X,COST.TRANS.NONBURN.PER.TONMILE,X$,X,MILES.NONBURN.FILL,X$,X,TIPFEE.NONBURN.PER.TON,X$,X,COST
.NONBURNFILL.PER.TON,X$
410 INPUT#1,X,COST.TRANS.ASH.PER.TONMILE,X$,X,MILES.ASH.FILL,X$,X,TIPFEE.ASH.PER.TON,X$,X,COST.ASHFILL.PER.TON,X$
420 INPUT#1,X,COST.TRANS.ALLWASTE.PER.TONMILE,X$,X,MILES.ALLWASTE.FILL,X$,X,TIPFEE.ALLWASTE.PER.TON,X$,X,COST.ALLWASTE.PER.TON,X$
430 FOR I=1 TO 10
440 INPUT#1,X,X,X$,X,COST.OTHER.ANNUAL(I),X$,X,OTHER.COST.PROJ.YR(I),X$,X,COST.OTHER.ONETIME(I),X$,X,X,OTHER.TYPE.COST$(I),X,OTHER.Y
R.DOLL%(I),X$
450 NEXT I
460 INPUT#1,X,TONS.NONBURN.PER.TON,X$,X,TURN.UP.PCT,X$,X,WASTE.BURN.PER.HR,X$,X,ASH.PER.TON.BURN,X$,X,COST.PER.BOILER.MBTU,X$,X,BOIL
ER.MBTU.YR.DOLL%,X$
470 INPUT#1,X,EFFICIENCY.BOILER,X$,X,HEAT.VAL.BURN.WASTE,X$,X,NUM.BURN.WEEKS,X$,X,EFFICIENCY.HRI,X$,X,ANN.DOWNTIME.PCT,X$,X,NUMBER.O
F.FAILURES,X$,X,MAX.REPAIR.TIME,X$
480 INPUT#1,X,X,FURNACE.TYPE$,X,TIME.FOR.DAYS.DELIVERY,X$,X,STORAGE.SPACE,X$,X,OP.DOWN.PCT(1),X$,X,OP.DOWN.PCT(2),X$,X,OP.DOWN.PCT(3
),X$
490 INPUT#1,X,DISCOUNT.PCT,X$,X,CAP.TOT.YR.DOLL%,X$,X,COST.CAP.TOT,X$,X,COST.CMAINT.LABOR.TOT,X$,X,OP.SCENARIO,X$
500 CLOSE #1
510 GOSUB 570 : REM   IDENTIFY INITIAL FUNDING DATE
520 GOSUB 630  :  REM  IDENTIFY ANNUAL HOUR TOTALS
530 GOSUB 740  : REM   INFLATE ALL COSTS TO POINT OF INITIAL FUNDING
540 GOSUB 2650 : REM  CALCULATE DISCOUNT TABLES
550 CHAIN "HRIMOD3.BAS",,ALL
560 REM
570 REM  IDENTIFY INITIAL FUNDING DATE
580 INIT.FUND.YEAR%=INT((ANALYSIS.MONTH% + NEAR.TERM.MONTHS%)/12) + ANALYSIS.YEAR%
590 INIT.FUND.MONTH% = ANALYSIS.MONTH% + NEAR.TERM.MONTHS% - INT((ANALYSIS.MONTH% + NEAR.TERM.MONTHS%)/12) * 12
600 RETURN
610 REM
620 REM  IDENTIFY ANNUAL HOUR TOTALS
630 IF OP.SCENARIO > 4 OR OP.SCENARIO < 1 THEN GOTO 660
640 IF OP.SCENARIO=1 THEN DAILY.BURN.TIME=16 : NUM.BURN.DAYS=5 ELSE IF OP.SCENARIO=2 THEN DAILY.BURN.TIME=24 : NUM.BURN.DAYS=5 ELSE
IF OP.SCENARIO=3 THEN DAILY.BURN.TIME=16 : NUM.BURN.DAYS=7 ELSE IF OP.SCENARIO=4 THEN DAILY.BURN.TIME=24 : NUM.BURN.DAYS=7
650 GOTO 670
660 IF OP.SCENARIO=5 THEN DAILY.BURN.TIME=24 : NUM.BURN.DAYS=4 ELSE DAILY.BURN.TIME=24 : NUM.BURN.DAYS=5
670 PLANNED.OP.HRS = DAILY.BURN.TIME * NUM.BURN.DAYS * NUM.BURN.WEEKS
680 DOWN.HOURS = PLANNED.OP.HRS * ANN.DOWNTIME.PCT/100
690 UP.HOURS = PLANNED.OP.HRS - DOWN.HOURS
700 SCHED.NONOP.HOURS = 8760 - PLANNED.OP.HRS
720 RETURN
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```
730 REM
740 REM  INFLATE ALL COSTS TO POINT OF INITIAL FUNDING
750 REM
760 REM  INFLATE CAPITAL COSTS
770 DEF FNINFLATE(COST,RATE,YEARS.DIFF)=COST*(1+RATE/100)^YEARS.DIFF
780 IF COST.CAP.TOT=0 THEN GOTO 850
790 YR.DOLL%=CAP.TOT.YR.DOLL%
800 GOSUB 2600
810 COST=COST.CAP.TOT
820 RATE=CAP.INF.RATE
830 COST.CAP.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
840 GOTO 1020
850 YR.DOLL%=EQP.YR.DOLL%
860 YEARS.DIFF=0
870 GOSUB 2600
880 COST=COST.EQP.TOT
890 RATE=CAP.INF.RATE
900 COST.EQP.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
910 YEARS.DIFF=0
920 YR.DOLL%=SUPP.YR.DOLL%
930 GOSUB 2600
940 COST=COST.SUPP.TOT
950 COST.SUPP.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
960 YEARS.DIFF=0
970 YR.DOLL%=CONST.YR.DOLL%
980 GOSUB 2600
990 COST=COST.CONST.TOT
1000 COST CONST.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1010 COST.CAP.TOT.INF = COST.EQP.TOT.INF + COST.SUPP.TOT.INF + COST.CONST.TOT.INF
1020 YEARS.DIFF=0
1030 YR.DOLL%=MOD.YR.DOLL%
1040 GOSUB 2600
1050 FOR I=1 TO 10
1060 IF COST.MOD(I)=0 THEN  GOTO 1140
1070 COST=COST.MOD(I)
1080 RATE=CAP.INF.RATE
1090 COST.MOD.INF(I)=FNINFLATE(COST,RATE,YEARS.DIFF)
1100 COST=COST.MOD(I) * AE.SERVICES.PCT/100
1110 RATE=OTHER.INF.RATE
1120 COST.MOD.AE.INF(I)=FNINFLATE(COST,RATE,YEARS.DIFF)
1130 COST.MOD.TOT.INF(I)=COST.MOD.INF(I) + COST.MOD.AE.INF(I)
1140 NEXT I
1150 YEARS.DIFF=0
1160 COST.AE.SERVICES.INF=COST.CAP.TOT.INF*(AE.SERVICES.PCT/100)
1170 REM
1180 REM  INFLATE LABOR COSTS
1190 YR.DOLL%=LABOR.YR.DOLL%
1200 GOSUB 2600
1210 COST=COST.OP.LABOR.TOT
1220 RATE=OTHER.INF.RATE
1230 COST.OP.LABOR.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1250 IF COST.DOWN.OP.LABOR.TOT <> 0 THEN GOTO 1320
1260 FOR I=1 TO 3
1270 DOWN.OP.TOT(I) = OP.TOT(I) / PLANNED.OP.HRS * UP.HOURS
1280 COST.DOWN.OP.LABOR.TOT = COST.DOWN.OP.LABOR.TOT + DOWN.OP.TOT(I)
1290 OP.CMAINT(I) = (OP.TOT(I) - DOWN.OP.TOT(I)) * (OP.DOWN.PCT(I)/100)
1300 OP.CMAINT.TOT = OP.CMAINT.TOT + OP.CMAINT(I)
1310 NEXT I
1320 COST = COST.DOWN.OP.LABOR.TOT
1330 COST.DOWN.OP.LABOR.TOT.INF = FNINFLATE(COST,RATE,YEARS.DIFF)
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1350 COST=COST.PMAINT.LABOR.TOT
1360 COST.PMAINT.LABOR.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1370 IF COST.CMAINT.LABOR.TOT <> 0 THEN GOTO 1390
1380 COST.CMAINT.LABOR.TOT = (SUPER.CMAINT.MHR * SUPER.CMAINT.LABOR.RATE + SKILL.CMAINT.MHR * SKILL.CMAINT.LABOR.RATE + UNSKIL.CMAIN
T.MHR * UNSKIL.CMAINT.LABOR.RATE) * DOWN.HOURS
1390 COST.CMAINT.LABOR.TOT = COST.CMAINT.LABOR.TOT + OP.CMAINT.TOT
1400 COST=COST.CMAINT.LABOR.TOT
1410 COST.CMAINT.LABOR.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1430 YEARS.DIFF=0
1440 REM
1450 REM  INFLATE COSTS OF ELECTRICITY AND FOSSIL FUELS
1460 YR.DOLL%=CONSUM.YR.DOLL%
1470 GOSUB 2600
1480 COST=COST.PER.KWH
1490 RATE=ENERGY.INF.RATE
1500 COST.PER.KWH.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1510 COST=LIQ.COST.GAL : LIQ.COST.GAL.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1520 COST=GAS.COST.CF : GAS.COST.CF.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1530 COST=SOL1.COST.TON : SOL1.COST.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1540 COST=SOL2.COST.TON : SOL2.COST.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1550 RATE=OTHER.INF.RATE
1560 COST=OFFSET.LIQ.COST.GAL : OFFSET.LIQ.COST.GAL.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1570 COST=OFFSET.GAS.COST.CF : OFFSET.GAS.COST.CF.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1580 COST=OFFSET.SOL1.COST.TON : OFFSET.SOL1.COST.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1590 COST=OFFSET.SOL2.COST.TON : OFFSET.SOL2.COST.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1600 REM
1610 REM INFLATE COST OF WATER
1620 IF COST.WATER.TOT <> 0 THEN GOTO 1660
1630 COST=WATER.COST.PER.GAL
1640 WATER.COST.PER.GAL.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1650 GOTO 1700
1660 COST=COST.WATER.TOT
1670 COST.WATER.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1680 REM
1690 REM  INFLATE COST OF CHEMICALS
1700 IF COST.CHEMICALS.TOT<>0 THEN GOTO 1800
1710 FOR I=1 TO 2
1720 IF CHEM.COST.TOT(I)<>0 THEN GOTO 1760
1730 COST=CHEM.COST.PER.UNIT(I)
1740 CHEM.COST.PER.UNIT.INF(I)=FNINFLATE(COST,RATE,YEARS.DIFF)
1750 GOTO 1780
1760 COST=CHEM.COST.TOT(I)
1770 CHEM.COST.TOT.INF(I)=FNINFLATE(COST,RATE,YEARS.DIFF)
1780 NEXT I
1790 GOTO 1820
1800 COST=COST.CHEMICALS.TOT
1810 COST.CHEMICALS.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1820 YEARS.DIFF=0
1830 REM
1840 REM INFLATE COSTS OF REPAIR PARTS AND SEWER
1850 YR.DOLL%=REPAIRPARTS.YR.DOLL%
1860 GOSUB 2600
1870 COST=COST.REPAIRPARTS.TOT
1880 COST.REPAIRPARTS.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1890 YEARS.DIFF=0
1900 YR.DOLL%=SEWER.YR.DOLL%
1910 GOSUB 2600
1920 COST=COST.SEWER.TOT
1930 COST.SEWER.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
1940 YEARS.DIFF=0
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1950 REM
1960 REM  INFLATE COST OF RESIDUE DISPOSAL
1970 YR.DOLL%=RESIDUEDISP.YR.DOLL%
1980 GOSUB 2600
1990 RATE=LANDFILL.INF.RATE
2000 IF COST.NONBURNFILL.PER.TON <> 0 THEN GOTO 2060
2010 COST=COST.TRANS.NONBURN.PER.TONMILE
2020 COST.TRANS.NONBURN.PER.TONMILE.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2030 COST=TIPFEE.NONBURN.PER.TON
2040 TIPFEE.NONBURN.PER.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2050 GOTO 2080
2060 COST=COST.NONBURNFILL.PER.TON
2070 COST.NONBURNFILL.PER.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2080 IF COST.ASHFILL.PER.TON <> 0 THEN GOTO 2140
2090 COST=COST.TRANS.ASH.PER.TONMILE
2100 COST.TRANS.ASH.PER.TONMILE.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2110 COST=TIPFEE.ASH.PER.TON
2120 TIPFEE.ASH.PER.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2130 GOTO 2160
2140 COST=COST.ASHFILL.PER.TON
2150 COST.ASHFILL.PER.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2160 IF COST.ALLWASTE.PER.TON <> 0 THEN GOTO 2220
2170 COST=COST.TRANS.ALLWASTE.PER.TONMILE
2180 COST.TRANS.ALLWASTE.PER.TONMILE.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2190 COST=TIPFEE.ALLWASTE.PER.TON
2200 TIPFEE.ALLWASTE.PER.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2210 GOTO 2240
2220 COST=COST.ALLWASTE.PER.TON
2230 COST.ALLWASTE.PER.TON.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2240 YEARS.DIFF=0
2250 REM
2260 REM  INFLATE COSTS OF INSURANCE AND PEST CONTROL
2270 YR.DOLL%=INSUR.YR.DOLL%
2280 GOSUB 2600
2290 RATE=OTHER.INF.RATE
2300 COST=COST.INSUR.TOT
2310 COST.INSUR.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2320 YEARS.DIFF=0
2330 YR.DOLL%=PEST.YR.DOLL%
2340 GOSUB 2600
2350 COST=COST.PEST.TOT
2360 COST.PEST.TOT.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2370 YEARS.DIFF=0
2380 REM
2390 REM  INFLATE COSTS OF OTHER EXPENDITURES
2400 FOR I=1 TO 10
2410 IF COST.OTHER.ANNUAL(I)=0 AND COST.OTHER.ONETIME(I)=0 THEN GOTO 2470
2420 YR.DOLL%=OTHER.YR.DOLL%(I)
2430 GOSUB 2600
2440 IF COST.OTHER.ANNUAL(I)<>0 THEN COST=COST.OTHER.ANNUAL(I) ELSE COST=COST.OTHER.ONETIME(I)
2450 IF OTHER.TYPE.COST$(I)="C" THEN RATE=CAP.INF.RATE ELSE IF OTHER.TYPE.COST$(I)="E" THEN RATE=ENERGY.INF.RATE ELSE IF OTHER.TYPE.
