# COST-EFFECTIVENESS ANALYSIS OF THE IRON AND STEEL INDUSTRY

EFFLUENT GUIDELINES REGULATION
DRAFT

For the:

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## CONCLUSION

The cost-effectiveness analysis for this regulation was based upon an assessment of the cost to remove a "pound-equivalent" of the various pollutants discharged by the steel industry. A "pound equivalent" is a toxicity weighted measure based upon established water quality criteria. The cost-effectiveness analysis was conducted for direct and indirect dischargers in all steel industry subcategories. The results indicate that this regulation is cost-effective relative to other proposed effluent guidelines and, that the technologies selected as the basis for the final effluent limitations and standards are generally the most cost effective option for each steel industry subcategory.

## COST EFFECTIVENESS METHODOLOGY

Cost-effectiveness is defined as the incremental annualized cost associated with a pollution control option in an industry or industry subcategory per incremental pound equivalent of pollutant removed by that control option. Cost-effectiveness analyses offer a useful way of quantifying comparisons among pollution control regulations and options which are credible to a wide audience because the technical data and assumptions used are empirical and objective.

In order to perform sophisticated cost-effectiveness analyses across industries, consistent and well-documented computer databases must be developed. Data sources for the databases came from EPA. These include development documents from the Effluent Guidelines Division (EGD), economic impact analyses from the Office of Analysis and Evaluation (OAE), OPRM rule-making packages, and discussions with EPA Project Officers. Data sets for each subcategory within an industry used in the cost-effectiveness analyses contain the following:

- The wastewater pollutants to be examined,
- The range of control options developed by EGD,
- Annual volume of loadings by pollutant
  - --Currently, and
  - --At each BPT, BAT or PSES control option, and
- Annualized costs for each control option (in 1978 dollars).

The theory of cost-effectiveness is predicated upon the ability to measure the incremental cost of a certain action so that it can be compared with its incremental effect. For water pollution control, cost-effectiveness refers to the incremental annual cost of pollution control systems divided by the annual amount of pollutants (pounds equivalent) removed.

Central to the role of a regulatory cost-effectiveness analysis is the ability to provide a meaningful comparison of costs and effects of various regulatory alternatives on both an intra- and interindustry basis. There are many ways

to do this, all of which affect the cost-effectiveness analysis. Some parameters that can be altered, thereby affecting comparisons, include:

- Limiting the types of pollutants used in the analysis (conventional, nonconventional, and toxics); and

- Specifying the relative importance of the pollutants, through a pollutant weighting mechanism.

EPA recognizes the potential differences in the toxicities of industrial pollutants. One way to incorporate these differences is through a weighting of the pollutants. Some weighting mechanisms which can be used include:

- Exposure-related weights which relate mass loadings for each pollutant to a measure similar to the man-rem dose used in radiation exposure;

- Health effect-related weights which relate mass loadings to dose-response information;

- Water quality-related weights which relate mass loadings to improvements in water quality;

- Concentration-related weights which address the issue that the toxicity of a pollutant is not always linearly proportional to its concentration; and

- Water quality-related weights which reflect water quality criteria designed to protect freshwater aquatic life.

To develop weighting mechanisms described by the first four approaches would require a significant amount of data collection and development of analytical capabilities which are currently beyond the state of the art. The fifth approach, developing a weighting system based on aquatic criteria, is possible, and is useful in explaining much of the variability in the interpollutant impacts that would be useful to decision-makers in the regulatory area.

In conjunction with EPA, the 24-hour averages for the aquatic criteria were chosen for these analyses.[1] These represent the best current estimate of long-term, chronic pollutant concentrations which will create significant impacts on the aquatic ecology.

The two major data sources of the aquatic criteria were:

- Federal Register, November 28, 1980, Part V, "Water Quality Criteria Documents: Availability," EPA (FR).
- Quality Criteria for Water, EPA-440/9-76-023, EPA, 1976 (Red Book).

Information on pollutant loadings provided in the development documents was usually presented as long-term average discharge emissions. This most closely matches the long-term, chronic nature of the 24-hour criteria used in the weighting mechanism. Most development documents also provided an estimate of daily variations in long-term average discharge so that 24-hour maximum effluent guidelines could be established. However, loadings based on these daily estimates were not developed developed since the ratio between daily maximum discharges and long term average dischargers are not constant for all pollutants. In addition, the use of toxic weighting factors and loadings based on daily maximum discharge does not characterize average industry performance, which is the basis for inter-industry comparisons. Thus, the long term average discharge data provides the most consistent data base for characterizing industry performance.

For some pollutants information on the criteria for 24-hour average exposure levels was not available so weights were developed using the following ordered set of sources, i.e., the chronic criteria were used first; if they were not available, then the Red Book was used, etc. This process continued until a weighting factor was developed.

- Chronic criteria in the Federal Register--similar to the 24-hour average criteria but based on a less extensive database,

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[1]As stated in the Federal Register (referenced on the top of page II-3): "A 24-hour period was chosen instead of a slightly longer or shorter period in recognition of daily fluctuations in waste discharges and of the influence of daily cycles of sunlight and darkness and temperature on both pollutants and aquatic organisms."

- o Red Book criteria--required interpretation of criteria,
- o Not-to-be-exceeded criteria in the Federal Register, or
- o Acute criteria in the Federal Register--similar to not-to-be-exceeded criteria except based on a less extensive database.

The weighting factors for each pollutant were calculated by dividing the 24-hour average criteria (or its proxy), expressed as a concentration in μg/liter, into the same criteria for a selected standard pollutant. Copper, a commonly detected industrial pollutant and a toxic metal, was selected as the standard pollutant for developing weighting factors. Table II-1 below presents an example of the calculation of weighting factors for four pollutants. Three toxic metals are listed in addition to copper. The relative aquatic criteria in μg/liter are shown in the second column. They are a surrogate for measuring how differing toxicities can affect the aquatic ecology. In this analysis they are referred to as (pounds equivalent. As such, they can be used by the regulator not only in assessing how much toxic material is being treated, but also in addressing the question of relative hazard among pollutants. Weightings extend the usefulness of cost-effectiveness as a tool by development of the "pounds equivalent" unit: a standardized measure of toxicity.

Table II-1

COPPER-BASED CRITERIA

| Pollutant | Aquatic Criteria μg/l | Weighting Calculation | Final Weight |
|---|---|---|---|
| Copper | 5.6 | 5.6/5.6 | 1.00 |
| Hexavalent Chromium | .29 | 5.6/.29 | 19.31 |
| Nickel | 96.00 | 5.6/96 | .06 |
| Cadmium | .40 | 5.6/.40 | 14.00 |

In order to compare the costs, effluent and cost-effectiveness of subcategories which discharge directly to surface waters with those that discharge indirectly via publicly owned treatment works (POTW's), adjustments were made to the "pounds equivalent" factors for indirect dischargers. These adjustments were based on the median removal efficiencies found in Fate of Priority Pollutants in Publicly Owned Treatment Works, Interim

Report, EPA-440/1-80-301, October 1980. For example, the median removal efficiency for copper in POTW's was found to 82 percent--typically, for every pound of copper in the effluent of an indirect dischargers only 0.18 pound is discharged to surface waters. Because of this, the toxic weighting factor for copper discharged indirectly was set to be equal to the factor for direct dischargers (1.00) times the POTW factor (0.18) or 0.18.

Given total subcategory loadings and a pollutant weighting mechanism, the cost-effectiveness computer model, developed by TBS, calculates cost-effectiveness for regulatory control options in the following manner. First, all options are identified by their total cost and the amount of "pounds equivalent" removed. The model then examines all options to determine if there are any options which are clearly suboptimal, i.e., if other options remove more P/E at a lower cost such options have suboptimal dollar per unit removal performance. The remaining options are then ranked in order of P/E removed and a preliminary cost-effectiveness is calculated based on the incremental cost and removals between adjacent options. Options in this ranking whose cost-effectiveness exceeds that of an option with greater removal are not cost-effective, and thus deleted from further analysis. Final cost-effectiveness levels are then calculated based on the incremental cost and P/E removed of the remaining options.

# III. THE IRON AND STEEL INDUSTRY

The iron and steel industry consists of over 2,000 individual production facilities at about 680 locations which are involved in the production of coke, iron, and steel and the forming and finishing of steel into basic steel products. Many manufacturing processes are involved in production of these products, each with unique pollution control considerations.

This chapter is segmented into three parts. First, there is a description of the methodology used for subcategorization of the industry. Second, a description of the data sources and the methodology for data reduction is presented. Third, the cost-effectiveness analysis is presented, including intra- and inter-industry comparisons.

## A. SUBCATEGORIZATION

For the purpose of technical analysis, the industry has been divided into 12 subcategories with 66 segments. Facilities in each discharge effluent either directly to surface waters and are therefore subject to the BPT and BAT guidelines or they discharge indirectly via publicly owned treatment works and are subject to PSES.

The focus of this chapter is on the direct discharging facilities only--results for indirect dischargers are presented in Appendix II.

The direct discharging subcategories which are sufficiently similar in production and pollution control characteristics have been aggregated into a total of 26 directly discharging subdivisions for EPA decision purposes. The 61 and the 26 subdivisions are presented in Exhibit 1. The definition and scope of the subcategories and subdivisions and the control options considered are provided in development documents prepared by EPA's Effluent Guideline Division (EGD).

## B. DATA COLLECTION AND REDUCTION

The collection and reduction of cost and loading data involved a three-step process. First, subcategory cost, flow, and pollutant concentration information (provided by EGD) was used in development of a database. Second, this information was converted and aggregated into subdivision cost and loading data. It assumed that no pollution control equipment was currently in place. Third, adjustments were made to the cost and loading data to account for equipment currently in place. In the following, the three sets of data corresponding to three steps are described--the first listing the raw data inputs, the second showing data in an intermediate form assuming no pollution controls are currently in place, and the third presenting the costs and loadings as they were used in the cost-effectiveness analysis.

### Data Collection

Data used in this analysis was provided by EGD. It included capital expenditures for in-place equipment, cost, flow, and concentration information. These data are described in the following; examples of the EGD data formats for the sintering subcategory are provided in Appendix I.

- The annualized costs of each control option for each subcategory were provided in millions of 1978 dollars and include operating and maintenance expenses as well as an annual charge for capital expenditures (see Appendix I, Exhibit 1). Annualized costs for all BAT options and for PSES options 2 through 7 are stated as increments to BPT and PSES 1 costs, respectively.

- Information on the daily flow of waste water discharged by subcategory was provided by EGD, in millions of gallons per day. EGD calculated this by multiplying the daily flow from an average-sized model plant times the number of applicable plants (see Appendix I, Exhibit 2). Annual flows for each subcategory and option combination were calculated by multiplying daily flow by the number of operating days per year (provided in Appendix I, Exhibit 2).