COST$(I)="L" THEN RATE=LANDFILL.INF.RATE ELSE RATE=OTHER.INF.RATE
2460 COST.OTHER.INF(I)=FNINFLATE(COST,RATE,YEARS.DIFF)
2470 NEXT I
2480 YEARS.DIFF=0
2490 REM
2500 REM  INFLATE COST OF MBTUS FOR BOILER
2510 YR.DOLL%=BOILER.MBTU.YR.DOLL%
2520 GOSUB 2600
2530 RATE=ENERGY.INF.RATE
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2540 COST=COST.PER.BOILER.MBTU
2550 COST.PER.BOILER.MBTU.INF=FNINFLATE(COST,RATE,YEARS.DIFF)
2560 YEARS.DIFF=0
2570 RETURN
2580 REM
2590 REM  IDENTIFY NUMBER OF YEARS BETWEEN YEAR-DOLLAR ENTERED AND POINT OF INITIAL FUNDING
2600 MONTHS.DIFF%=INIT.FUND.MONTH% - 6
2605 IF YR.DOLL% <= 0 OR YR.DOLL% > ANALYSIS.YEAR% THEN YR.DOLL% = ANALYSIS.YEAR%
2610 YEARS.DIFF = ((INIT.FUND.YEAR% - YR.DOLL%) * 12 + MONTHS.DIFF%) / 12
2620 RETURN
2630 REM
2640 REM  CALCULATE DISCOUNT TABLES
2650 GOSUB 2710
2660 DEF FNPOS.SINGLE.DIFF(DISCOUNT.RATE,RATE,I)=(((1+RATE)/(1+DISCOUNT.RATE))^I + ((1+RATE)/(1+DISCOUNT.RATE))^(I-1))/2
2670 DEF FNNEG.SINGLE.DIFF(DISCOUNT.RATE,RATE,I)=((1/((1+DISCOUNT.RATE)+RATE))^I + (1/((1+DISCOUNT.RATE)+RATE))^(I-1))/2
2680 IF ENERGY.DIFF.INF.PCT=0 THEN GOSUB 2780 ELSE IF ENERGY.DIFF.INF.PCT>0 THEN GOSUB 2830 ELSE IF ENERGY.DIFF.INF.PCT<0 THEN GOSUB
 2890
2690 IF LANDFILL.DIFF.INF.PCT=0 THEN GOSUB 2950 ELSE IF LANDFILL.DIFF.INF.PCT>0 THEN GOSUB 3000 ELSE IF LANDFILL.DIFF.INF.PCT<0 THEN
 GOSUB 3060
2700 RETURN
2710 FOR I=1 TO 30
2720 IF DISCOUNT.PCT=0 THEN DISCOUNT.PCT=10
2730 DISCOUNT.RATE = DISCOUNT.PCT/100
2740 SINGLE(I)=((1/(1+DISCOUNT.RATE))^I + (1/(1+DISCOUNT.RATE))^(I-1))/2
2750 CUM(I)=SINGLE(I) + CUM(I-1)
2760 NEXT I
2770 RETURN
2780 FOR I=1 TO 30
2790 SINGLE.ENERGY.DIFF(I)=SINGLE(I)
2800 CUM.ENERGY.DIFF(I)=SINGLE.ENERGY.DIFF(I) + CUM.ENERGY.DIFF(I-1)
2810 NEXT I
2820 RETURN
2830 RATE=ENERGY.DIFF.INF.PCT/100
2840 FOR I=1 TO 30
2850 SINGLE.ENERGY.DIFF(I)=FNPOS.SINGLE.DIFF(DISCOUNT.RATE,RATE,I)
2860 CUM.ENERGY.DIFF(I)=SINGLE.ENERGY.DIFF(I) + CUM.ENERGY.DIFF(I-1)
2870 NEXT I
2880 RETURN
2890 RATE=ABS(ENERGY.DIFF.INF.PCT/100)
2900 FOR I=1 TO 30
2910 SINGLE.ENERGY.DIFF(I)=FNNEG.SINGLE.DIFF(DISCOUNT.RATE,RATE,I)
2920 CUM.ENERGY.DIFF(I)=SINGLE.ENERGY.DIFF(I) + CUM.ENERGY.DIFF(I-1)
2930 NEXT I
2940 RETURN
2950 FOR I=1 TO 30
2960 SINGLE.LANDFILL.DIFF(I)=SINGLE(I)
2970 CUM.LANDFILL.DIFF(I)=SINGLE.LANDFILL.DIFF(I) + CUM.LANDFILL.DIFF(I-1)
2980 NEXT I
2990 RETURN
3000 RATE=LANDFILL.DIFF.INF.PCT/100
3010 FOR I=1 TO 30
3020 SINGLE.LANDFILL.DIFF(I)=FNPOS.SINGLE.DIFF(DISCOUNT.RATE,RATE,I)
3030 CUM.LANDFILL.DIFF(I)=SINGLE.LANDFILL.DIFF(I) + CUM.LANDFILL.DIFF(I-1)
3040 NEXT I
3050 RETURN
3060 RATE=ABS(LANDFILL.DIFF.INF.PCT/100)
3070 FOR I=1 TO 30
3080 SINGLE.LANDFILL.DIFF(I)=FNNEG.SINGLE.DIFF(DISCOUNT.RATE,RATE,I)
3090 CUM.LANDFILL.DIFF(I)=SINGLE.LANDFILL.DIFF(I) + CUM.LANDFILL.DIFF(I-1)
3100 NEXT I
3110 RETURN
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20 REM  THIS IS HRIMOD3.BAS
25 GOSUB 52 : REM  IDENTIFY LEAD TIME
30 GOSUB 60 : REM  IDENTIFY REHEATING COSTS
40 GOSUB 720 : REM  IDENTIFY ANNUAL TONS OF TRASH BURNED
50 CHAIN "HRIMOD1.BAS",,ALL
52 REM
53 REM  IDENTIFY LEAD TIME
54 FOR I=1 TO 5
55 IF LEAD.AE.PCT(I)<>0 OR LEAD.CAP.PCT(I)<>0 THEN LEAD=I
56 NEXT I
57 RETURN
60 REM
70 REM  IDENTIFY REHEATING COSTS
100 IF FURNACE.TYPE$ = "R" THEN TC=20 ELSE TC=12
110 REHEAT.OFFSET.FUEL.BTU.TON.LOST = (OFFSET.LIQ.GAL.TON * OFFSET.LIQ.BTU.GAL) ^ .667 + (OFFSET.GAS.CF.TON * OFFSET.GAS.BTU.CF) ^
667 + (OFFSET.SOL1.TON.TON * OFFSET.SOL1.BTU.TON) ^ .667 + (OFFSET.SOL2.TON.TON * OFFSET.SOL2.BTU.TON) ^ .667
120 REHEAT.FUEL.BTU.TON.LOST = (LIQ.GAL.TON * LIQ.BTU.GAL) ^ .667 + (GAS.CF.TON * GAS.BTU.CF) ^ .667 + (SOL1.TON.TON * SOL1.BTU.TON)
 ^ .667 + (SOL2.TON.TON * SOL2.BTU.TON) ^ .667
150 FUEL.FOR.ONE.LONG.DOWN = (1.5 * WASTE.BURN.PER.HR) * (HEAT.VAL.BURN.WASTE ^ .667 + REHEAT.OFFSET.FUEL.BTU.TON.LOST + REHEAT.FUEL
.BTU.TON.LOST)
165 AVE.REPAIR.TIME = DOWN.HOURS / NUMBER.OF.FAILURES
170 IF DAILY.BURN.TIME = 16 THEN GOSUB 680 ELSE GOSUB 200
172 COST.ALL.REHEATS = FUEL.ALL.REHEATS * (EFFICIENCY.HRI/100) * COST.PER.BOILER.MBTU.INF * .000001
176 DIS.LC.COST.ALL.REHEATS = COST.ALL.REHEATS * (CUM.ENERGY.DIFF(LEAD+ECON.LIFE) - CUM.ENERGY.DIFF(LEAD))
180 RETURN
200 MEAN1 = (-5.41205 + 2*LOG(MAX.REPAIR.TIME) + SQR((5.41205 - 2*LOG(MAX.REPAIR.TIME))^2 - 4*(LOG(MAX.REPAIR.TIME)^2) + 21.6482*LOG
(AVE.REPAIR.TIME))) / 2
220 MEAN2 = (-5.41205 + 2*LOG(MAX.REPAIR.TIME) - SQR((5.41205 - 2*LOG(MAX.REPAIR.TIME))^2 - 4*(LOG(MAX.REPAIR.TIME)^2) + 21.6482*LOG
(AVE.REPAIR.TIME))) / 2
240 IF MEAN1 >= MEAN2 THEN MEAN=MEAN1 ELSE MEAN=MEAN2
250 STD.DEV = (LOG(MAX.REPAIR.TIME) - MEAN) / 1.645
260 Z.SCORE = (LOG(TC) - MEAN) / STD.DEV
280 IF Z.SCORE <= 3.99 AND Z.SCORE >= -3.99 THEN GOTO 360
290 IF Z.SCORE < -3.99 THEN GOTO 330
295 TIME.SHORT.DOWNS = NUMBER.OF.FAILURES * 1.5 * EXP(MEAN)/TC
300 FUEL.SHORT.DOWNS = NUMBER.OF.FAILURES * FUEL.FOR.ONE.LONG.DOWN * EXP(MEAN) / TC
310 IF NUM.BURN.DAYS=4 OR NUM.BURN.DAYS=5 THEN TIME.LONG.DOWNS = 1.5 * NUM.BURN.WEEKS : FUEL.LONG.DOWNS = NUM.BURN.WEEKS * FUEL.FOR.