- The concentration of each pollutant in the effluent for each subcategory and option combina-

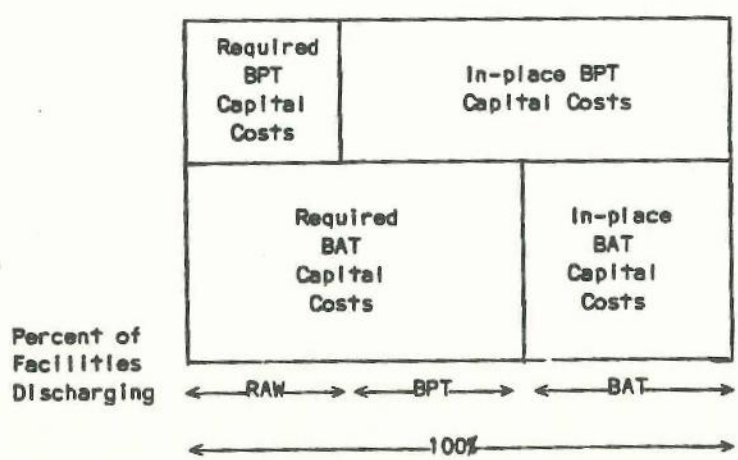
tion was provided in milligrams per liter (see Appendix I, Exhibit 2). These concentrations were based on data collection, observation, and judgment of EGD personnel and their contractors.

- For Phase I subcategories which include coke, iron, and steel-making and steel-casting processes, EGD supplied information in the form of annual loadings in kilograms per year (see Appendix I, Exhibit 3). This information was used directly instead of the flow and concentration data described above. However, the calculations performed by EGD to develop these data are identical to those developed by TBS for Phase II subcategories.

A substantial portion of iron and steel facilities have installed water pollution control equipment which currently meet the BPT, BAT, and PSES effluent guidelines analyzed in this report. Such equipment reduces the current effluent of the industry relative to its raw effluent and reduces the cost of complying with proposed effluent guidelines. Figure 1 indicates how data on in-place equipment (see Appendix I, Exhibit 4) was used to determine the percentage of facilities in a subdivision which discharge raw waste water and the percentage which discharge waste water meeting BPT and BAT effluent guidelines.

Figure 1

Calculating the Current Effluent Distribution in a Subdivision




These data are provided in Volume II, Appendix 1.

Costs and Loadings: No Equipment Currently In-Place

The information provided by EGD was converted into the format needed by the cost-effectiveness model. This format requires costs and loadings that would result assuming a given control option were selected by EPA. For simplicity, the costs and loadings for each subdivision are first presented assuming that no water pollution controls have been installed and the industry is currently discharging raw waste water. The following conversions were performed:

- Annual costs were multiplied by 1,000 to put them into units of thousands of dollars per year. In addition, BPT and PSES1 costs were added into the costs of BAT and the other PSES options respectively.

- Loadings for Phase I subcategories were multiplied by 2.204 pounds per kilogram and divided by 1,000 to put them into units of thousands of pounds per year.

- Loadings for Phase II subcategories were calculated by multiplying the following elements together:

  --Flow in millions of gallons per day,

  --Days of operation per year,

  --Concentration in milligrams per liter,

  --The conversion factor of 1 liter per 0.264 gallons,

  --The conversion factor of 2.204 pounds per million milligrams, and

  --0.001 to convert to thousands of pounds per year

- Finally, subcategory costs and loadings were aggregated into subdivisions. These are shown in Exhibit 1.

The resulting costs and loadings are shown in Volume II, Appendix II. Exhibit 2 summarizes the loadings of the raw effluent of the iron and steel industry by pollutant.

Cost and Loadings: With Equipment Currently In Place

The calculation of costs and loadings was repeated to account for pollution control equipment currently in place. These adjustments used the distribution of facilities discharging at each regulatory level described previously. The following assumptions were incorporated:

- Costs for water pollution control which have been incurred to date were credited toward achieving specified control options.
- Pollutant loadings at facilities currently achieving a greater level of control than would be required to achieve a control option are assumed to remain at their current levels.
- Pollutant loadings at all other facilities are assumed to be at the level of the specified control option.

The results of the adjustments described above are provided in Volume II, Appendix III. These results form the basis of the cost-effectiveness analysis described in Section C. Exhibit 3 presents a summary of the current loadings and the loadings if options selected by EPA were implemented for the iron and steel industry.

## C. COST-EFFECTIVENESS ANALYSIS

### Cost-Effectiveness Calculations

The cost-effectiveness analysis presented below has been calculated using two different methodologies. The first incorporates toxic weighting factors to facilitate differentiating the environmental result derived from each control option. Exhibits in this chapter refer to cost-effective analyses for direct dischargers using this method. Appendix II provides the same exhibits for indirect dischargers. The second method makes no distinction about varying toxicities among pollutants by using pounds of effluent removed instead of "pounds equivalent." Appendices III and IV show the results of the cost-effectiveness analysis using the second methodology. In both methodologies the removals of priority and non-conventional pollutants are considered. Conventional pollutants are not considered.

The toxic weighting system for direct dischargers is specified in Exhibit 3. Exhibit 4 presents the costs, loadings, cost-effectiveness, and percent "pounds equivalent" removal for the control options for direct dischargers in the iron and steel industry. This information is summarized graphically in Exhibits 5 and 6.

The cost-effectiveness for the selected options for direct dischargers averages $1.39 per "pounds equival." However, in specific subdivisions the cost-effectiveness of selected options varies from a low of $0.03 per "pounds equivalent" for the descaling subdivision to a high of $250,000 per "pounds equivalent" for the alkaline cleaning subdivision. (One subdivision, primary hot forming, has a negative cost-effectiveness of -$0.51 per "pounds equivalent" which stems from the value of the reuse of scale collected in the pollution control equipment.) In aggregate, the selected options will remove approximately 97.4 percent of the "pounds equivalent" in the current iron and steel industry effluent. Relative to the raw effluent, the selected options will increase removals from the current 86.0 percent of the raw effluent by an additional 13.6 percentage points to 99.6 percent of raw effluent.

## Cross-Industry Comparisons

A comparison of the cost-effectiveness of water pollution control regulations in the iron and steel industry with eight other industries for which regulations have been proposed is shown in Exhibits 7, 8, and 9. Only 2 of the 8 industries--inorganic chemicals and coil coating--have an average cost-effectiveness less than iron and steel.

## Comparison of Selected and Optimal Control Options

The cost-effectiveness analysis described above was performed using the selected options in each subdivision. However, the cost-effectiveness calculations also provide a method which can be useful in determining the economically efficient or optimal set of control options, i.e., the set which removes the largest number of "pounds equivalent" per dollar invested. This type of analysis ranks the pollution control options by their cost-effectiveness level, regardless of whether the specific options were proposed as the selected ones. The efficiency ranking can be used for comparison with the cost-effectiveness analysis for the selected options. In

this manner EPA can focus on those selected options which may not appear to be the most cost-effective choice based solely on cost or "pounds equivalent" removed. While the selected control options may not always be the most cost-effective choices, there may be compelling reasons for their choice. Thus, EPA will be in a position to substantiate its regulatory decisions on control option choices for the cost-effective areas and to present justification for choices where other decisions have been made.

The method used to develop the sets of options involves three steps. These steps ensure that in setting up a range of efficient sets of options, the more cost-effective options are included before the less cost-effective options. First, options in each subcategory which are suboptimal or not-cost-effective, as defined in Chapter II, are identified and eliminated from further analysis. Second, all remaining subdivision and option combinations are ranked from lowest to highest in order of their cost-effectiveness. Third, for each option identified on the list, an optimal set of options is specified as initially leaving each subdivision at its current level (with no additional pollution controls required) and then adding the requirements of all options listed prior to and including the identified option.

Two optimal sets of options are of particular interest: the set where the cost most closely approximates the cost of options selected by EPA and the set where the effluent "pounds equivalent" most closely approximates the "pounds equivalent" volume of options selected by EPA. The ordered list of subcategory and option combinations for the iron and steel industry direct dischargers is shown in Exhibit 10. Exhibit 11 indicates the options selected by EPA and the optimal sets of options with cost and effluent "pounds equivalent" most closely approximating the selected options. Exhibits 12 and 13 graph the cost and effluent "pounds equivalent" of all of the optimal sets of options.

EXHIBITS 1 TO 13

- DIRECT DISCHARGERS
- POUNDS EQUIVALENT ANALYSIS

Exhibit 1

SUBCATEGORIZATION OF THE IRON AND STEEL INDUSTRY
DIRECT DISCHARGERS

| Phase | Subdivision | Selected Option | Subcategory |
|---|---|---|---|
| I | Iron and Steel Cokemaking | BAT 1 | Iron and Steel Cokemaking |
| | Merchant Cokemaking | BAT 1 | Merchant Cokemaking |
| | Sintering | BAT 1 | Sintering |
| | Ironmaking | BAT 4 | Ironmaking |
| | Basic Oxygen Furnace-Semi-Wet | BPT | Semi-wet |
| | Basic Oxygen Furnace-Wet-Suppresed Combustion | BAT 2 | Wet-Suppressed Combustion |
| | Basic Oxygen Furnace-Open Combustion | BAT 2 | Wet-Open Combustion |
| | Open Hearth Furnace | BAT 2 | Wet |
| | Electric Arc Furnace-Semi-Wet | BPT | Semi-wet |
| | Electric Arc Furnace-Wet | BAT 2 | Wet |
| | Vacuum Degassing | BAT 1 | Vacuum Degassing |
| | Continuous Casting | BAT 1 | Continuous Casting |
| II | Hot Forming-Primary | BPT | Primary--No Scarfers--Carbon<br>Primary--Scarfers--Carbon<br>Primary--No Scarfers--Specialty<br>Primary--Scarfers--Specialty |
| | Hot Forming-Section | BPT | Section--Carbon<br>Section--Specialty |
| | Hot Forming-Strip/Sheet | BPT | Flat--Carbon--Strip/Sheet<br>Flat--Specialty--Strip/Sheet |
| | Hot Forming-Plate | BPT | Flat--Carbon--Plate<br>Flat--Specialty--Plate |
| | Hot Forming-Pipe and Tube | BPT | Pipe and Tube--Carbon<br>Pipe and Tube--Specialty |
| | Scale Removal | BPT | Oxidizing--Batch--Sheet/Plate<br>Oxidizing--Batch--Rod/Wire<br>Oxidizing--Batch--Pipe and Tube<br>Oxidizing--Continuous<br>Reducing--Batch<br>Reducing--Continuous |

continued

Exhibit 1 (continued)

| Phase | Subdivision | Selected Option | Subcategory |
|---|---|---|---|
| II | Alkaline Cleaning | BPT | Batch<br>Continuous |
| | Cold Rolling | BPT | Recirculation--Single Stand<br>Recirculation--Multi Stand<br>Combination<br>Direct Application--Single Stand<br>Direct Application--Multi Stand |
| | Cold Rolling-Pipe and Tube | BPT | Cold Pipe and Tube--Water<br>Cold Pipe and Tube--Oil |
| | Pickling--Sulfuric Acid | BPT | Strip/Sheet/Plate[1]<br>Rod/Wire/Coil[1]<br>Bar/Billet/Bloom[2]<br>Pipe and Tube[1] |
| | Pickling--Hydrochloric Acid | BPT | Strip/Sheet/Plate[1]<br>Rod/Wire/Coil[2]<br>Pipe and Tube[2] |
| | Pickling--Combination Acid | BPT | Batch Strip/Sheet/Plate[2]<br>Continuous Strip/Sheet/Plate[2]<br>Rod/Wire/Coil[2]<br>Bar/Bullet/Bloom[2]<br>Pipe and Tube[2] |
| | Hot Coating-No Scrubbers | BPT | Galvanizing--Strip/Sheet/Misc<br>Galvanizing--Wire Prod/Fasteners<br>Terne--Strip/Sheet/Misc<br>Other--Strip/Sheet/Misc<br>Other--Wire Prod/Fasteners |
| | Hot Coating-With Scrubbers | BAT 1 | Galvanizing--Strip/Sheet/Misc<br>Galvanizing--Wire Prod/Fasteners<br>Terne--Strip/Sheet/Misc<br>Other--Strip/Sheet/Misc<br>Other--Wire Prod/Fasteners |

[1]Includes two subcategories Neutralization and Acid Recovery.
[2]Neutralization only.

EXHIBIT 2

INDUST IRON AND STEEL - DIRECTS - NO PCE IN PLACE

| POLLUTANT | P/E Weight | LOAD (CURRENT) | LOAD (SELECTED) | P/E (CURRENT) | P/E (SELECTED) | PERCENT REMOVAL |
|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.011000 | 0.2528 | 0.0386 | 0.0028 | 0.0004 | 84.7126 |
| ACRYLONITRILE | 0.000740 | 87.9057 | 1.3854 | 0.0651 | 0.0010 | 98.4240 |
| AMMONIA | 0.280000 | 94834.8828 | 930.5359 | 26553.7676 | 260.5500 | 99.0188 |
| ANTIMONY | 0.003500 | 215.5432 | 23.9440 | 0.7544 | 0.0838 | 88.8913 |
| ARSENIC | 0.013000 | 747.6902 | 57.5273 | 9.7200 | 0.7479 | 92.3060 |
| BENZENE | 0.001100 | 2563.9153 | 2.7709 | 2.8203 | 0.0030 | 99.8919 |
| BERYLLIUM | 1.100000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CADMIUM | 14.000000 | 786.9921 | 6.4180 | 11017.8896 | 89.8524 | 99.1845 |
| CARBONTETRACHLORIDE | 0.000160 | 0.3981 | 0.3603 | 0.0001 | 0.0001 | 9.4890 |
| 1.1.1.TRICHLOROETHANE | 0.000310 | 2.6835 | 2.4324 | 0.0008 | 0.0008 | 9.3557 |
| CHLORINE | 2.800000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CHLOROFORM | 0.004500 | 45.6138 | 16.2766 | 0.2053 | 0.0732 | 64.3166 |
| 2.CHLOROPHENOL | 0.002800 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| 3CHROMIUM.TRIVALENT | 0.130000 | 21993.6172 | 93.2924 | 2859.1702 | 12.1280 | 99.5758 |
| 6CHROMIUM.HEXAVALENT | 19.000000 | 2579.1482 | 0.4950 | 49003.8164 | 9.4048 | 99.9808 |
| COPPER | 1.000000 | 30043.1328 | 101.8296 | 30043.1328 | 101.8296 | 99.6611 |
| CYANIDE | 1.600000 | 33227.8164 | 180.8888 | 53164.5078 | 289.4220 | 99.4556 |
| 2.4.DICHLOROPHENOL | 0.015000 | 24.5863 | 0.9733 | 0.3688 | 0.0146 | 96.0413 |
| 2.4.DIMETHYLPHENOL | 0.002600 | 489.2056 | 1.9336 | 1.2719 | 0.0050 | 99.6048 |
| 2.4.DINITROTOLUENE | 0.024000 | 22.2458 | 1.0409 | 0.5339 | 0.0250 | 95.3209 |
| ETHYLBENZENE | 0.000180 | 1099.4498 | 4.0753 | 0.1979 | 0.0007 | 99.6293 |
| FLUORANTHENE | 0.001400 | 266.2161 | 8.2843 | 0.3727 | 0.0116 | 96.8881 |
| IRON | 0.005600 | 671607.5625 | 199.1467 | 3761.0022 | 1.1152 | 99.9703 |
| ISOPHORONE | 0.000048 | 36.6274 | 0.6927 | 0.0018 | 0.0000 | 98.1087 |
| LEAD | 1.500000 | 43803.8359 | 57.3679 | 65705.7578 | 86.0519 | 99.8690 |
| MANGANESE | 0.003700 | 845.1559 | 4.2533 | 3.1271 | 0.0157 | 99.4967 |
| MERCURY | 28.000000 | 8.1123 | 0.1170 | 227.1455 | 3.2751 | 98.5582 |
| NAPHTHALENE | 0.009000 | 2326.1506 | 0.8036 | 20.9354 | 0.0072 | 99.9655 |
| NICKEL | 0.058000 | 36913.0703 | 103.6685 | 2140.9583 | 6.0128 | 99.7192 |
| NITRATES | 0.093000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| NITROPHENOLS | 0.037000 | 0.8067 | 0.0423 | 0.0298 | 0.0016 | 94.7541 |
| OIL.AND.GREASE | 0.000000 | 635915.6250 | 14272.9355 | 0.0000 | 0.0000 | 97.7555 |
| PENTACHLOROPHENOL | 1.800000 | 9.5971 | 0.3888 | 17.2748 | 0.6998 | 95.9489 |
| PHENOL | 0.002200 | 51162.2383 | 6.5505 | 112.5569 | 0.0144 | 99.9872 |
| PHTHALATE.ESTERS | 1.900000 | 366.2737 | 13.8546 | 695.9200 | 26.3237 | 96.2174 |
| SELENIUM | 0.160000 | 217.9776 | 8.7070 | 34.8764 | 1.3931 | 96.0056 |
| SILVER | 47.000000 | 41.1034 | 1.9819 | 1931.8579 | 93.1508 | 95.1782 |
| SULFIDES | 2.800000 | 10988.2090 | 27.7091 | 30766.9844 | 77.5856 | 99.7478 |
| TETRACHLOROETHYLENE | 0.006700 | 4.6690 | 1.8128 | 0.0313 | 0.0121 | 61.1745 |
| THALLIUM | 0.140000 | 24.6736 | 2.8147 | 3.4543 | 0.3941 | 88.5921 |
| TOLUENE | 0.000320 | 1834.0762 | 5.7104 | 0.5869 | 0.0018 | 99.6887 |
| TRICHLOROETHYLENE | 0.000260 | 3.1306 | 0.0000 | 0.0008 | 0.0000 | 100.0000 |
| TSS | 0.000000 | 20901246.0000 | 47792.6523 | 0.0000 | 0.0000 | 99.7713 |
| ZINC | 0.120000 | 113820.9766 | 114.8775 | 13658.5166 | 13.7853 | 99.8991 |
| TOTAL LOAD | | 22660206.0000 | 64050.5898 | | | 99.7173 |
| TOTAL HAZARD | | | | 291739.6875 | 1073.9943 | 99.6319 |

Source: TBS CE Model

*P/E : "pounds equivalent"

EXHIBIT 3

INDUSTF IRON AND STEEL - DIRECTS - WITH PCE IN PLACE

| POLLUTANT | P/E WEIGHT | LOAD (CURRENT) | LOAD (SELECTED) | P/E (CURRENT) | P/E (SELECTED) | PERCENT REMOVAL |
|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.011000 | 0.0622 | 0.0386 | 0.0007 | 0.0004 | 37.8708 |
| ACRYLONITRILE | 0.000740 | 28.8206 | 1.3854 | 0.0213 | 0.0010 | 95.1929 |
| AMMONIA | 0.280000 | 22064.6504 | 930.5359 | 6178.1021 | 260.5500 | 95.7827 |
| ANTIMONY | 0.003500 | 34.7548 | 22.9980 | 0.1216 | 0.0805 | 33.8279 |
| ARSENIC | 0.013000 | 132.2911 | 56.3653 | 1.7198 | 0.7327 | 57.3930 |
| BENZENE | 0.001100 | 775.2123 | 2.7709 | 0.8527 | 0.0030 | 99.6426 |
| BERYLLIUM | 1.100000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CADMIUM | 14.000000 | 37.1002 | 6.2518 | 519.4026 | 87.5254 | 83.1488 |
| CARBONTETRACHLORIDE | 0.000160 | 0.3645 | 0.3603 | 0.0001 | 0.0001 | 1.1401 |
| 1.1.1.TRICHLOROETHANE | 0.000310 | 2.4601 | 2.4324 | 0.0008 | 0.0008 | 1.1226 |
| CHLORINE | 2.800000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CHLOROFORM | 0.004500 | 22.3071 | 16.2717 | 0.1004 | 0.0732 | 27.0557 |
| 2.CHLOROPHENOL | 0.002800 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| 3CHROMIUM.TRIVALENT | 0.130000 | 2201.0652 | 86.4371 | 286.1385 | 11.2368 | 96.0729 |
| 6CHROMIUM.HEXAVALENT | 19.000000 | 432.0833 | 0.4950 | 8209.5820 | 9.4048 | 99.8854 |
| COPPER | 1.000000 | 3553.4741 | 84.0093 | 3553.4741 | 84.0093 | 97.6359 |
| CYANIDE | 1.600000 | 3142.3535 | 180.8160 | 5027.7656 | 289.3056 | 94.2458 |
| 2.4.DICHLOROPHENOL | 0.015000 | 3.4935 | 0.9733 | 0.0524 | 0.0146 | 72.1400 |
| 2.4.DIMETHYLPHENOL | 0.002600 | 126.6938 | 1.9336 | 0.3294 | 0.0050 | 98.4738 |
| 2.4.DINITROTOLUENE | 0.024000 | 8.0759 | 1.0361 | 0.1938 | 0.0249 | 87.1710 |
| ETHYLBENZENE | 0.000180 | 339.3421 | 4.0753 | 0.0611 | 0.0007 | 98.7991 |
| FLUORANTHENE | 0.001400 | 39.8377 | 8.2795 | 0.0558 | 0.0116 | 79.2170 |
| IRON | 0.005600 | 39263.5195 | 186.8216 | 219.8757 | 1.0462 | 99.5242 |
| ISOPHORONE | 0.000048 | 15.9477 | 0.6927 | 0.0008 | 0.0000 | 95.6563 |
| LEAD | 1.500000 | 3965.7786 | 52.5662 | 5948.6680 | 78.8493 | 98.6745 |
| MANGANESE | 0.003700 | 219.5828 | 4.2533 | 0.8125 | 0.0157 | 98.0630 |
| MERCURY | 28.000000 | 0.3101 | 0.1170 | 8.6815 | 3.2751 | 62.2755 |
| NAPHTHALENE | 0.009000 | 668.3313 | 0.8036 | 6.0150 | 0.0072 | 99.8798 |
| NICKEL | 0.058000 | 4232.7651 | 94.0088 | 245.5004 | 5.4525 | 97.7790 |
| NITRATES | 0.093000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| NITROPHENOLS | 0.037000 | 0.0423 | 0.0423 | 0.0016 | 0.0016 | 0.0000 |
| OIL.AND.GREASE | 0.000000 | 81973.6406 | 11667.0195 | 0.0000 | 0.0000 | 85.7673 |
| PENTACHLOROPHENOL | 1.800000 | 3.2164 | 0.3888 | 5.7895 | 0.6998 | 87.9124 |
| PHENOL | 0.002200 | 13294.3916 | 6.5505 | 29.2477 | 0.0144 | 99.9507 |
| PHTHALATE.ESTERS | 1.900000 | 160.9710 | 13.8546 | 305.8449 | 26.3237 | 91.3931 |
| SELENIUM | 0.160000 | 23.9110 | 8.7070 | 3.8258 | 1.3931 | 63.5858 |
| SILVER | 47.000000 | 2.6340 | 1.9127 | 123.7979 | 89.8973 | 27.3838 |
| SULFIDES | 2.800000 | 3311.6279 | 27.7091 | 9272.5576 | 77.5856 | 99.1633 |
| TETRACHLOROETHYLENE | 0.006700 | 2.0904 | 1.8031 | 0.0140 | 0.0121 | 13.7462 |
| THALLIUM | 0.140000 | 3.3301 | 2.8147 | 0.4662 | 0.3941 | 15.4751 |
| TOLUENE | 0.000320 | 560.5742 | 5.7104 | 0.1794 | 0.0018 | 98.9813 |
| TRICHLOROETHYLENE | 0.000260 | 0.3131 | 0.0000 | 0.0001 | 0.0000 | 100.0000 |
| TSS | 0.000000 | 1897459.6250 | 40300.0352 | 0.0000 | 0.0000 | 97.8761 |
| ZINC | 0.120000 | 6642.2817 | 101.9566 | 797.0738 | 12.2348 | 98.4650 |
| TOTAL LOAD | | 2084749.2500 | 53885.2344 | | | 97.4153 |
| TOTAL HAZARD | | | | 40746.3320 | 1040.1848 | 97.4472 |