ONE.LONG.DOWN ELSE TIME.LONG.DOWNS = 0 : FUEL.LONG.DOWNS = 0
320 GOTO 645
330 IF NUM.BURN.DAYS=4 OR NUM.BURN.DAYS=5 THEN FUEL.LONG.DOWNS = (NUM.BURN.WEEKS + NUMBER.OF.FAILURES) * FUEL.FOR.ONE.LONG.DOWN ELSE
 FUEL.LONG.DOWNS = NUMBER.OF.FAILURES * FUEL.FOR.ONE.LONG.DOWN
335 IF NUM.BURN.DAYS=4 OR NUM.BURN.DAYS=5 THEN TIME.LONG.DOWNS = (NUM.BURN.WEEKS + NUMBER.OF.FAILURES) * 1.5 ELSE TIME.LONG.DOWNS =
NUMBER.OF.FAILURES * 1.5
338 TIME.SHORT.DOWNS = 0
340 FUEL.SHORT.DOWNS = 0
350 GOTO 645
360 Z = INT(ABS(Z.SCORE) * 100 + .5) + 1
380 OPEN "R",#2,"NORMAL2",6
390 FIELD #2, 6 AS ZPCT2$
400 GET #2, Z
410 ZPCT.TABLE = CVS(ZPCT2$)
420 IF Z.SCORE > 0 THEN PROB.DOWN.GT.TC = ZPCT.TABLE ELSE PROB.DOWN.GT.TC = 1 - ZPCT.TABLE
440 IF NUM.BURN.DAYS=4 OR NUM.BURN.DAYS=5 THEN LONG.DOWNS = NUM.BURN.WEEKS + (PROB.DOWN.GT.TC * NUMBER.OF.FAILURES) ELSE LONG.DOWNS
= PROB.DOWN.GT.TC * NUMBER.OF.FAILURES
445 TIME.LONG.DOWNS = 1.5 * LONG.DOWNS
450 FUEL.LONG.DOWNS = LONG.DOWNS * FUEL.FOR.ONE.LONG.DOWN
460 PROB.DOWN.LT.TC = 1 - PROB.DOWN.GT.TC
470 SHORT.DOWNS = PROB.DOWN.LT.TC * NUMBER.OF.FAILURES
480 I=1
490 GET #2, I
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500 ZPCT.TABLE.LOW = CVS(ZPCT2$)
510 IF PROB.DOWN.LT.TC/2 >= ZPCT.TABLE.LOW THEN GOTO 540
520 I=I+1
530 GOTO 490
540 GET #2, I-1
550 ZPCT.TABLE.HIGH = CVS(ZPCT2$)
560 IF ZPCT.TABLE.HIGH - PROB.DOWN.LT.TC/2 <= PROB.DOWN.LT.TC/2 - ZPCT.TABLE LOW THEN MED TIME.SHORT.DOWN.ZSCORE = -((I-1)/100 - .01
) ELSE MED.TIME.SHORT.DOWN.ZSCORE = -(I/100 - .01)
570 CLOSE #2
590 MED.TIME.SHORT.DOWN.LN = MED.TIME.SHORT.DOWN.ZSCORE * STD.DEV + MEAN
600 MED.TIME.SHORT.DOWN = EXP(MED.TIME.SHORT.DOWN.LN)
620 FUEL.FOR.ONE.SHORT.DOWN = FUEL.FOR.ONE LONG.DOWN * MED.TIME.SHORT.DOWN / TC
625 TIME.SHORT DOWNS = SHORT.DOWNS * 1.5 * MED.TIME.SHORT.DOWN/TC
630 FUEL.SHORT.DOWNS = SHORT.DOWNS * FUEL.FOR.ONE.SHORT.DOWN
645 TIME.ALL.REHEATS = TIME.LONG.DOWNS + TIME.SHORT.DOWNS
650 FUEL.ALL.REHEATS = FUEL.LONG.DOWNS + FUEL.SHORT.DOWNS
670 RETURN
680 FUEL.FOR.ONE.SHORT.DOWN = FUEL.FOR.ONE.LONG.DOWN * 8 / TC
690 IF NUM.BURN DAYS=5 THEN FUEL.ALL.REHEATS=NUM.BURN.WEEKS * (4 * FUEL.FOR.ONE.SHORT DOWN + FUEL.FOR.ONE LONG.DOWN) ELSE FUEL.ALL R
EHEATS = NUM BURN.WEEKS * 7 * FUEL.FOR.ONE.SHORT.DOWN
695 IF NUM.BURN.DAYS = 5 THEN TIME.ALL.REHEATS = NUM.BURN.WEEKS * (4 * 1.5 * 8/TC + 1.5) ELSE TIME.ALL.REHEATS = NUM.BURN.WEEKS * 7
* 1.5 * 8/TC
710 RETURN
720 REM
730 REM  ANNUAL TONS OF TRASH BURNED
750 TURN.UP.RATE = (1 + TURN.UP.PCT/100) * WASTE.BURN.PER.HR
760 IF TURN.UP.RATE > WASTE.BURN.PER.HR + .001 THEN GOTO 800
770 TOTAL.TONS.LOST = DOWN.HOURS * WASTE.BURN.PER.HR
780 TOTAL.TURN.UP.TIME = 0
790 GOTO 830
800 WASTE.PER.WEEK = NUM BURN DAYS * DAILY.BURN.TIME * WASTE.BURN.PER.HR
810 BURNABLE.INPUT.RATE = WASTE.PER.WEEK / 5 / TIME.FOR.DAYS.DELIVERY
820 IF NUM.BURN.DAYS = 4 THEN GOSUB 1720 ELSE GOSUB 850
830 ANN.TRASH.BURNED = PLANNED.OP.HRS * WASTE.BURN.PER.HR - TOTAL.TONS.LOST
840 RETURN
850 IF NUM.BURN.DAYS = 5 THEN DAILY.ADDITIONAL = 0 ELSE DAILY.ADDITIONAL = WASTE.PER.WEEK * 2 / 35
860 FOR I=0 TO 7 : TRASH.IN.STORAGE.NORMAL(I)=0 : NEXT I
870 IF NUM.BURN.DAYS=5 THEN GOTO 940
880 FOR I=1 TO 5
890 TRASH.IN.STORAGE.NORMAL(I) = TRASH.IN.STORAGE.NORMAL(I-1) + DAILY.ADDITIONAL
900 NEXT I
910 FOR I=6 TO 7
920 TRASH.IN.STORAGE.NORMAL(I) = TRASH.IN.STORAGE.NORMAL(I-1) - DAILY.BURN.TIME * WASTE BURN.PER.HR
930 NEXT I
940 PROB.OF.FAIL.DURING.RECEIPT = TIME.FOR.DAYS.DELIVERY / (NUM.BURN.DAYS * DAILY.BURN.TIME)
950 PROB.OF.FAIL.DURING.BURN = (DAILY.BURN.TIME - TIME.FOR.DAYS.DELIVERY) / (NUM.BURN.DAYS * DAILY.BURN.TIME)
960 IF NUM.BURN.DAYS=5 THEN PROB.OF.FAIL.DURING.BURN.ONLY = 0 ELSE PROB.OF.FAIL.DURING.BURN.ONLY = 1/7
970 BURN.FLAG$="NO" : BURN.ONLY.FLAG$="NO"
980 RCPT ONE.FAILURE.TONS.LOST=0 : RCPT.ONE.FAILURE.TURN.UP.TIME=0 : BURN.ONE.FAILURE.TONS.LOST=0 : BURN.ONE.FAILURE.TURN.UP.TIME=0
: BURN.ONLY.ONE.FAILURE.TONS.LOST=0 : BURN.ONLY.ONE.FAILURE.TURN.UP TIME=0
990 FOR J=1 TO 5
1000 GOSUB 1240
1020 RCPT.ONE.FAILURE.TONS.LOST = RCPT.ONE.FAILURE.TONS.LOST + (TONS.LOST * PROB.OF.FAIL.DURING.RECEIPT)
1030 RCPT.ONE.FAILURE.TURN.UP.TIME = RCPT.ONE.FAILURE.TURN.UP.TIME + (TIME.AT.TURN.UP.RATE * PROB.OF.FAIL.DURING.RECEIPT)
1040 NEXT J
1050 FOR J=1 TO 5
1060 BURN.FLAG$="YES"
1070 GOSUB 1240
1090 BURN.ONE.FAILURE.TONS.LOST = BURN.ONE.FAILURE.TONS.LOST + (TONS.LOST * PROB.OF.FAIL.DURING.BURN)
1100 BURN.ONE.FAILURE.TURN.UP.TIME = BURN.ONE.FAILURE.TURN.UP.TIME + (TIME.AT.TURN.UP.RATE * PROB.OF.FAIL.DURING.BURN)
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1110 NEXT J
1120 IF NUM.BURN.DAYS = 5 THEN GOTO 1200
1130 FOR J=6 TO 7
1140 BURN.ONLY.FLAG$="YES"
1150 GOSUB 1240
1170 BURN.ONLY.ONE.FAILURE.TONS.LOST = BURN.ONLY.ONE.FAILURE.TONS.LOST + (TONS.LOST * PROB.OF.FAIL.DURING.BURN.ONLY)
1180 BURN.ONLY.ONE.FAILURE.TURN.UP.TIME = BURN.ONLY.ONE.FAILURE.TURN.UP.TIME + (TIME.AT.TURN.UP.RATE * PROB.OF.FAIL.DURING.BURN.ONLY
)
1190 NEXT J
1200 TOTAL.TONS.LOST = (RCPT.ONE.FAILURE.TONS.LOST + BURN.ONE.FAILURE.TONS.LOST + BURN.ONLY.ONE.FAILURE.TONS.LOST) * NUMBER.OF.FAILU
RES
1210 TOTAL.TURN.UP.TIME = (RCPT.ONE.FAILURE.TURN.UP.TIME + BURN.ONE.FAILURE.TURN.UP.TIME + BURN.ONLY.ONE.FAILURE.TURN.UP.TIME) * NUM
BER.OF.FAILURES
1230 RETURN
1240 TONS.LOST=0 : TIME.SINCE.FAILURE=0 : LOSING.TONS=1 : TIME.AT.TURN.UP.RATE=0
1250 IF NUM.BURN.DAYS = 5 THEN GOTO 1280 ELSE IF J<>1 THEN GOTO 1280
1260 IF BURN.FLAG$="NO" THEN STORAGE.REQUIREMENT = TRASH.IN.STORAGE.NORMAL(7) ELSE STORAGE.REQUIREMENT = TRASH.IN.STORAGE.NORMAL(7)
+ TIME.FOR.DAYS.DELIVERY * (BURNABLE.INPUT.RATE - WASTE.BURN.PER.HR)
1270 GOTO 1290
1280 IF BURN.FLAG$="NO" THEN STORAGE.REQUIREMENT = TRASH.IN.STORAGE.NORMAL(J-1) ELSE STORAGE.REQUIREMENT = TRASH.IN.STORAGE.NORMAL(J
-1) + TIME.FOR.DAYS.DELIVERY * (BURNABLE.INPUT.RATE - WASTE.BURN.PER.HR)
1290 I=J
1300 WHILE LOSING.TONS
1310 IF BURN.FLAG$="YES" THEN GOTO 1520
1320 IF BURN.ONLY.FLAG$ = "YES" THEN GOTO 1600
1330 IF I=6 OR I=7 THEN GOTO 1600
1340 TIME.SINCE.FAILURE = TIME.SINCE.FAILURE + TIME.FOR.DAYS.DELIVERY
1350 IF TIME.SINCE.FAILURE <= AVE.REPAIR.TIME THEN GOTO 1450
1360 TIME.AT.TURN.UP.RATE = TIME.AT.TURN.UP.RATE + TIME.FOR.DAYS.DELIVERY
1370 NEW.STORAGE.REQUIREMENT = STORAGE.REQUIREMENT + TIME.FOR.DAYS.DELIVERY * (BURNABLE.INPUT.RATE - TURN.UP.RATE)
1380 IF NEW.STORAGE.REQUIREMENT <= STORAGE.SPACE THEN GOTO 1430
1390 TIME.TILL.PIT.FULL = (STORAGE.SPACE - STORAGE.REQUIREMENT) / (BURNABLE.INPUT.RATE - TURN.UP.RATE)
1400 TONS.LOST = TONS.LOST + (TIME.FOR.DAYS.DELIVERY - TIME.TILL.PIT.FULL) * BURNABLE.INPUT.RATE
1410 STORAGE.REQUIREMENT = STORAGE.SPACE - (TIME.FOR.DAYS.DELIVERY - TIME.TILL.PIT.FULL) * TURN.UP.RATE
1420 GOTO 1520
1430 STORAGE.REQUIREMENT = NEW.STORAGE.REQUIREMENT
1440 GOTO 1520
1450 NEW.STORAGE.REQUIREMENT = STORAGE.REQUIREMENT + TIME.FOR.DAYS.DELIVERY * BURNABLE.INPUT.RATE
1460 IF NEW.STORAGE.REQUIREMENT <= STORAGE.SPACE THEN GOTO 1510
1470 TIME.TILL.PIT.FULL = (STORAGE.SPACE - STORAGE.REQUIREMENT) / BURNABLE.INPUT.RATE
1480 TONS.LOST = TONS.LOST + (TIME.FOR.DAYS.DELIVERY - TIME.TILL.PIT.FULL) * BURNABLE.INPUT.RATE
1490 STORAGE.REQUIREMENT = STORAGE.SPACE
1500 GOTO 1520
1510 STORAGE.REQUIREMENT = NEW.STORAGE.REQUIREMENT
1520 BURN.FLAG$="NO"
1530 TIME.SINCE.FAILURE = TIME.SINCE.FAILURE + DAILY.BURN.TIME - TIME.FOR.DAYS.DELIVERY
1540 IF TIME.SINCE.FAILURE <= AVE.REPAIR.TIME THEN GOTO 1680
1550 TIME.AT.TURN.UP.RATE = TIME.AT.TURN.UP.RATE + DAILY.BURN.TIME - TIME.FOR.DAYS.DELIVERY
1560 STORAGE.REQUIREMENT = STORAGE.REQUIREMENT - TURN.UP.RATE * (DAILY.BURN.TIME - TIME.FOR.DAYS.DELIVERY)
1570 IF STORAGE.REQUIREMENT > TRASH.IN.STORAGE.NORMAL(I) THEN GOTO 1680
1580 LOSING.TONS = 0
1590 GOTO 1690
1600 BURN.ONLY.FLAG$="NO"
1610 TIME.SINCE.FAILURE = TIME.SINCE.FAILURE + DAILY.BURN.TIME
1620 IF TIME.SINCE.FAILURE <= AVE.REPAIR.TIME THEN GOTO 1680
1630 TIME.AT.TURN.UP.RATE = TIME.AT.TURN.UP.RATE + DAILY.BURN.TIME
1640 STORAGE.REQUIREMENT = STORAGE.REQUIREMENT - TURN.UP.RATE * DAILY.BURN.TIME
1650 IF STORAGE.REQUIREMENT > TRASH.IN.STORAGE.NORMAL(I) THEN GOTO 1680
1660 LOSING.TONS = 0
1670 GOTO 1690
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1680 IF (NUM.BURN.DAYS=5 AND I=5) OR (NUM.BURN.DAYS=7 AND I=7) THEN I=1 ELSE I=I+1
1690 WEND
1700 RETURN
1710 REM
1720 DAILY.ADDITIONAL = (96/5 - 24) * WASTE.BURN.PER.HR
1730 TRASH.IN.STORAGE.NORMAL(1) = WASTE.PER.WEEK / 5
1740 FOR I=2 TO 5
1750 TRASH.IN.STORAGE.NORMAL(I) = TRASH.IN.STORAGE.NORMAL(I-1) + DAILY.ADDITIONAL
1760 NEXT I
1770 TIME.FOR.LAST.BURN = 96/5 - TIME.FOR.DAYS.DELIVERY
1780 TIME.FOR.FIRST.BURN = 24 - TIME.FOR.DAYS.DELIVERY - TIME.FOR.LAST.BURN
1790 PROB.OF.FAIL.DURING.FIRST.BURN = TIME.FOR.FIRST.BURN / 96
1800 PROB.OF.FAIL.DURING.RECEIPT = TIME.FOR.DAYS.DELIVERY / 96
1810 PROB.OF.FAIL.DURING.LAST.BURN = TIME.FOR.LAST.BURN / 96
1820 RCPT.FLAG$="NO" : LAST.BURN.FLAG$="NO"
1830 FIRST.BURN.TONS.LOST=0 : FIRST.BURN.TURN.UP.TIME=0 : RCPT.TONS.LOST=0 : RCPT.TURN.UP.TIME=0 : LAST.BURN.TONS.LOST=0 : LAST.BURN
.TURN.UP.TIME=0
1840 FOR J=2 TO 5
1850 GOSUB 2080
1870 FIRST.BURN.TONS.LOST = FIRST.BURN.TONS.LOST + (TONS.LOST * PROB.OF.FAIL.DURING.FIRST.BURN)
1880 FIRST.BURN.TURN.UP.TIME = FIRST.BURN.TURN.UP.TIME + (TIME.AT.TURN.UP.RATE * PROB.OF.FAIL.DURING.FIRST.BURN)
1890 NEXT J
1900 FOR J=2 TO 5
1910 RCPT.FLAG$ = "YES"
1920 GOSUB 2080
1940 RCPT.TONS.LOST = RCPT.TONS.LOST + (TONS.LOST * PROB.OF.FAIL.DURING.RECEIPT)
1950 RCPT.TURN.UP.TIME = RCPT.TURN.UP.TIME + (TIME.AT.TURN.UP.RATE * PROB.OF.FAIL.DURING.RECEIPT)
1960 NEXT J
1970 FOR J=2 TO 5
1980 LAST.BURN.FLAG$ = "YES"
1990 GOSUB 2080
2010 LAST.BURN.TONS.LOST = LAST.BURN.TONS.LOST + (TONS.LOST * PROB.OF.FAIL.DURING.LAST.BURN)
2020 LAST.BURN.TURN.UP.TIME = LAST.BURN.TURN.UP.TIME + (TIME.AT.TURN.UP.RATE * PROB.OF.FAIL.DURING.LAST.BURN)
2030 NEXT J
2040 TOTAL.TONS.LOST = (FIRST.BURN.TONS.LOST + RCPT.TONS.LOST + LAST.BURN.TONS.LOST) * NUMBER.OF.FAILURES
2050 TOTAL.TURN.UP.TIME = (FIRST.BURN.TURN.UP.TIME + RCPT.TURN.UP.TIME + LAST.BURN.TURN.UP.TIME) * NUMBER.OF.FAILURES
2070 RETURN
2080 TONS.LOST=0 : TIME.SINCE.FAILURE=0 : LOSING.TONS=1 : TIME.AT.TURN.UP.RATE=0
2090 IF RCPT.FLAG$ = "YES" OR LAST.BURN.FLAG$ = "YES" THEN GOTO 2110 ELSE STORAGE.REQUIREMENT = TRASH.IN.STORAGE.NORMAL(J-1)
2100 GOTO 2130
2110 IF RCPT.FLAG$ = "YES" THEN  STORAGE.REQUIREMENT = TRASH.IN.STORAGE.NORMAL(J-1) - TIME.FOR.FIRST.BURN * WASTE.BURN.PER.HR
2120 IF LAST.BURN.FLAG$ = "YES" THEN STORAGE.REQUIREMENT = TRASH.IN.STORAGE.NORMAL(J-1) - TIME.FOR.FIRST.BURN * WASTE.BURN.PER.HR +
TIME.FOR.DAYS.DELIVERY * (BURNABLE.INPUT.RATE - WASTE.BURN.PER.HR)
2130 I=J
2140 WHILE LOSING.TONS
2150 IF RCPT.FLAG$ = "YES" THEN GOTO 2210
2160 IF LAST.BURN.FLAG$ = "YES" THEN GOTO 2400
2170 TIME.SINCE.FAILURE = TIME.SINCE.FAILURE + TIME.FOR.FIRST.BURN
2180 IF TIME.SINCE.FAILURE <= AVE.REPAIR.TIME THEN GOTO 2210
2190 TIME.AT.TURN.UP.RATE = TIME.AT.TURN.UP.RATE + TIME.FOR.FIRST.BURN
2200 STORAGE.REQUIREMENT = STORAGE.REQUIREMENT - TURN.UP.RATE * TIME.FOR.FIRST.BURN
2210 RCPT.FLAG$ = "NO"
2220 TIME.SINCE.FAILURE = TIME.SINCE.FAILURE + TIME.FOR.DAYS.DELIVERY
2230 IF TIME.SINCE.FAILURE <= AVE.REPAIR.TIME THEN GOTO 2330
2240 TIME.AT.TURN.UP.RATE = TIME.AT.TURN.UP.RATE + TIME.FOR.DAYS.DELIVERY
2250 NEW.STORAGE.REQUIREMENT = STORAGE.REQUIREMENT + TIME.FOR.DAYS.DELIVERY * (BURNABLE.INPUT.RATE - TURN.UP.RATE)
2260 IF NEW.STORAGE.REQUIREMENT <= STORAGE.SPACE THEN GOTO 2310
2270 TIME.TILL.PIT.FULL = (STORAGE.SPACE - STORAGE.REQUIREMENT) / (BURNABLE.INPUT.RATE - TURN.UP.RATE)
2280 TONS.LOST = TONS.LOST + (TIME.FOR.DAYS.DELIVERY - TIME.TILL.PIT.FULL) * BURNABLE.INPUT.RATE
2290 STORAGE.REQUIREMENT = STORAGE.SPACE - (TIME.FOR.DAYS.DELIVERY - TIME.TILL.PIT.FULL) * TURN.UP.RATE
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2300 GOTO 2400
2310 STORAGE.REQUIREMENT = NEW.STORAGE.REQUIREMENT
2320 GOTO 2400
2330 NEW.STORAGE.REQUIREMENT = STORAGE.REQUIREMENT + TIME.FOR.DAYS.DELIVERY * BURNABLE.INPUT.RATE
2340 IF NEW STORAGE.REQUIREMENT <= STORAGE.SPACE THEN GOTO 2390
2350 TIME.TILL.PIT.FULL = (STORAGE.SPACE - STORAGE.REQUIREMENT) / BURNABLE.INPUT.RATE
2360 TONS.LOST = TONS.LOST + (TIME.FOR.DAYS.DELIVERY - TIME.TILL.PIT.FULL) * BURNABLE.INPUT.RATE
2370 STORAGE.REQUIREMENT = STORAGE.SPACE
2380 GOTO 2400
2390 STORAGE.REQUIREMENT = NEW.STORAGE.REQUIREMENT
2400 LAST.BURN.FLAG$ = "NO"
2410 TIME.SINCE.FAILURE = TIME.SINCE.FAILURE + TIME.FOR.LAST.BURN
2420 IF TIME.SINCE.FAILURE <= AVE.REPAIR.TIME THEN GOTO 2480
2430 TIME.AT.TURN.UP.RATE = TIME.AT.TURN.UP.RATE + TIME.FOR.LAST.BURN
2440 STORAGE.REQUIREMENT = STORAGE.REQUIREMENT - TURN.UP.RATE * TIME.FOR LAST.BURN
2450 IF STORAGE.REQUIREMENT > TRASH.IN.STORAGE NORMAL(I) THEN GOTO 2480
2460 LOSING.TONS = 0
2470 GOTO 2590
2480 IF I <> 5 THEN GOTO 2580
2490 I=2
2500 NEW.STORAGE.REQUIREMENT = STORAGE.REQUIREMENT + TIME.FOR.DAYS.DELIVERY * BURNABLE.INPUT.RATE
2510 IF NEW.STORAGE.REQUIREMENT <= STORAGE.SPACE THEN GOTO 2560
2520 TIME.TILL.PIT.FULL = (STORAGE.SPACE - STORAGE.REQUIREMENT) / BURNABLE.INPUT.RATE
2530 TONS.LOST = TONS.LOST + (TIME.FOR.DAYS.DELIVERY - TIME.TILL.PIT.FULL) * BURNABLE INPUT.RATE
2540 STORAGE.REQUIREMENT = STORAGE.SPACE
2550 GOTO 2590
2560 STORAGE.REQUIREMENT = NEW.STORAGE.REQUIREMENT
2570 GOTO 2590
2580 I=I+1
2590 WEND
2600 RETURN
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650 GOSUB 2990 : REM  IDENTIFY LEAD TIME COSTS
660 GOSUB 3100 : REM  IDENTIFY COST OF EXPECTED MODIFICATIONS
670 GOSUB 3180 : REM  IDENTIFY LABOR COSTS
680 GOSUB 3270 : REM  IDENTIFY COST OF CONSUMABLES
690 GOSUB 4800 : REM  IDENTIFY COSTS OF RESIDUE DISPOSAL AND OTHER
691 GOSUB 5180 : REM  IDENTIFY COST OF CORRECTIVE MAINTENANCE DOWNTIME
693 CHAIN "HRIMOD2.BAS",,ALL
2980 REM
2990 REM IDENTIFY LEAD TIME COSTS
3030 FOR I=1 TO LEAD
3040 UNDIS.COST.LEAD(I)=COST.AE.SERVICES.INF * LEAD.AE.PCT(I)/100 + COST.CAP.TOT.INF * LEAD.CAP.PCT(I)/100
3050 DIS.COST.LEAD(I) = UNDIS.COST.LEAD(I) * SINGLE(I)
3060 DIS.COST.LEAD.TOT = DIS.COST.LEAD.TOT + DIS.COST.LEAD(I)
3070 NEXT I
3080 RETURN
3090 REM
3100 REM  IDENTIFY COST OF EXPECTED MODIFICATIONS
3110 FOR I=1 TO 10
3120 IF YEAR.MOD(I) = 0 THEN GOTO 3150