Source: TBS CE Model

*P/E : "pounds equivalent"

EXHIBIT 4

IRON AND STEEL - DIRECTS
COST-EFFECTIVENESS

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000 P/E) | #CE INC |
|---|---|---|---|---|---|---|
| FURNACE. COKE | CURRENT | - | 0.00 | 0.0 | 15660.7 | - |
| | BPT | 0.8386 | 84.01 | 11033.6 | 2504.2 | CURRENT |
| | *BAT1 | 3.1623 | 97.06 | 17495.8 | 460.7 | BPT |
| | BAT2 | 1739.5809 | 97.06 | 19265.8 | 459.6 | BAT1 |
| | BAT3 | 65.1023 | 97.78 | 24895.8 | 347.0 | BAT1 |
| MERCHANT. COKE | CURRENT | - | 0.00 | 0.0 | 869.0 | - |
| | BPT | 0.9212 | 66.24 | 530.2 | 293.4 | CURRENT |
| | *BAT1 | 3.3487 | 93.19 | 1314.6 | 59.2 | BPT |
| | BAT2 | 1454.3153 | 93.21 | 1504.6 | 59.0 | BAT1 |
| | BAT3 | 57.5426 | 94.87 | 2154.6 | 44.6 | BAT1 |
| SINTERING | CURRENT | - | 0.00 | 0.0 | 120.7 | - |
| | BPT | 15.4248 | 50.06 | 931.7 | 60.3 | CURRENT |
| | *BAT1 | 89.7343 | 57.09 | 1693.1 | 51.8 | BPT |
| | BAT2 | 65.8720 | 57.51 | 1523.9 | 51.3 | BPT |
| | BAT3 | 66.4910 | 39.18 | 3143.1 | 73.4 | CURRENT |
| | BAT4 | 168.3539 | 39.25 | 7973.1 | 73.3 | CURRENT |
| | BAT5 | 284.7399 | 100.00 | 16123.1 | 0.0 | BAT2 |
| BLAST. FURNACES | CURRENT | - | 0.00 | 0.0 | 5807.0 | - |
| | BPT | 0.5110 | 75.81 | 2249.5 | 1404.4 | CURRENT |
| | BAT2 | 4.3719 | 80.65 | 3476.2 | 1123.8 | BPT |
| | BAT3 | 11.2224 | 81.61 | 4102.6 | 1068.0 | BAT2 |
| | *BAT4 | 6.3603 | 98.29 | 9992.5 | 99.3 | BAT2 |
| | BAT5 | 27182.7441 | 98.30 | 19862.5 | 98.9 | BAT4 |
| | BAT6 | 245.6936 | 100.00 | 34392.5 | 0.0 | BAT4 |
| BOF. SEMI. WET | CURRENT | - | 0.00 | 0.0 | 39.9 | - |
| | *BPT | 7.4225 | 100.00 | 296.0 | 0.0 | CURRENT |
| BOF. SUPPRESSED. COMBUSTIO | CURRENT | - | 0.00 | 0.0 | 10.3 | - |
| | BPT | 0.0000 | 0.00 | 0.0 | 10.3 | CURRENT |
| | BAT1 | 98.1950 | 8.07 | 81.6 | 9.5 | CURRENT |
| | *BAT2 | 57.1739 | 18.19 | 107.1 | 8.4 | CURRENT |
| | BAT3 | 459.3889 | 100.00 | 3977.1 | 0.0 | BAT2 |
| BOF. OPEN. COMBUSTION | CURRENT | - | 0.00 | 0.0 | 237.1 | - |
| | BPT | 1.5299 | 72.94 | 264.6 | 64.1 | CURRENT |
| | BAT1 | 94.9523 | 76.62 | 1092.6 | 55.4 | BPT |
| | *BAT2 | 34.7962 | 82.20 | 1028.2 | 42.2 | BPT |
| | BAT3 | 484.7835 | 100.00 | 21488.2 | 0.0 | BAT2 |
| OPEN. HEARTH. WET | CURRENT | - | 0.00 | 0.0 | 35.3 | - |
| | BPT | 0.0000 | 0.00 | 0.0 | 35.3 | CURRENT |
| | BAT1 | 39.1851 | 20.25 | 280.0 | 28.1 | CURRENT |
| | *BAT2 | 9.1479 | 89.86 | 290.0 | 3.6 | CURRENT |
| | BAT3 | 1489.9972 | 100.00 | 5620.0 | 0.0 | BAT2 |

*P/E: "pounds equivalent"

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COS ($1000'S) | P/E (1000 P/E) | #INC. TO |
|---|---|---|---|---|---|---|
| EAF. SEMI. WET | CURRENT | - | 0.00 | 0.0 | 62.0 | - |
| | *BPT | 0.6383 | 100.00 | 39.6 | 0.0 | CURRENT |
| EAF. WET | CURRENT | - | 0.00 | 0.0 | 102.8 | - |
| | BPT | 0.0000 | 0.00 | 0.0 | 102.8 | CURRENT |
| | BAT1 | 9.3161 | 12.68 | 121.5 | 89.8 | CURRENT |
| | *BAT2 | 2.4605 | 80.03 | 202.5 | 20.5 | CURRENT |
| | BAT3 | 162.1771 | 100.00 | 3532.5 | 0.0 | BAT2 |
| VACUUM. DEGASSING | CURRENT | - | 0.00 | 0.0 | 112.1 | - |
| | BPT | 10.9680 | 97.81 | 1202.5 | 2.5 | CURRENT |
| | *BAT1 | 67.5263 | 99.35 | 1318.9 | 0.7 | BPT |
| | BAT2 | 7854.8042 | 100.00 | 7028.9 | 0.0 | BAT1 |
| CONTINUOUS. CASTING | CURRENT | - | 0.00 | 0.0 | 20.0 | - |
| | BPT | 58.9858 | 74.15 | 876.0 | 5.2 | CURRENT |
| | *BAT1 | 51.0636 | 96.08 | 982.6 | 0.8 | CURRENT |
| | BAT2 | 7356.0288 | 100.00 | 6762.6 | 0.0 | BAT1 |
| HOT. FORMING. PRIMARY | CURRENT | - | 0.00 | 0.0 | 4730.7 | - |
| | *BPT | 0.0000 | 99.43 | -2410.0 | 26.8 | CURRENT |
| | BAT1 | 639.0486 | 99.93 | 12590.0 | 3.3 | BPT |
| | BAT2 | 20866.9316 | 100.00 | 81665.5 | 0.0 | BAT1 |
| HOT. FORMING. SECTION | CURRENT | - | 0.00 | 0.0 | 2287.2 | - |
| | *BPT | 0.9574 | 98.96 | 2167.1 | 23.8 | CURRENT |
| | BAT1 | 562.3107 | 99.88 | 13995.8 | 2.8 | BPT |
| | BAT2 | 21104.5098 | 100.00 | 72425.8 | 0.0 | BAT1 |
| HOT. FORMING. STRIP. SHEET | CURRENT | - | 0.00 | 0.0 | 709.4 | - |
| | *BPT | 1.5786 | 94.79 | 1061.5 | 37.0 | CURRENT |
| | BAT1 | 481.0745 | 99.35 | 16639.6 | 4.6 | BPT |
| | BAT2 | 20064.2402 | 100.00 | 108719.6 | 0.0 | BAT1 |
| HOT. FORMING. PLATE | CURRENT | - | 0.00 | 0.0 | 624.7 | - |
| | *BPT | 0.3511 | 99.57 | 218.4 | 2.7 | CURRENT |
| | BAT1 | 751.5369 | 99.94 | 1934.5 | 0.4 | BPT |
| | BAT2 | 19618.8633 | 100.00 | 9314.6 | 0.0 | BAT1 |
| HOT. FORMING. PIPE. TUBE | CURRENT | - | 0.00 | 0.0 | 250.7 | - |
| | *BPT | 3.9614 | 99.13 | 984.6 | 2.2 | CURRENT |
| | BAT1 | 1195.3143 | 99.82 | 3072.1 | 0.4 | BPT |
| | BAT2 | 29444.9434 | 100.00 | 16142.1 | 0.0 | BAT1 |
| DESCALING | CURRENT | - | 0.00 | 0.0 | 6662.0 | - |
| | *BPT | 0.0317 | 99.87 | 210.8 | 8.5 | CURRENT |
| | BAT1 | 195.8316 | 99.88 | 317.2 | 7.9 | BPT |
| | BAT2 | 622.6780 | 100.00 | 5261.2 | 0.0 | BAT1 |
| ALKALINE. CLEANING | CURRENT | - | 0.00 | 0.0 | 10.8 | - |
| | *BPT | ********** | 0.01 | 145.6 | 10.8 | CURRENT |
| | BAT1 | 116.1219 | 89.91 | 1129.6 | 1.1 | CURRENT |
| | BAT2 | 6232.0410 | 100.00 | 7905.6 | 0.0 | BAT1 |