3130 MOD.CASH.FLOW.YR = LEAD + YEAR.MOD(I)
3140 DIS.COST.MODS.TOT = DIS.COST.MODS.TOT + COST.MOD.TOT.INF(I) * SINGLE(MOD.CASH.FLOW.YR)
3150 NEXT I
3160 RETURN
3170 REM
3180 REM  IDENTIFY LABOR COSTS
3190 ANN.COST.LABOR=COST.DOWN.OP.LABOR.TOT.INF + COST.PMAINT.LABOR.TOT.INF + COST.CMAINT.LABOR.TOT.INF
3200 DIS.LC.COST.LABOR=ANN.COST.LABOR * (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
3250 RETURN
3260 REM
3270 REM  IDENTIFY COST OF CONSUMABLES
3300 GOSUB 4300 : REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF ELECTRICITY
3310 GOSUB 4380 : REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF FOSSIL FUELS
3320 GOSUB 4520 : REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF WATER
3330 GOSUB 4610 : REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF CHEMICALS
3340 RETURN
4300 REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF ELECTRICITY
4310 KWH.PER.DOWN.HR = KWH.PER.OP.HR * KWH.PER.DOWN.HR.PCT/100
4320 KWH.PER.SCHED.NONOP.HR = KWH.PER.OP.HR * KWH.PER.SCHED.NONOP.HR.PCT/100
4330 ANN.USE.ELEC = KWH.PER.OP.HR * (UP.HOURS - TOTAL.TURN.UP.TIME) + KWH.PER.OP.HR * (1 + .33 * TURN UP.PCT/100) * TOTAL.TURN.UP.TI
ME + KWH.PER.DOWN.HR * DOWN.HOURS + KWH.PER.SCHED.NONOP.HR * SCHED.NONOP.HOURS
4340 ANN.COST.ELEC = ANN.USE.ELEC * COST.PER.KWH.INF
4350 DIS.LC.COST.ELEC = ANN.COST.ELEC * (CUM.ENERGY.DIFF(LEAD+ECON.LIFE) - CUM.ENERGY.DIFF(LEAD))
4360 RETURN
4370 REM
4380 REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF FOSSIL FUELS
4390 NOMINAL.TONS.BURNED = (UP.HOURS - TOTAL.TURN.UP.TIME) * WASTE.BURN.PER.HR
4400 TURNUP.TONS.BURNED = TOTAL.TURN.UP.TIME * TURN.UP.RATE
4410 NOMINAL.OFFSET.COST.TON = OFFSET.LIQ.GAL.TON * OFFSET.LIQ.COST.GAL.INF + OFFSET.GAS.CF.TON * OFFSET.GAS.COST.CF.INF + OFFSET.SO
L1.TON.TON * OFFSET.SOL1.COST.TON.INF + OFFSET.SOL2.TON.TON * OFFSET.SOL2.COST.TON INF
4420 NOMINAL.COST.TON = LIQ.GAL.TON * LIQ.COST.GAL.INF + GAS.CF.TON * GAS.COST.CF.INF + SOL1.TON.TON * SOL1.COST.TON.INF + SOL2.TON.
TON * SOL2.COST.TON.INF
4422 ANN.COST.OFFSET.FUELS = NOMINAL.OFFSET.COST.TON * NOMINAL.TONS.BURNED + (1 + TURN.UP.PCT/100) * NOMINAL.OFFSET.COST.TON * TURNU
P.TONS.BURNED
4424 ANN.COST.NONOFF.FUELS = NOMINAL.COST.TON * NOMINAL.TONS.BURNED + (1 + TURN.UP.PCT/100) * NOMINAL.COST.TON * TURNUP.TONS.BURNED
4430 ANN.COST.FUELS = ANN.COST.OFFSET.FUELS + ANN.COST.NONOFF.FUELS
4490 DIS.LC.COST.OFFSET.FUELS = ANN.COST.OFFSET.FUELS * (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
4492 DIS.LC.COST.NONOFF.FUELS = ANN.COST.NONOFF.FUELS * (CUM.ENERGY.DIFF(LEAD+ECON.LIFE) - CUM.ENERGY.DIFF(LEAD))
4494 DIS.LC.COST.FUELS = DIS.LC.COST.OFFSET.FUELS + DIS.LC.COST.NONOFF.FUELS
4500 RETURN
4510 REM
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4520 REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF WATER
4530 IF COST.WATER.TOT.INF <> 0 THEN GOTO 4570
4540 NODOWNTIME.COST.WATER = WATER.GAL.PER.TON * WATER.COST.PER.GAL.INF/1000 * PLANNED.OP.HRS * WASTE.BURN.PER.HR
4550 COST.WATER.TOT.INF = (WATER.GAL.PER.TON * (NOMINAL.TONS.BURNED + (1 + TURN.UP.PCT/100) * TURNUP.TONS.BURNED)) * WATER.COST.PER.
GAL.INF/1000
4560 GOTO 4580
4570 NODOWNTIME.COST.WATER = COST.WATER.TOT.INF
4580 DIS.LC.COST.WATER = COST.WATER.TOT.INF * (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
4590 RETURN
4600 REM
4610 REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF CHEMICALS
4620 IF COST.CHEMICALS.TOT.INF <> 0 THEN GOSUB 4650 ELSE GOSUB 4680
4630 DIS.LC.COST.CHEMICALS = COST.CHEMICALS.TOT.INF * (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
4640 RETURN
4650 NODOWNTIME.COST.CHEM = COST.CHEMICALS.TOT.INF
4660 RETURN
4680 FOR I=1 TO 2
4690 IF CHEM.COST.TOT.INF(I) <> 0 THEN GOTO 4750
4700 CHEM.COST.TOT.INF(I) = ((CHEM.UNITS.PER.GAL(I)/1000 * WATER.GAL.PER.TON) * (NOMINAL.TONS.BURNED + (1 + TURN.UP.PCT/100) ^ 2 * T
URNUP.TONS.BURNED)) * CHEM.COST.PER.UNIT.INF(I)
4710 NODOWNTIME.COST.CHEM(I) = CHEM.UNITS.PER.GAL(I)/1000 * CHEM.COST.PER.UNIT.INF(I) * WATER.GAL.PER.TON * PLANNED.OP.HRS * WASTE.B
URN.PER.HR
4720 NODOWNTIME.COST.CHEM = NODOWNTIME.COST.CHEM + NODOWNTIME.COST.CHEM(I)
4740 GOTO 4760
4750 NODOWNTIME.COST.CHEM = NODOWNTIME.COST.CHEM + CHEM.COST.TOT.INF(I)
4760 COST.CHEMICALS.TOT.INF = COST.CHEMICALS.TOT.INF + CHEM.COST.TOT.INF(I)
4770 NEXT I
4780 RETURN
4790 REM
4800 REM  IDENTIFY COSTS OF RESIDUE DISPOSAL AND OTHER
4810 GOSUB 4860 : REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF RESIDUE DISPOSAL
4820 GOSUB 4950 : REM  IDENTIFY LIFE CYCLE COSTS OF REPAIR PARTS, SEWER, INSURANCE, AND PEST AND VERMIN CONTROL
4830 GOSUB 5020 : REM  IDENTIFY LIFE CYCLE COSTS OF OTHER EXPENDITURES
4840 RETURN
4850 REM
4860 REM  IDENTIFY ANNUAL AND LIFE CYCLE COSTS OF RESIDUE DISPOSAL
4870 IF COST.NONBURNFILL.PER.TON=0 THEN COST.NONBURNFILL.PER.TON.INF = COST.TRANS.NONBURN.PER.TONMILE.INF * MILES.NONBURN.FILL + TIP
FEE.NONBURN.PER.TON.INF
4880 ANN.COST.NONBURN.DISP = WASTE.BURN.PER.HR * NUM.BURN.DAYS * DAILY.BURN.TIME * 52 * (1/(1 - TONS.NONBURN.PER.TON) - 1) * COST.NO
NBURNFILL.PER.TON.INF
4890 IF COST.ASHFILL.PER.TON.INF=0 THEN COST.ASHFILL.PER.TON.INF = COST.TRANS.ASH.PER.TONMILE.INF * MILES.ASH.FILL + TIPFEE.ASH.PER.
TON.INF
4900 ANN.COST.ASH.DISP = ASH.PER.TON.BURN * ANN.TRASH.BURNED * COST.ASHFILL.PER.TON.INF
4901 IF COST.ALLWASTE.PER.TON.INF = 0 THEN COST.ALLWASTE.PER.TON.INF = COST.TRANS.ALLWASTE.PER.TONMILE.INF * MILES.ALLWASTE.FILL + T
IPFEE.ALLWASTE.PER.TON.INF
4902 ANN.COST.SCHED.DOWN.DISP = (52 - NUM.BURN.WEEKS) * NUM.BURN.DAYS * DAILY.BURN.TIME * WASTE.BURN.PER.HR  * COST.ALLWASTE.PER.TON
.INF
4910 ANN.COST.RES.DISP = ANN.COST.NONBURN.DISP + ANN.COST.ASH.DISP + ANN.COST.SCHED.DOWN.DISP
4920 DIS.LC.COST.RES.DISP = ANN.COST.RES.DISP * (CUM.LANDFILL.DIFF(LEAD+ECON.LIFE) - CUM.LANDFILL.DIFF(LEAD))
4930 RETURN
4940 REM
4950 REM  IDENTIFY LIFE CYCLE COSTS OF REPAIR PARTS, SEWER, INSURANCE, AND PEST AND VERMIN CONTROL
4960 DIS.LC.COST.REPAIRPARTS = COST.REPAIRPARTS.TOT.INF * (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
4970 DIS.LC.COST.SEWER = COST.SEWER.TOT.INF * (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
4980 DIS.LC.COST.INSUR = COST.INSUR.TOT.INF * (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
4990 DIS.LC.COST.PEST = COST.PEST.TOT.INF * (CUM(LEAD+ECON.LIFE)- CUM(LEAD))
5000 RETURN
5010 REM
5020 REM  IDENTIFY LIFE CYCLE COSTS OF OTHER EXPENDITURES
5030 FOR I=1 TO 10
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5040 IF COST.OTHER.INF(I)=0 THEN GOTO 5140
5050 IF OTHER TYPE.COST$(I) = "E" THEN GOTO 5060 ELSE IF OTHER.TYPE.COST$(I) = "L" THEN GOTO 5090 ELSE GOTO 5120
5060 IF OTHER.COST.PROJ.YR(I) = 0 THEN DIS.LC.COST.OTHER(I) = COST.OTHER.INF(I) * (CUM.ENERGY DIFF(LEAD+ECON.LIFE) - CUM.ENERGY.DIFF
(LEAD)) ELSE DIS.LC.COST.OTHER(I) = COST.OTHER.INF(I) * SINGLE.ENERGY.DIFF(LEAD + OTHER.COST.PROJ.YR(I))
5070 DIS.LC COST.OTHER ENERGY = DIS.LC.COST.OTHER.ENERGY + DIS.LC.COST OTHER(I)
5080 GOTO 5140
5090 IF OTHER.COST PROJ.YR(I) = 0 THEN DIS.LC.COST.OTHER(I) = COST.OTHER.INF(I) * (CUM.LANDFILL.DIFF(LEAD+ECON.LIFE) - CUM.LANDFILL.