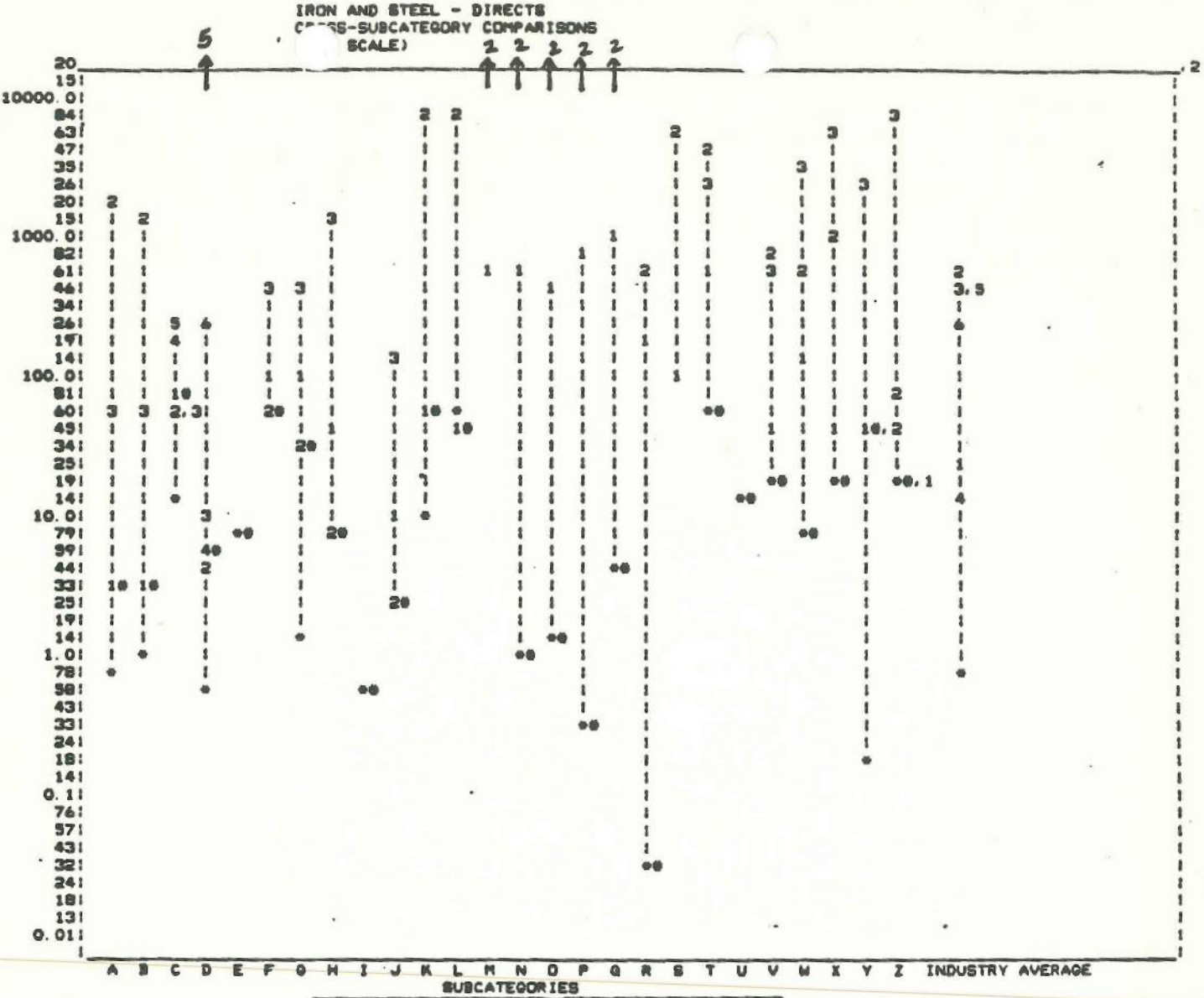
P/E: "pounds equivalent"

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000 P/E) | #INC. TO |
|---|---|---|---|---|---|---|
| COLD. ROLLING | CURRENT | - | 0.00 | 0.0 | 39.1 | - |
| | *BPT | 63.0691 | 33.51 | 826.1 | 26.0 | CURRENT |
| | BAT1 | 536.9146 | 41.88 | 2583.9 | 22.7 | BPT |
| | BAT2 | 4980.1016 | 41.67 | 16713.9 | 22.8 | BPT |
| | BAT3 | 2313.1755 | 100.00 | 55133.9 | 0.0 | BAT1 |
| COLD. ROLLING. PIPE. TUBE | CURRENT | - | 0.00 | 0.0 | 13.1 | - |
| | *BPT | 14.0806 | 100.00 | 185.0 | 0.0 | CURRENT |
| PICKLING. H2SO4 | CURRENT | - | 0.00 | 0.0 | 262.5 | - |
| | *BPT | 20.1940 | 72.76 | 3857.4 | 71.5 | CURRENT |
| | BAT1 | 46.2437 | 93.00 | 6315.0 | 18.4 | BPT |
| | BAT2 | 894.3714 | 93.24 | 6885.0 | 17.7 | BAT1 |
| | BAT3 | 575.1171 | 100.00 | 16885.0 | 0.0 | BAT1 |
| PICKLING. HCL | CURRENT | - | 0.00 | 0.0 | 147.1 | - |
| | *BPT | 9.0228 | 79.60 | 1056.3 | 30.0 | CURRENT |
| | BAT1 | 166.5331 | 96.78 | 5264.5 | 4.7 | BPT |
| | BAT2 | 669.3497 | 97.37 | 5844.5 | 3.9 | BAT1 |
| | BAT3 | 3719.6328 | 100.00 | 20254.5 | 0.0 | BAT2 |
| PICKLING. COMBINATION | CURRENT | - | 0.00 | 0.0 | 52.7 | - |
| | *BPT | 16.6912 | 73.44 | 645.6 | 14.0 | CURRENT |
| | BAT1 | 45.9609 | 95.64 | 1183.0 | 2.3 | BPT |
| | BAT2 | 1064.4625 | 96.35 | 1577.9 | 1.9 | BAT1 |
| | BAT3 | 6612.0625 | 100.00 | 14297.9 | 0.0 | BAT2 |
| HOT. COATING. SCRUBBER | CURRENT | - | 0.00 | 0.0 | 1848.2 | - |
| | BPT | 0.1665 | 98.58 | 303.4 | 26.3 | CURRENT |
| | *BAT1 | 46.9075 | 98.68 | 392.0 | 24.4 | BPT |
| | BAT2 | 41.5145 | 99.84 | 1273.0 | 3.0 | BPT |
| | BAT3 | 2797.8311 | 100.00 | 9564.0 | 0.0 | BAT2 |
| HOT. COATING. NO. SCRUB | CURRENT | - | 0.00 | 0.0 | 31.2 | - |
| | *BPT | 18.9706 | 50.60 | 299.5 | 15.4 | CURRENT |
| | BAT1 | 18.0513 | 53.18 | 299.5 | 14.6 | CURRENT |
| | BAT2 | 69.7931 | 96.81 | 1249.5 | 1.0 | BAT1 |
| | BAT3 | 9188.9170 | 100.00 | 10395.5 | 0.0 | BAT2 |
| TOTALS | CURRENT | - | 0.00 | 0.0 | 40746.3 | - |
| | BPT | 0.7500 | 88.28 | 26975.0 | 4777.4 | - |
| | BAT1 | 26.4607 | 97.52 | 90093.4 | 863.6 | - |
| | BAT2 | 584.1290 | 95.52 | 376167.8 | 1818.8 | - |
| | BAT3 | 427.7591 | 93.92 | 195444.6 | 1533.0 | - |
| | BAT4 | 13.5177 | 97.09 | 17965.6 | 172.6 | - |
| | BAT5 | 473.8861 | 98.33 | 35985.6 | 98.9 | - |
| | BAT6 | 245.6934 | 100.00 | 34392.5 | 0.0 | - |
| SELECTED OPTIONS | * | 1.3938 | 97.45 | 44400.7 | 1040.2 | - |

* SELECTED OPTIONS
\# INDICATES INCREMENT FROM WHICH COST-EFFECTIVENESS IS CALCULATED.

Source: TBS CE Model
*P/E: "pounds equivalent"

IRON AND STEEL - DIRECTS
CROSS-SUBCATEGORY COMPARISONS
SCALE)




Source: TBS CE Model

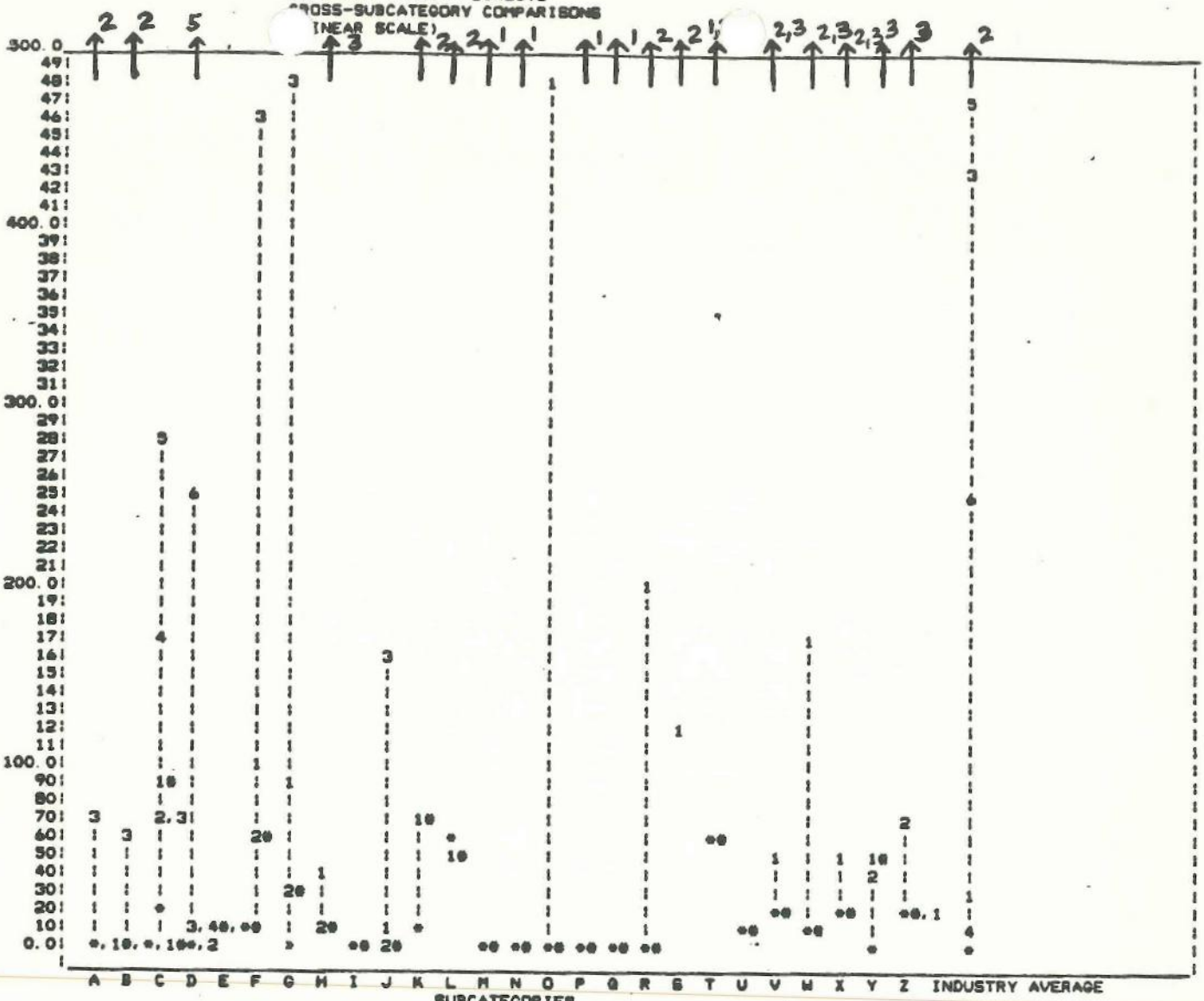
SUBCATEGORIES (COST-EFF)

| | | |
|---|---|---|
| A | FURNACE. COKE | ( 3.162276) |
| B | MERCHANT. COKE | ( 3.348727) |
| C | SINTERING | ( 89.734283) |
| D | BLAST. FURNACES | ( 6.360327) |
| E | BOF. SEMI. WET | ( 7.422459) |
| F | BOF. SUPPRESSED. COMBUSTION | ( 37.173885) |
| G | BOF. OPEN. COMBUSTION | ( 34.796173) |
| H | OPEN. HEARTH. WET | ( 9.147942) |
| I | EAF. SEMI. WET | ( 0.638324) |
| J | EAF. WET | ( 2.460512) |
| K | VACUUM. DEGASSING | ( 67.926306) |
| L | CONTINUOUS. CASTING | ( 91.063583) |
| M | HOT. | (.....) |
| N | HOT. FORMING. SECTION | ( 0.957439) |
| O | HOT. FORMING. STRIP. SHEET | ( 1.578631) |
| P | HOT. FORMING. PLATE | ( 0.391118) |
| Q | HOT. FORMING. PIPE. TUBE | ( 3.961429) |
| R | DESCALING | ( 0.031682) |
| S | ALKALINE. CLEANING | (.....) |
| T | COLD. ROLLING | ( 63.069061) |
| U | COLD. ROLLING. PIPE. TUBE | ( 14.080642) |
| V | PICKLING. H2SO4 | ( 20.193996) |
| W | PICKLING. HCL | ( 9.022823) |
| X | PICKLING. COMBINATION | ( 16.691187) |
| Y | HOT. COATING. SCRUBBER | ( 46.907459) |
| Z | HOT. COATING. NO. SCRUB | ( 18.970594) |
| * | INDUSTRY AVERAGE | |