DIFF(LEAD)) ELSE DIS.LC.COST.OTHER(I) =COST.OTHER.INF(I) * SINGLE.LANDFILL DIFF(LEAD + OTHER.COST.PROJ.YR(I))
5100 DIS.LC COST.OTHER.LANDFILL = DIS.LC.COST.OTHER.LANDFILL + DIS.LC.COST.OTHER(I)
5110 GOTO 5140
5120 IF OTHER.COST.PROJ.YR(I) = 0 THEN DIS.LC.COST.OTHER(I) = COST.OTHER.INF(I) * (CUM(LEAD+ECON.LIFE) - CUM(LEAD)) ELSE DIS.LC.COST
.OTHER(I) = COST.OTHER.INF(I) * SINGLE(LEAD + OTHER.COST.PROJ.YR(I))
5130 DIS.LC.COST.OTHER.OTHER = DIS.LC.COST.OTHER.OTHER + DIS.LC.COST.OTHER(I)
5140 NEXT I
5150 DIS.LC.COST.OTHER.TOT = DIS.LC.COST.OTHER.ENERGY + DIS.LC.COST.OTHER.LANDFILL + DIS.LC.COST.OTHER.OTHER
5160 RETURN
5170 REM
5180 REM  IDENTIFY COST OF CORRECTIVE MAINTENANCE DOWNTIME
5190 GOSUB 5280 : REM  COMPUTE HRI BTUS OF STEAM OUTPUT PER TON OF WASTE INPUT
5200 GOSUB 5370 : REM  COMPUTE HRI ANNUAL STEAM PRODUCTION (IF NEVER DOWN) AND THE COST OF USING A BOILER TO PRODUCE AN EQUIVALENT Q
UANTITY OF STEAM
5220 GOSUB 5490 : REM  COMPUTE ANNUAL COST OF LANDFILLING THE NO-DOWNTIME HRI SOLID WASTE CAPACITY
5230 GOSUB 5550 : REM  COMPUTE ANNUAL COST OF NO HRI
5240 GOSUB 5600 : REM  COMPUTE ANNUAL NO-DOWNTIME COST OF HRI
5250 GOSUB 5790 : REM  COMPUTE ANNUAL AND LIFE CYCLE COSTS OF DOWNTIME
5260 RETURN
5270 REM
5280 REM  COMPUTE HRI BTUS OF STEAM OUTPUT PER TON OF WASTE INPUT
5290 STEADY.OFFSET.FUEL.BTU.TON = OFFSET.LIQ.GAL.TON * OFFSET.LIQ.BTU.GAL + OFFSET.GAS.CF.TON * OFFSET.GAS.BTU.CF + OFFSET SOL1.TON.
TON * OFFSET.SOL1.BTU.TON + OFFSET.SOL2.TON.TON * OFFSET.SOL2 BTU.TON
5300 STEADY FUEL.BTU.TON = LIQ GAL.TON * LIQ.BTU.GAL + GAS.CF.TON * GAS.BTU.CF + SOL1 TON.TON * SOL1 BTU.TON + SOL2.TON.TON * SOL2.B
TU.TON
5305 IF DAILY.BURN.TIME=16 THEN IF NUM.BURN.DAYS=5 THEN NODOWN.TIME.ALL.REHEATS = NUM.BURN.WEEKS * (4 * 1.5 * 8/TC + 1.5) ELSE  NODO
WN.TIME.ALL.REHEATS = NUM.BURN.WEEKS * 7 * 1.5 * 8/TC
5308 IF DAILY.BURN.TIME=24 THEN IF NUM.BURN.DAYS=4 OR NUM.BURN.DAYS=5 THEN NODOWN.TIME.ALL.REHEATS = NUM.BURN.WEEKS * 1.5 ELSE NODOW
N.TIME.ALL.REHEATS = 0
5310 NODOWN.STEADY.STATE.TRASH.BURNED = (PLANNED.OP.HRS - NODOWN.TIME.ALL.REHEATS) * WASTE.BURN.PER.HR
5320 NODOWN.STEADY.STATE.ELEC.BTU.PER.TON = (KWH.PER.OP.HR * (PLANNED.OP.HRS - NODOWN.TIME.ALL.REHEATS) + KWH.PER.SCHED.NONOP.HR*SCH
ED.NONOP.HOURS) / NODOWN.STEADY.STATE.TRASH.BURNED * 11600
5330 NODOWN.FUEL.EQ.BTUS.TO.HRI = STEADY.OFFSET.FUEL.BTU.TON + STEADY.FUEL.BTU.TON
5340 NODOWN.HRI.BTUOUT.PER.TON = (NODOWN.FUEL.EQ.BTUS.TO.HRI + HEAT.VAL.BURN.WASTE) * EFFICIENCY.HRI/100
5350 RETURN
5360 REM
5370 REM  COMPUTE HRI ANNUAL STEAM PRODUCTION (IF NEVER DOWN) AND THE COST OF USING A BOILER TO PRODUCE AN EQUIVALENT QUANTITY OF ST
EAM
5380 NODOWN.STEADY STATE.STEAM.PROD = NODOWN.HRI BTUOUT.PER.TON * NODOWN.STEADY.STATE TRASH.BURNED
5381 REHEAT.ELEC.BTU.TON = KWH.PER.OP.HR / WASTE.BURN.PER.HR * 11600
5382 REHEAT.BTUOUT.PER.TON = ((STEADY.OFFSET.FUEL.BTU.TON + STEADY.FUEL.BTU.TON + HEAT.VAL.BURN.WASTE) - (REHEAT OFFSET.FUEL.BTU.TON
.LOST + REHEAT.FUEL.BTU.TON.LOST + HEAT.VAL.BURN.WASTE ^ .667)) * EFFICIENCY HRI/100
5384 NODOWN.REHEAT.STEAM.PROD = REHEAT.BTUOUT.PER.TON * NODOWN.TIME ALL.REHEATS * WASTE.BURN.PER.HR
5385 NODOWN.STEAM.PROD = NODOWN.STEADY.STATE.STEAM.PROD + NODOWN.REHEAT.STEAM.PROD
5390 ANN.COST.EQUIV.BOILER = COST.PER.BOILER.MBTU.INF * NODOWN.STEAM.PROD/1E+06
5400 DIS.LC.COST.EQUIV.BOILER = ANN.COST.EQUIV.BOILER * (CUM.ENERGY.DIFF(LEAD+ECON LIFE) - CUM.ENERGY.DIFF(LEAD))
5410 RETURN
5480 REM
5490 REM  COMPUTE ANNUAL COST OF LANDFILLING THE NO-DOWNTIME HRI SOLID WASTE CAPACITY
5510 ANN.COST.LANDFILL.ALLWASTE = (1/(1 - TONS.NONBURN.PER.TON)) * WASTE.BURN.PER.HR * NUM.BURN.DAYS * DAILY.BURN.TIME * 52 * COST.A
LLWASTE.PER.TON.INF
5520 DIS.LC.COST.LANDFILL.ALLWASTE = ANN.COST.LANDFILL.ALLWASTE * (CUM.LANDFILL.DIFF(LEAD+ECON.LIFE) - CUM.LANDFILL.DIFF(LEAD))
5530 RETURN
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5540 REM
5550 REM  COMPUTE ANNUAL COST OF NO HRI
5560 ANN.COST.NO.HRI = ANN.COST.EQUIV.BOILER + ANN.COST.LANDFILL.ALLWASTE
5570 DIS.LC.COST.NO.HRI = DIS.LC.COST.EQUIV.BOILER + DIS.LC.COST.LANDFILL.ALLWASTE
5580 RETURN
5590 REM
5600 REM  COMPUTE ANNUAL NO-DOWNTIME COST OF HRI
5610 ANN.COST.LEAD.AND.MODS = (DIS.COST.LEAD.TOT + DIS.COST.MODS.TOT) / (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
5630 ANN.COST.NODOWNTIME.LABOR = COST.OP.LABOR.TOT.INF + COST.PMAINT.LABOR.TOT.INF
5640 NODOWNTIME.COST.ELEC = (KWH.PER.OP.HR * PLANNED.OP.HRS + KWH.PER.SCHED.NONOP.HR * SCHED.NONOP.HOURS) * COST.PER.KWH.INF
5650 NODOWNTIME.COST.FUELS = (NOMINAL.OFFSET.COST.TON + NOMINAL.COST.TON) * PLANNED.OP.HRS * WASTE.BURN.PER.HR
5680 NODOWNTIME.COST.CONSUM = NODOWNTIME.COST.ELEC + NODOWNTIME.COST.FUELS + NODOWNTIME.COST.WATER + NODOWNTIME.COST.CHEM
5690 NODOWNTIME.COST.REST = .2*COST.REPAIRPARTS.TOT.INF + COST.SEWER.TOT.INF + COST.INSUR.TOT.INF + COST.PEST.TOT.INF
5700 ANN.COST.OTHER.ENERGY = DIS.LC.COST.OTHER.ENERGY / (CUM.ENERGY.DIFF(LEAD+ECON.LIFE) - CUM.ENERGY.DIFF(LEAD))
5710 ANN.COST.OTHER.LANDFILL = DIS.LC.COST.OTHER.LANDFILL / (CUM.LANDFILL.DIFF(LEAD+ECON.LIFE) - CUM.LANDFILL.DIFF(LEAD))
5720 ANN.COST.OTHER.OTHER = DIS.LC.COST.OTHER.OTHER / (CUM(LEAD+ECON.LIFE) - CUM(LEAD))
5730 ANN.COST.OTHER.TOT = ANN.COST.OTHER.ENERGY + ANN.COST.OTHER.LANDFILL + ANN.COST.OTHER.OTHER
5740 NODOWNTIME.COST.ASH.DISP = ASH.PER.TON.BURN * PLANNED.OP.HRS * WASTE.BURN.PER.HR * COST.ASHFILL.PER.TON.INF
5750 NODOWNTIME.COST.DISP = ANN.COST.NONBURN.DISP + NODOWNTIME.COST.ASH.DISP + ANN.COST.SCHED.DOWN.DISP
5755 IF DAILY.BURN.TIME=16 THEN NODOWN.COST.REHEATS=COST.ALL.REHEATS ELSE IF NUM.BURN.DAYS=4 OR NUM.BURN.DAYS=5 THEN NODOWN.COST.REH
EATS=NUM.BURN.WEEKS*FUEL.FOR.ONE.LONG.DOWN*(EFFICIENCY.HRI/100)*COST.PER.BOILER.MBTU.INF*.000001 ELSE NODOWN.COST.REHEATS=0
5760 ANN.NODOWNTIME.COST.HRI = ANN.COST.LEAD.AND.MODS + ANN.COST.NODOWNTIME.LABOR + NODOWNTIME.COST.CONSUM + NODOWNTIME.COST.REST +
ANN.COST.OTHER.TOT + NODOWNTIME.COST.DISP + NODOWN.COST.REHEATS
5770 RETURN
5780 REM
5790 REM  COMPUTE ANNUAL AND LIFE CYCLE COSTS OF DOWNTIME
5800 IF ANN.COST.NO.HRI > ANN.NODOWNTIME.COST.HRI THEN ANN.COST.DOWNTIME = (ANN.COST.NO.HRI - ANN.NODOWNTIME.COST.HRI) / (PLANNED.OP
.HRS * WASTE.BURN.PER.HR) * TOTAL.TONS.LOST ELSE ANN.COST.DOWNTIME = 0
5810 DIS.LC.COST.DOWNTIME.ENERGY = (ANN.COST.EQUIV.BOILER/ANN.COST.NO.HRI) * ANN.COST.DOWNTIME * (CUM.ENERGY.DIFF(LEAD+ECON.LIFE) -
CUM.ENERGY.DIFF(LEAD))
5820 DIS.LC.COST.DOWNTIME.LANDFILL = (ANN.COST.LANDFILL.ALLWASTE/ANN.COST.NO.HRI) * ANN.COST.DOWNTIME * (CUM.LANDFILL.DIFF(LEAD+ECON
.LIFE) - CUM.LANDFILL.DIFF(LEAD))
5830 DIS.LC.COST.DOWNTIME = DIS.LC.COST.DOWNTIME.ENERGY + DIS.LC.COST.DOWNTIME.LANDFILL
5840 RETURN
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30 GOSUB 110 : REM  IDENTIFY ANNUAL AND DISCOUNTED LIFE CYCLE COSTS OF HRI
40 GOSUB 240 : REM  IDENTIFY HRI SAVINGS-TO-INVESTMENT RATIO
50 GOSUB 890 : REM  IDENTIFY HRI PAYBACK PERIOD
60 GOSUB 1000 : REM  IDENTIFY HRI FOSSIL FUEL OFFSET
70 GOSUB 1350 : REM  IDENTIFY HRI LANDFILL SPACE CONSERVED
80 GOSUB 1450 : REM  PRINT REPORT
90 SYSTEM
100 REM
110 REM  IDENTIFY ANNUAL AND DISCOUNTED LIFE CYCLE COSTS OF HRI
120 ANN.COST.CONSUM = ANN.COST.ELEC + ANN.COST.FUELS + COST.WATER.TOT.INF + COST.CHEMICALS.TOT.INF
140 ANN.COST.REST = COST.REPAIRPARTS.TOT.INF + COST.SEWER.TOT.INF + COST.INSUR.TOT.INF + COST.PEST.TOT.INF
160 ANN.COST.HRI = ANN.COST.LEAD.AND.MODS + ANN.COST.LABOR + ANN.COST.CONSUM + ANN.COST.REST + ANN.COST.OTHER.TOT + ANN.COST.RES.DIS
P + ANN.COST.DOWNTIME + COST.ALL.REHEATS
180 DIS.LC.COST.O.AND.M = DIS.LC.COST.LABOR + DIS.LC.COST.WATER + DIS.LC.COST.CHEMICALS + DIS.LC.COST.REPAIRPARTS + DIS.LC.COST.SEWE
R + DIS.LC.COST.INSUR + DIS.LC.COST.PEST + DIS.LC.COST.ELEC + DIS.LC.COST.FUELS + DIS.LC.COST.RES.DISP
200 DIS.LC.COST.HRI = DIS.COST.LEAD.TOT + DIS.COST.MODS.TOT + DIS.LC.COST.O.AND.M + DIS.LC.COST.OTHER.TOT + DIS.LC.COST.DOWNTIME + D
IS.LC.COST.ALL.REHEATS
210 DIS.LC.COST.HRI.PER.TON = DIS.LC.COST.HRI / (ANN.TRASH.BURNED * ECON.LIFE)
220 RETURN
230 REM
240 REM  IDENTIFY HRI SAVINGS TO INVESTMENT RATIO
250 SIR.ANN.COST.HRI.ENERGY = ANN.COST.ELEC + ANN.COST.NONOFF.FUELS + (ANN.COST.EQUIV.BOILER/ANN.COST.NO.HRI) * ANN.COST.DOWNTIME +
COST.ALL.REHEATS
270 SIR.ANN.COST.HRI.LANDFILL = ANN.COST.RES.DISP + (ANN.COST.LANDFILL.ALLWASTE/ANN.COST.NO.HRI) * ANN.COST.DOWNTIME
290 SIR.ANN.COST.HRI.OTHER = ANN.COST.OFFSET.FUELS + ANN.COST.LABOR + COST.WATER.TOT.INF + COST.CHEMICALS.TOT.INF + COST.REPAIRPARTS
.TOT.INF + COST.SEWER.TOT.INF + COST.INSUR.TOT.INF + COST.PEST.TOT.INF
310 FOR I=1 TO 10
320 IF COST.OTHER.ANNUAL(I) = 0 THEN GOTO 400
330 IF OTHER.TYPE.COST$(I) <> "E" THEN GOTO 360
340 SIR.ANN.COST.HRI.ENERGY = SIR.ANN.COST.HRI.ENERGY + COST.OTHER.INF(I)
350 GOTO 400
360 IF OTHER.TYPE.COST$(I) <> "L" THEN GOTO 390
370 SIR.ANN.COST.HRI.LANDFILL = SIR.ANN.COST.HRI.LANDFILL + COST.OTHER.INF(I)
380 GOTO 400
390 SIR.ANN.COST.HRI.OTHER = SIR.ANNUAL.COST.HRI.OTHER + COST.OTHER.INF(I)
400 NEXT I
440 FOR I=LEAD+1 TO LEAD+ECON.LIFE
450 SIR.COST.HRI.ENERGY(I) = SIR.ANN.COST.HRI.ENERGY
460 SIR.COST.HRI.LANDFILL(I) = SIR.ANN.COST.HRI.LANDFILL
470 SIR.COST.HRI.OTHER(I) = SIR.ANN.COST.HRI.OTHER
480 NEXT I
490 FOR I=LEAD+1 TO LEAD+ECON.LIFE
500 FOR J=1 TO 10
510 IF COST.OTHER.ONETIME(J) = 0 THEN GOTO 630
520 IF OTHER.COST.PROJ.YR(J) + LEAD <> I THEN GOTO 630
530 IF OTHER.TYPE.COST$(J) <> "E" THEN GOTO 570
540 SIR.COST.HRI.ENERGY(I) = SIR.COST.HRI.ENERGY(I) + COST.OTHER.INF(J)
560 GOTO 630
570 IF OTHER.TYPE.COST$(J) <> "L" THEN GOTO 610
580 SIR.COST.HRI.LANDFILL(I) = SIR.COST.HRI.LANDFILL(I) + COST.OTHER.INF(J)
600 GOTO 630
610 SIR.COST.HRI.OTHER(I) = SIR.COST.HRI.OTHER(I) + COST.OTHER.INF(J)
630 NEXT J
640 NEXT I
650 FOR I=LEAD+1 TO LEAD+ECON.LIFE
660 FOR J=1 TO 10
670 IF COST.MOD.TOT.INF(J) = 0 THEN GOTO 710
680 IF YEAR.MOD(J) + LEAD <> I THEN GOTO 710
690 SIR.COST.HRI.OTHER(I) = SIR.COST.HRI.OTHER(I) + COST.MOD.TOT.INF(J)
710 NEXT J
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720 NEXT I
730 FOR I=LEAD+1 TO LEAD+ECON.LIFE
740 DIS.ENERGY.SAVINGS(I) = (ANN.COST.EQUIV.BOILER - SIR.COST.HRI.ENERGY(I)) * SINGLE.ENERGY.DIFF(I)
760 DIS.LANDFILL.SAVINGS(I) = (ANN.COST.LANDFILL.ALLWASTE - SIR.COST.HRI.LANDFILL(I)) * SINGLE.LANDFILL.DIFF(I)
780 DIS.OTHER.SAVINGS(I) = (0 - SIR.COST.HRI.OTHER(I)) * SINGLE(I)
800 DIS.TOT.SAVINGS(I) = DIS.ENERGY.SAVINGS(I) + DIS.LANDFILL.SAVINGS(I) + DIS.OTHER.SAVINGS(I)
820 DIS.TOT.SAVINGS = DIS.TOT.SAVINGS + DIS.TOT.SAVINGS(I)
830 NEXT I
840 DIS.TOT.SAVINGS.PER.TON = DIS.TOT.SAVINGS / (ANN.TRASH.BURNED * ECON.LIFE)
850 SIR = DIS.TOT.SAVINGS / DIS.COST.LEAD.TOT
870 RETURN
880 REM
890 REM  IDENTIFY HRI PAYBACK PERIOD
900 M=LEAD+1
910 IF DIS.TOT.SAVINGS(M) + CUM.DIS.TOT.SAVINGS >= DIS.COST.LEAD.TOT THEN GOTO 950
920 CUM.DIS.TOT.SAVINGS = CUM.DIS.TOT.SAVINGS + DIS.TOT.SAVINGS(M)
930 M=M+1
940 IF M < LEAD+ECON.LIFE THEN GOTO 910 ELSE GOTO 980
950 PAYBACK.YEAR = M-1 + (DIS.COST.LEAD.TOT - CUM.DIS.TOT.SAVINGS) / DIS.TOT.SAVINGS(M)
970 GOTO 990
980 REM  PRINT "PAYBACK PERIOD IS LONGER THAN PROJECT ECONOMIC LIFE"
990 RETURN
1000 REM
1010 REM  IDENTIFY HRI FOSSIL FUEL OFFSET
1020 STEADY.STATE.TRASH.BURNED = (UP.HOURS - TOTAL.TURN.UP.TIME - TIME.ALL.REHEATS) * WASTE.BURN.PER.HR
1030 STEADY.STATE.ELEC.USED = ANN.USE.ELEC - KWH.PER.OP.HR * TIME.ALL.REHEATS - KWH.PER.OP.HR * (1 + .33 * TURN.UP.PCT/100) * TOTAL.
TURN.UP.TIME
1040 HRI.ELEC.BTU.PER.TON = STEADY.STATE.ELEC.USED / STEADY.STATE.TRASH.BURNED * 11600
1050 FUEL.EQ.BTUS.TO.HRI = STEADY.OFFSET.FUEL.BTU.TON + STEADY.FUEL.BTU.TON
1060 HRI.BTUOUT.PER.TON = (FUEL.EQ.BTUS.TO.HRI + HEAT.VAL.BURN.WASTE) * EFFICIENCY.HRI/100
1075 STEADY.STATE.STEAM.PROD = HRI.BTUOUT.PER.TON * STEADY.STATE.TRASH.BURNED
1080 FOSSIL.FUEL.EQUIV.HRI.BTUOUT = HRI.BTUOUT.PER.TON  / (EFFICIENCY.BOILER/100)
1100 HRI.FOSSIL.FUEL.BTU.OFFSET.PER.TON = FOSSIL.FUEL.EQUIV.HRI.BTUOUT - STEADY.FUEL.BTU.TON - HRI.ELEC.BTU.PER.TON
1120 HRI.STEADY.STATE.BTU.OFFSET = HRI.FOSSIL.FUEL.BTU.OFFSET.PER.TON * STEADY.STATE.TRASH.BURNED
1150 REHEAT.STEAM.PROD = REHEAT.BTUOUT.PER.TON * TIME.ALL.REHEATS * WASTE.BURN.PER.HR
1160 REHEAT.FOSSIL.FUEL.EQUIV.BTUOUT = REHEAT.BTUOUT.PER.TON / (EFFICIENCY.BOILER/100)
1170 REHEAT.FOSSIL.FUEL.BTU.OFFSET.PER.TON = REHEAT.FOSSIL.FUEL.EQUIV.BTUOUT - (STEADY.FUEL.BTU.TON - REHEAT.FUEL.BTU.TON.LOST) - RE
HEAT.ELEC.BTU.TON
1180 REHEAT.BTU.OFFSET = REHEAT.FOSSIL.FUEL.BTU.OFFSET.PER.TON * TIME.ALL.REHEATS * WASTE.BURN.PER.HR
1190 TURNUP.ELEC.BTU.TON = KWH.PER.OP.HR * (1 + .33 * TURN.UP.PCT/100) / TURN.UP.RATE * 11600
1200 TURNUP.BTUOUT.PER.TON = ((1 + TURN.UP.PCT/100) * (STEADY.OFFSET.FUEL.BTU.TON + STEADY.FUEL.BTU.TON) + HEAT.VAL.BURN.WASTE) * EF
FICIENCY.HRI/100
1210 TURNUP.STEAM.PROD = TURNUP.BTUOUT.PER.TON * TURN.UP.RATE * TOTAL.TURN.UP.TIME
1220 TURNUP.FOSSIL.FUEL.EQUIV.BTUOUT = TURNUP.BTUOUT.PER.TON / (EFFICIENCY.BOILER/100)
1230 TURNUP.FOSSIL.FUEL.BTU.OFFSET.PER.TON = TURNUP.FOSSIL.FUEL.EQUIV.BTUOUT - (1 + TURN.UP.PCT/100) * STEADY.FUEL.BTU.TON - TURNUP.