CONTROL OPTIONS

| | |
|---|---|
| * | BPT |
| 1 | BAT1 |
| 2 | BAT2 |
| 3 | BAT3 |
| 4 | BAT4 |
| 5 | BAT5 |
| 6 | BAT6 |
| • | SELECTED OPTION |

IRON AND STEEL - DIRECTS
CROSS-SUBCATEGORY COMPARISONS
(LINEAR SCALE)




Source: TBS CE Model

SUBCATEGORIES (COST-EFF)

| | | |
|---|---|---|
| A | FURNACE. COKE | ( 3.162276) |
| B | MERCHANT. COKE | ( 3.348727) |
| C | SINTERING | ( 89.734283) |
| D | BLAST. FURNACES | ( 6.360327) |
| E | BOF. SEMI. WET | ( 7.422459) |
| F | BOF. SUPPRESSED. COMBUSTION | ( 57.173885) |
| G | BOF. OPEN. COMBUSTION | ( 34.796173) |
| H | OPEN. HEARTH. WET | ( 9.147942) |
| I | EAF. SEMI. WET | ( 0.638324) |
| J | EAF. WET | ( 2.460512) |
| K | VACUUM. DEGASSING | ( 67.526306) |
| L | CONTINUOUS. CASTING | ( 91.063583) |
| M | HOT. | (.....) |
| N | HOT. FORMING. SECTION | ( 0.957439) |
| O | HOT. FORMING. STRIP. SHEET | ( 1.578631) |
| P | HOT. FORMING. PLATE | ( 0.351118) |
| Q | HOT. FORMING. PIPE. TUBE | ( 3.961429) |
| R | DESCALING | ( 0.031682) |
| S | ALKALINE. CLEANING | (.....) |
| T | COLD. ROLLING | ( 63.069061) |
| U | COLD. ROLLING. PIPE. TUBE | ( 14.080642) |
| V | PICKLING. H2SO4 | ( 20.193996) |
| W | PICKLING. HCL | ( 9.022923) |
| X | PICKLING. COMBINATION | ( 16.691187) |
| Y | HOT. COATING. SCRUBBER | ( 46.907459) |
| Z | HOT. COATING. NO. SCRUB | ( 18.970594) |
| * | INDUSTRY AVERAGE | |

CONTROL OPTIONS

| | |
|---|---|
| * | BPT |
| 1 | BAT1 |
| 2 | BAT2 |
| 3 | BAT3 |
| 4 | BAT4 |
| 5 | BAT5 |
| 6 | BAT6 |

EXHIBIT 7

DIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LOG SCALE)

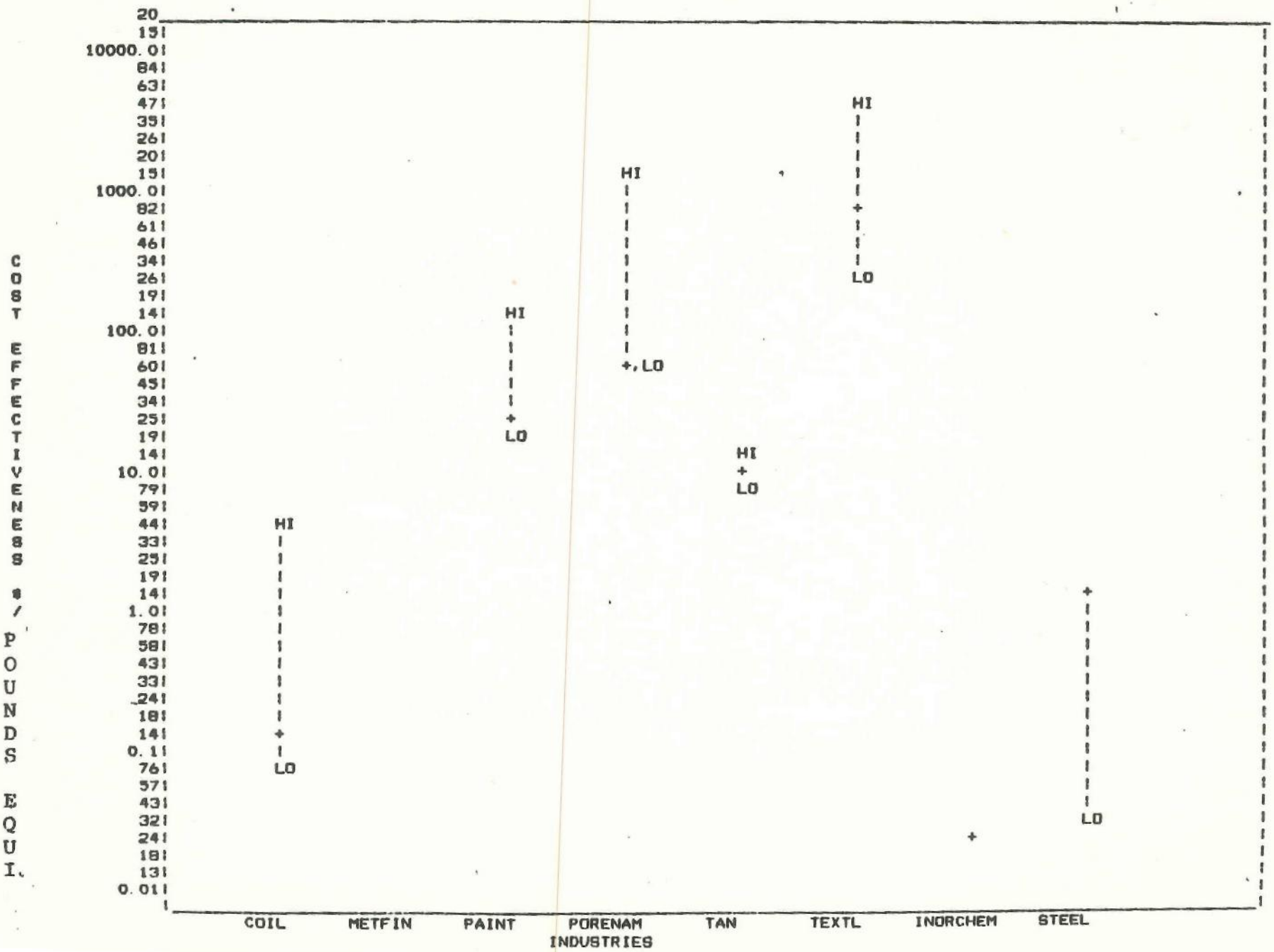


EXHIBIT 8

DIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LINEAR SCALE)

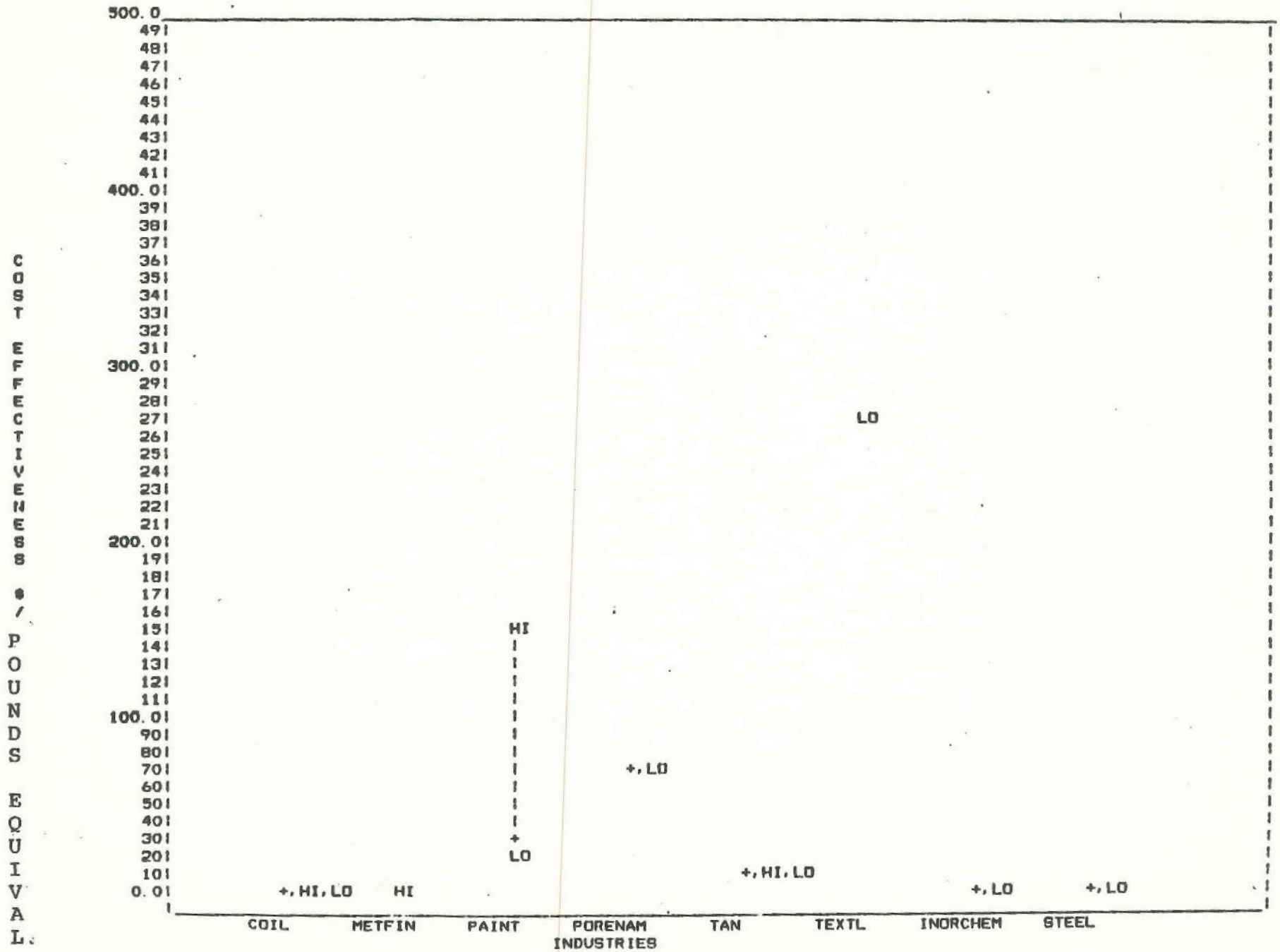


Exhibit 9

CROSS INDUSTRY COMPARISON
COST-EFFECTIVENESS OF SELECTED OPTIONS
DIRECT DISCHARGERS

(1978 dollars per hazard unit)

| Industry | Low | Average | High |
|---|---|---|---|
| Coil Coating | $ .07 | $ .12 | $ 4.49 |
| Inorganic Chemicals | .01 | .02 | 40,987.34 |
| Metal Finishing | ----- | at selected | option------ |
| Paint | 19.67 | 28.85 | 152.50 |
| Porcelain Enameling | 67.34 | 68.20 | 1,640.06 |
| Steel | .03 | 1.39 | 250,282.73 |
| Tanning | 7.64 | 11.56 | 13.11 |
| Textiles | 273.85 | 828.42 | 4,340.56 |

Source: TBS CE Model.