ELEC.BTU.TON
1240 TURNUP.BTU.OFFSET = TURNUP.FOSSIL.FUEL.BTU.OFFSET.PER.TON * TOTAL.TURN.UP.TIME * TURN.UP.RATE
1300 HRI.ANN.BTU.OFFSET = HRI.STEADY.STATE.BTU.OFFSET + REHEAT.BTU.OFFSET + TURNUP.BTU.OFFSET
1310 HRI.ANN.BOE.OFFSET = HRI.ANN.BTU.OFFSET / 5.8E+06
1322 LC.STEAM.PROD = ECON.LIFE * (STEADY.STATE.STEAM.PROD + REHEAT.STEAM.PROD + TURNUP.STEAM.PROD) * .000001
1324 DIS.LC.COST.HRI.PER.MBTU = DIS.LC.COST.HRI / LC.STEAM.PROD
1326 DIS.TOT.SAVINGS.PER.MBTU = DIS.TOT.SAVINGS / LC.STEAM.PROD
1330 RETURN
1340 REM
1350 REM  IDENTIFY HRI LANDFILL SPACE CONSERVED
1355 ANN.TOTAL.WASTE = WASTE.BURN.PER.HR * NUM.BURN.DAYS * DAILY.BURN.TIME * 52 / (1 - TONS.NONBURN.PER.TON)
1360 ANN.NONBURNABLE.TO.LANDFILL = ANN.TOTAL.WASTE * TONS.NONBURN.PER.TON
1380 ANN.ASH.TO.LANDFILL = ANN.TRASH.BURNED * ASH.PER.TON.BURN
1390 SCHED.DOWN.BURNABLE = (52 - NUM.BURN.WEEKS) * NUM.BURN.DAYS * DAILY.BURN.TIME * WASTE.BURN.PER.HR
1420 ANN.LANDFILL.SPACE.CONSERVED = ANN.TOTAL.WASTE - (ANN.NONBURNABLE.TO.LANDFILL + ANN.ASH.TO.LANDFILL + TOTAL.TONS.LOST + SCHED.D
```

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OWN BURNABLE)
1440 RETURN
1450 LPRINT CHR$(12)
1460 LPRINT
1470 LPRINT
1480 LPRINT TAB(40) "HRI COST AND PERFORMANCE REPORT"
1490 LPRINT
1500 LPRINT
1510 REM  PRINT REPORT
1520 LPRINT "INFLATED PER TON COST OF DISPOSING WASTE OF THE TYPE GENERATED AT THE SITE TO THE LANDFILL:",,
1530 LPRINT USING "$$###.##"; COST.ALLWASTE.PER.TON.INF
1540 LPRINT "INFLATED PER MBTU COST OF THE FOSSIL FUEL BOILER TO WHICH THE HRI IS BEING COMPARED:",,
1550 LPRINT USING "$$###.##"; COST.PER.BOILER.MBTU.INF
1560 LPRINT
1570 LPRINT
1580 LPRINT "TONS OF TRASH BURNED ANNUALLY BY THE HRI: ",,,,,
1590 LPRINT USING "######,."; ANN.TRASH.BURNED
1620 LPRINT "MBTUS PRODUCED ANNUALLY BY THE HRI (CONSIDERING NO DOWNTIME): ",,,,
1630 LPRINT USING "##.##^^^^"; NODOWN.STEAM.PROD * .000001
1660 LPRINT "VIRGIN FUEL OFFSET ANNUALLY BY THE HRI IN BARRELS-OF-OIL-EQUIVALENT: ",,,,
1670 LPRINT USING "######,."; HRI.ANN.BOE.OFFSET
1680 LPRINT "LANDFILL SPACE CONSERVED ANNUALLY BY THE HRI IN TONS: ",,,,,
1690 LPRINT USING "######,."; ANN.LANDFILL.SPACE.CONSERVED
1700 LPRINT
1710 LPRINT
1720 LPRINT "COST OF USING A BOILER TO PRODUCE THE ANNUAL NO-DOWNTIME QUANTITY OF STEAM PRODUCED BY THE HRI AND LANDFIL-"
1730 LPRINT "    LING ALL WASTE:",,,,,,,
1740 LPRINT USING "$$#######,."; ANN.COST.NO.HRI
1750 LPRINT "INFLATED TOTAL CAPITAL COST OF THE HRI (INCLUDES EQUIPMENT, SUPPORT FACILITIES, AND CONSTRUCTION AND SETUP): ",
1760 LPRINT USING "$$#########,."; COST.CAP.TOT.INF
1770 LPRINT "UNIFORM ANNUAL COST OF THE HRI (THE COST OF CAPITAL, MODIFICATIONS, LABOR, CONSUMABLES, RESIDUE DISPOSAL,"
1780 LPRINT "    DOWNTIME, AND OTHER COSTS SPREAD OVER THE ECONOMIC LIFE OF THE HRI): ",,,
1790 LPRINT USING "$$#######,.", ANN.COST.HRI
1800 LPRINT "ANNUAL NO-DOWNTIME COST OF THE HRI (THE TOTAL OF NO-DOWNTIME COSTS SPREAD OVER THE ECONOMIC LIFE OF THE HRI): ",
1810 LPRINT USING "$$#######,."; ANN.NODOWNTIME.COST.HRI
1820 LPRINT
1830 LPRINT
1840 LPRINT "DISCOUNTED LIFE CYCLE COST OF USING A BOILER TO PRODUCE THE LIFE CYCLE NO-DOWNTIME QUANTITY OF STEAM PRODUCED"
1850 LPRINT "    BY THE HRI AND LANDFILLING ALL WASTE (COSTS DISCOUNTED TO THE POINT OF INITIAL FUNDING): ",,
1860 LPRINT USING "$$#########,."; DIS.LC.COST.NO.HRI
1870 LPRINT "DISCOUNTED LIFE CYCLE COST OF THE HRI: ",,,,,,
1880 LPRINT USING "$$#########,."; DIS.LC.COST.HRI
1890 LPRINT "DISCOUNTED LIFE CYCLE COST OF AUXILIARY FUELS USED BY THE HRI: ",,,,
1900 LPRINT USING "$$#######,."; DIS.LC.COST.FUELS
1910 LPRINT "DISCOUNTED LIFE CYCLE COST OF NONCOMBUSTIBLE WASTE, ASH, AND SCHEDULED DOWNTIME WASTE DISPOSAL: ",,
1920 LPRINT USING "$$#########,."; DIS.LC.COST.RES.DISP
1930 LPRINT "DISCOUNTED LIFE CYCLE COST OF HRI DOWNTIME: ",,,,,
1940 LPRINT USING "$$#######,.-"; DIS.LC.COST.DOWNTIME
1950 LPRINT
1960 LPRINT
1970 LPRINT "DISCOUNTED LIFE CYCLE COST OF THE HRI PER TON OF WASTE FIRED: ",,,,
1980 LPRINT USING "$$###.##"; DIS.LC.COST.HRI.PER.TON
1990 LPRINT "DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI PER TON OF WASTE FIRED: ",,,,
1991 LPRINT USING "$$###.##-"; DIS.TOT.SAVINGS.PER.TON
1992 LPRINT "DISCOUNTED LIFE CYCLE COST OF THE HRI PER MBTU PRODUCED: ",,,,
1993 LPRINT USING "$$###.##"; DIS.LC.COST.HRI.PER.MBTU
1994 LPRINT "DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI PER MBTU PRODUCED: ",,,,
1995 LPRINT USING "$$###.##-"; DIS.TOT.SAVINGS.PER.MBTU
1996 LPRINT
1997 LPRINT
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2000 LPRINT "DISCOUNTED LIFE CYCLE SAVINGS OF THE HRI: ".,,,,
2010 LPRINT USING "$$#########,.-"; DIS.TOT.SAVINGS
2020 LPRINT "HRI SAVINGS-TO-INVESTMENT RATIO: ",,,,,,
2030 LPRINT USING "+##.##"; SIR
2040 LPRINT "PAYBACK PERIOD IN YEARS (INCLUDES PROJECT LEAD TIME):",,,,,
2050 IF PAYBACK.YEAR <> 0 THEN LPRINT USING "##.#"; PAYBACK.YEAR ELSE LPRINT "> PROJECT LIFE"
2060 RETURN
```

Appendix D

EQUATIONS FOR TECHNO-ECONOMIC FUNCTIONS SHOWN IN TEXT

Title	Equation
Discounted Life Cycle Cost vs Capital Cost	$F(x) = 0.6637x + 3{,}397{,}650$
Discounted Life Cycle Savings vs Capital Cost	$F(x) = 0.2319x + 5{,}604{,}340$
HRI Savings-to-Investment Ratio vs Capital Cost	$F(x) = 0.64246x^2 - 4.0872x + 8.99$
Payback Period in Years vs Capital Cost	$F(x) = 1.8095\ E\text{-}6x + 4.9$
Discounted Life Cycle Cost vs Cost of Solid Waste Disposal	$F(x) = 84{,}811x + 3{,}519{,}339$
Discounted Life Cycle Savings vs Cost of Solid Waste Disposal	$F(x) = 84{,}469x + 4{,}824{,}225$
HRI Savings-to-Investment Ratio vs Cost of Solid Waste Disposal	$F(x) = 0.04488x + 2.5672$
Payback Period in Years vs Cost of Solid Waste Disposal	$F(x) = 0.0002904x^2 - 0.051311x + 9.3353$
Discounted Life Cycle Cost vs Btu/lb Waste Input	$F(x) = 194x + 3{,}822{,}335$
Discounted Life Cycle Savings vs Btu/lb Waste Input	$F(x) = 1{,}098x + 601{,}620$
HRI Savings-to-Investment Ratio vs Btu/lb Waste Input	$F(x) = 0.00058x + 0.34$
Payback Period in Years vs But/lb Waste Input	$F(x) = 1.7929\ E\text{-}7x^2 - 2.5324\ E\text{-}3x + 16.9126$
Discounted Life Cycle Cost vs HRI % Thermal Efficiency	$F(x) = 17{,}635x + 3{,}821{,}550$
Discounted Life Cycle Savings vs HRI % Thermal Efficiency	$F(x) = 99{,}871x + 598{,}318$

Title	Equation
HRI Savings-to-Investment Ratio vs HRI % Thermal Efficiency	$F(x) = 0.053333x + 0.30668$
Payback Period in Years vs HRI % Thermal Efficiency	$F(x) = 0.0020388x^2 - 0.29279x + 18.636$
Discounted Life Cycle Cost vs Economic Life (yr)	$F(x) = -3{,}277.7x^2 + 1{,}254{,}993x + 2{,}192{,}255$
Discounted Life Cycle Savings vs Economic Life (yr)	$F(x) = -5{,}308.6x^2 + 2{,}119{,}500x + 576{,}563$
Savings-to-Investment Ratio vs Economic Life (yr)	$F(x) = -0.0027639x^2 + 1.10726x + 0.312376$
Payback Period in Years vs Economic Life (yr)	$F(x) = 0.002484x^2 - 0.84773x + 9.1176$
Discounted Life Cycle Cost vs Wet Ash/Waste Burned (tons)	$F(x) = 1{,}657{,}804x + 4{,}045{,}456$
Discounted Life Cycle Savings vs Wet Ash/Waste Burned (tons)	$F(x) = -1{,}657{,}804x + 6{,}837{,}224$
Savings-to-Investment Ratio vs Wet Ash/Waste Burned (tons)	$F(x) = -0.88572x + 3.6385$
Payback Period in Years vs Wet Ash/Waste Burned (tons)	$F(x) = 37.682x^2 - 109.94x + 8.2985$
Discounted Life Cycle Cost vs Differential Energy Inflation Rate	$F(x) = 2{,}998.6x^2 + 21{,}599x + 4{,}608{,}500$
Discounted Life Cycle Savings vs Differential Energy Inflation Rate	$F(x) = 38{,}594x^2 + 277{,}932x + 4{,}701{,}580$
Savings-to-Investment Ratio vs Differential Energy Inflation Rate	$F(x) = 0.020694x^2 + 0.14628x + 1.9912$

Title	Equation
Payback Period in Years vs Differential Energy Inflation Rate	$F(x) = 0.022243x^2 - 0.49262x + 10.640$
Discounted Life Cycle Cost vs Differential Landfill Inflation Rate	$F(x) = 7,562.1x^2 + 54,451x + 4,330,150$
Discounted Life Cycle Savings vs Differential Landfill Inflation Rate	$F(x) = 8,779.7x^2 + 63,233x + 5,555,564$
Savings-to-Investment Ratio vs Differential Landfill Inflation Rate	$F(x) = 0.0053142x^2 + 0.026382x + 2.9752$
Payback Period in Years vs Differential Landfill Inflation Rate	$F(x) = -0.0006433x^2 - 0.052187x + 9.01002$
Savings-to-Investment Ratio vs Discount Rate	$F(x) = -0.25666x + 5.8066$
Payback Period in Years vs Discount Rate	$F(x) = 0.066665x + 8.03335$

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