INCREMENTAL COST-EFFECTIVENESS ANAL'

| NO. | INDUSTRY | SUB-CATEGORY | INCREMENTAL OPTION | COST-EFF ($/HU) | EFFLUENT (MM HU) | COST ($MM) |
|---|---|---|---|---|---|---|
| 0 | ALL INDUSTRY | | CURRENT | 0.000 | 40.7455 | 0.0000 |
| 1 | STEEL DIR | HOT. FORMING PRIMA | *BPT | -0.512 | 36.0413 | -2.4100 |
| 2 | STEEL DIR | DESCALING | *BPT | 0.032 | 29.3878 | -2.1992 |
| 3 | STEEL DIR | HOT COATING SCRUBB | BPT | 0.167 | 27.5661 | -1.8958 |
| | STEEL DIR | HOT. FORMING PLATE | *BPT | 0.391 | 26.9440 | -1.6774 |
| | STEEL DIR | BLAST FURNACES | BPT | 0.511 | 22.5410 | 0.5716 |
| 6 | STEEL DIR | EAF SEMI. WET | *BPT | 0.638 | 22.4790 | 0.6112 |
| 7 | STEEL DIR | FURNACE. COKE | BPT | 0.839 | 9.3230 | 11.6412 |
| 8 | STEEL DIR | MERCHANT. COKE | BPT | 0.921 | 8.7474 | 12.1714 |
| 9 | STEEL DIR | HOT. FORMING. SECTIO | *BPT | 0.957 | 6.4842 | 14.3384 |
| 10 | STEEL DIR | BOF OPEN. COMBUSTIO | BPT | 1.530 | 6.3113 | 14.6030 |
| 11 | STEEL DIR | HOT. FORMING. STRIP | *BPT | 1.579 | 5.6388 | 15.6640 |
| 12 | STEEL DIR | EAF WET | *BAT2 | 2.461 | 5.5566 | 15.8665 |
| 13 | STEEL DIR | FURNACE. COKE | *BAT1 | 3.162 | 3.5133 | 22.3365 |
| 14 | STEEL DIR | MERCHANT. COKE | *BAT1 | 3.349 | 3.2790 | 23.1213 |
| 15 | STEEL DIR | HOT. FORMING PIPE. T | *BPT | 3.961 | 3.0305 | 24.1059 |
| 16 | STEEL DIR | BLAST. FURNACES | BAT2 | 4.372 | 2.7505 | 25.3329 |
| 17 | STEEL DIR | BLAST. FURNACES | *BAT4 | 6.360 | 1.7258 | 31.8489 |
| 18 | STEEL DIR | BOF. SEMI WET | *BPT | 7.422 | 1.6859 | 32.1449 |
| 19 | STEEL DIR | PICKLING HCL | *BPT | 9.023 | 1.5689 | 33.2009 |
| 20 | STEEL DIR | OPEN HEARTH. WET | *BAT2 | 9.148 | 1.5372 | 33.4909 |
| 21 | STEEL DIR | VACUUM DEGASSING | BPT | 10.970 | 1.4275 | 34.6939 |
| 22 | STEEL DIR | COLD. ROLLING. PIPE. | *BPT | 14.080 | 1.4144 | 34.8789 |
| 23 | STEEL DIR | SINTERING | BPT | 15.420 | 1.3539 | 35.8106 |
| 24 | STEEL DIR | PICKLING. COMBINATI | *BPT | 16.690 | 1.3152 | 36.4562 |
| 25 | STEEL DIR | HOT. COATING. NO. SCR | BAT1 | 18.050 | 1.2987 | 36.7557 |
| 26 | STEEL DIR | PICKLING. H2SO4 | *BPT | 20.190 | 1.1077 | 40.6127 |
| 27 | STEEL DIR | BOF. OPEN. COMBUSTIO | *BAT2 | 34.800 | 1.0857 | 41.3761 |
| 28 | STEEL DIR | HOT. COATING. SCRUBB | BAT2 | 41.510 | 1.0624 | 42.3457 |
| 29 | STEEL DIR | PICKLING COMBINATI | BAT1 | 45.960 | 1.0507 | 42.8831 |
| 30 | STEEL DIR | PICKLING. H2SO4 | BAT1 | 46.240 | 0.9975 | 45.3411 |
| 31 | STEEL DIR | CONTINUOUS. CASTING | *BAT1 | 51.060 | 0.9783 | 46.3237 |
| 32 | STEEL DIR | BOF. SUPPRESSED. COM | *BAT2 | 57.170 | 0.9764 | 46.4308 |
| 33 | STEEL DIR | MERCHANT. COKE | BAT3 | 57.940 | 0.9618 | 47.2708 |
| 34 | STEEL DIR | COLD. ROLLING | *BPT | 63.070 | 0.9487 | 48.0969 |
| 35 | STEEL DIR | FURNACE. COKE | BAT3 | 65.100 | 0.8350 | 55.4969 |
| 36 | STEEL DIR | SINTERING | BAT2 | 65.870 | 0.8260 | 56.0892 |
| 37 | STEEL DIR | VACUUM DEGASSING | *BAT1 | 67.530 | 0.8243 | 56.2052 |
| 38 | STEEL DIR | HOT. COATING. NO. SCR | BAT2 | 69.790 | 0.8107 | 57.1547 |
| 39 | STEEL DIR | ALKALINE. CLEANING | BAT1 | 116.100 | 0.8010 | 58.2807 |
| 40 | STEEL DIR | EAF WET | BAT3 | 162.200 | 0.7805 | 61.6112 |
| 41 | STEEL DIR | PICKLING HCL | BAT1 | 166.500 | 0.7552 | 65.8202 |
| 42 | STEEL DIR | DESCALING | BAT1 | 195.800 | 0.7546 | 65.9266 |
| | STEEL DIR | BLAST FURNACES | BAT6 | 245.700 | 0.6553 | 90.3246 |
| | STEEL DIR | SINTERING | BAT5 | 284.700 | 0.6041 | 104.9206 |
| 45 | STEEL DIR | BOF. SUPPRESSED. COM | BAT3 | 459.400 | 0.5956 | 108.7905 |
| 46 | STEEL DIR | HOT. FORMING. STRIP. | BAT1 | 481.100 | 0.5633 | 124.3695 |
| 47 | STEEL DIR | BOF. OPEN. COMBUSTIO | BAT3 | 484.800 | 0.5211 | 144.8315 |
| 48 | STEEL DIR | COLD ROLLING | BAT1 | 536.900 | 0.5178 | 146.5894 |
| 49 | STEEL DIR | HOT. FORMING. SECTIO | BAT1 | 562.300 | 0.4968 | 158.4224 |
| 50 | STEEL DIR | PICKLING. H2SO4 | BAT3 | 575.100 | 0.4784 | 168.9874 |
| 51 | STEEL DIR | DESCALING | BAT2 | 622.700 | 0.4704 | 173.9312 |
| 52 | STEEL DIR | HOT FORMING PRIMA | BAT1 | 639.000 | 0.4470 | 188.9312 |
| 53 | STEEL DIR | PICKLING HCL | BAT2 | 669.300 | 0.4461 | 189.5112 |
| 54 | STEEL DIR | HOT. FORMING PLATE | BAT1 | 751.500 | 0.4438 | 191.2278 |
| 55 | STEEL DIR | PICKLING. COMBINATI | BAT2 | 1064.000 | 0.4434 | 191.6228 |
| 56 | STEEL DIR | HOT FORMING PIPE. T | BAT1 | 1195.000 | 0.4417 | 193.7102 |
| 57 | STEEL DIR | OPEN HEARTH WET | BAT3 | 1490.000 | 0.4381 | 199.0402 |
| 58 | STEEL DIR | COLD ROLLING | BAT3 | 2313.000 | 0.4154 | 251.5862 |
| 59 | STEEL DIR | HOT COATING. SCRUBB | BAT3 | 2798.000 | 0.4124 | 259.8772 |
| 60 | STEEL DIR | PICKLING. HCL | BAT3 | 3720.000 | 0.4086 | 274.2822 |
| 61 | STEEL DIR | ALKALINE. CLEANING | BAT2 | 6232.000 | 0.4075 | 281.0622 |
| 62 | STEEL DIR | PICKLING. COMBINATI | BAT3 | 6612.000 | 0.4056 | 293.7842 |
| 63 | STEEL DIR | CONTINUOUS CASTING | BAT2 | 7356.000 | 0.4048 | 299.5646 |
| 64 | STEEL DIR | VACUUM. DEGASSING | BAT2 | 7855.000 | 0.4040 | 305.2746 |
| 65 | STEEL DIR | HOT. COATING. NO. SCR | BAT3 | 9189.000 | 0.4030 | 314.4256 |
| 66 | STEEL DIR | HOT. FORMING. PLATE | BAT2 | 19620.000 | 0.4027 | 321.8056 |
| 67 | STEEL DIR | HOT. FORMING. STRIP. | BAT2 | 20060.000 | 0.3981 | 413.8656 |
| 68 | STEEL DIR | HOT FORMING. PRIMA | BAT2 | 20870.000 | 0.3948 | 482.9456 |
| 69 | STEEL DIR | HOT. FORMING. SECTIO | BAT2 | 21100.000 | 0.3920 | 541.3756 |
| 70 | STEEL DIR | HOT. FORMING. PIPE. T | BAT2 | 29440.000 | 0.3916 | 554.4436 |

* SELECTED OPTION

EXHIBIT II

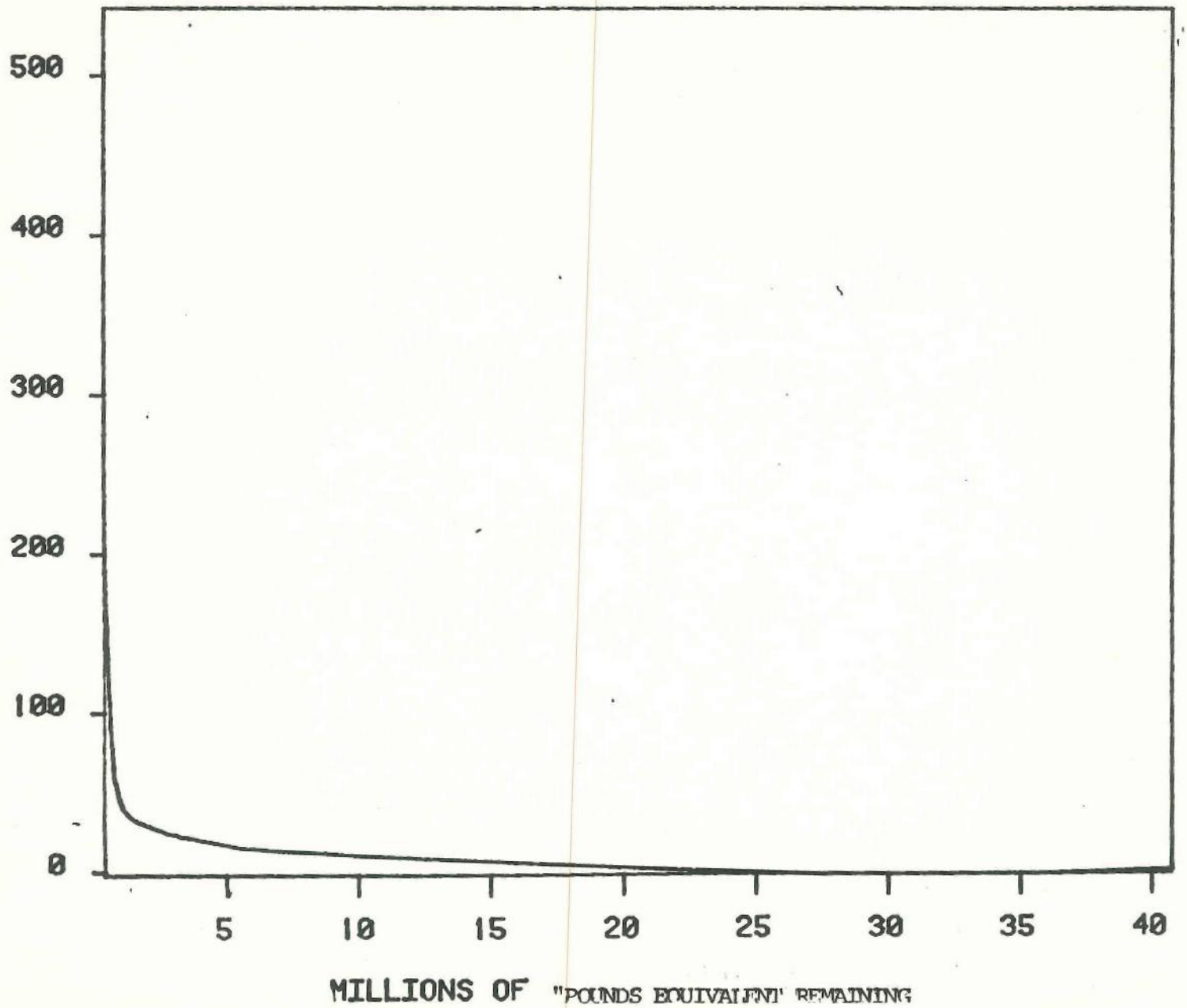
STEEL DIR

COMPARISONS OF SELECTED AND OPTIMAL OPTIONS

| PROCESS | SELECTED | 29 | 30 |
|---|---|---|---|
| FURNACE. COKE | BAT1 | BAT1 | BAT1 |
| MERCHANT. COKE | BAT1 | BAT1 | BAT1 |
| SINTERING | BAT1 | *BPT | *BPT |
| BLAST. FURNACES | BAT4 | BAT4 | BAT4 |
| BOF. SEMI. WET | BPT | BPT | BPT |
| BOF. SUPPRESSED. COMBU | BAT2 | *CURRENT | *CURRENT |
| BOF. OPEN. COMBUSTION | BAT2 | BAT2 | BAT2 |
| OPEN. HEARTH. WET | BAT2 | BAT2 | BAT2 |
| EAF. SEMI. WET | BPT | BPT | BPT |
| EAF. WET | BAT2 | BAT2 | BAT2 |
| VACUUM DEGASSING | BAT1 | *BPT | *BPT |
| CONTINUOUS. CASTING | BAT1 | *CURRENT | *CURRENT |
| HOT. FORMING. PRIMARY | BPT | BPT | BPT |
| HOT. FORMING. SECTION | BPT | BPT | BPT |
| HOT. FORMING. STRIP. SH | BPT | BPT | BPT |
| HOT. FORMING. PLATE | BPT | BPT | BPT |
| HOT. FORMING. PIPE. TUB | BPT | BPT | BPT |
| DESCALING | BPT | BPT | BPT |
| ALKALINE. CLEANING | BPT | *CURRENT | *CURRENT |
| COLD. ROLLING | BPT | *CURRENT | *CURRENT |
| COLD. ROLLING. PIPE. TU | BPT | BPT | BPT |
| PICKLING. H2SO4 | BPT | BPT | *BAT1 |
| PICKLING. HCL | BPT | BPT | BPT |
| PICKLING. COMBINATION | BPT | *BAT1 | *BAT1 |
| HOT. COATING. SCRUBBER | BAT1 | *BAT2 | *BAT2 |
| HOT. COATING. NO. SCRUB | BPT | *BAT1 | *BAT1 |
| TOTAL COST($MM) | 44.40 | 42.88 | 45.34 |
| TOTAL HAZARD(MM HU) | 1.04 | 1.05 | 1.00 |
| COST-EFFECTIVENESS($/HU) | - | 45.96 | 46.24 |

EXHIBIT 12

IRON AND STEEL - DIRECT DISCHARGERS
OPTIMAL COST- POUNDS EQUIVALENT FRONTIER

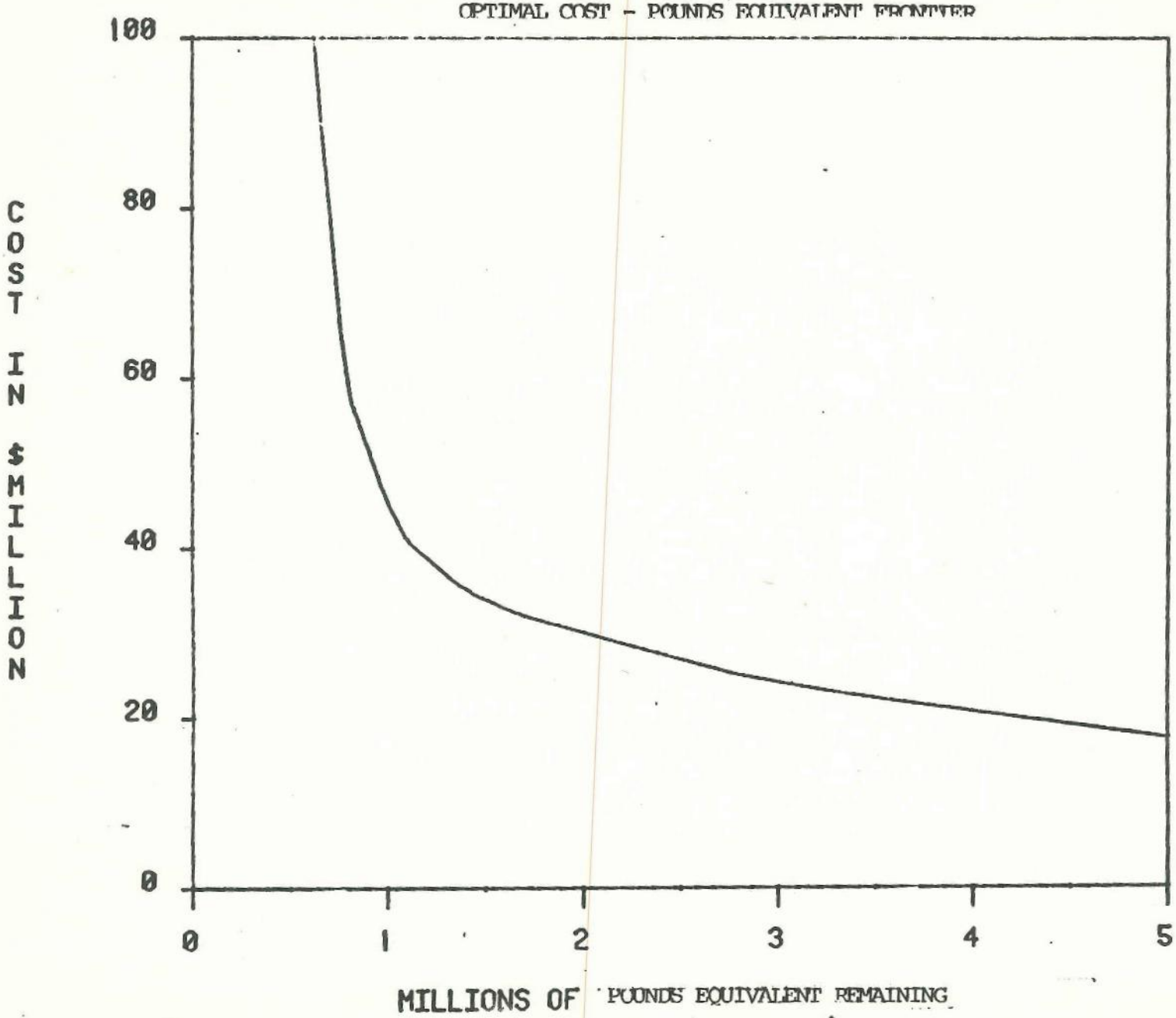



Source: TBS CE Model.

EXHIBIT 13

IRON AND STEEL - DIRECT DISCHARGERS

OPTIMAL COST - POUNDS EQUIVALENT FRONTIER



# APPENDIX I

# EXHIBIT I-1

## SUMMARY OF EFFLUENT LOADINGS AND TREATMENT COSTS
## SINTERING SUBCATEGORY

### DIRECT DISCHARGERS[1]

| SUBCATEGORY LOAD SUMMARY (TONS/YEAR) | RAW WASTE | BPT | BAT-1 | BAT-2 | BAT-3 | BAT-4 | BAT-5 |
|---|---|---|---|---|---|---|---|
| Flow (MGD) | 93.4 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 0 |
| Ammonia (N) | 853.3 | 76.7 | 76.7 | 76.7 | 65.8 | 65.8 | - |
| Cyanide (Total) | 28.4 | 2.2 | 1.1 | 1.1 | 0.3 | 0.3 | - |
| Fluoride | 853.3 | 274.0 | 219.2 | 219.2 | 219.2 | 219.2 | - |
| Oil and Grease | 34,132.9 | 76.7 | 38.4 | 76.7 | 76.7 | 38.4 | - |
| Phenols (4AAP) | 28.4 | 2.2 | 1.1 | 1.1 | 0.2 | 0.2 | - |
| Residual Chlorine | - | - | - | - | 5.5 | 5.5 | - |
| Total Suspended Solids | 876,544.1 | 427.4 | 109.6 | 241.1 | 241.1 | 109.6 | - |
| Total Toxic Metals | 298.7 | 14.0 | 4.8 | 2.8 | 2.8 | 2.4 | - |
| Total Organics[2] | 4.3 | 1.3 | 1.3 | 1.3 | 1.3 | 0.3 | - |
| **SUBCATEGORY COST SUMMARY ($X10$^{-6}$)** | | | | | | | |
| Investment | - | 63.89 | 6.20 | 4.98 | 10.33 | 48.03 | 74.80 |
| Annual | - | 13.31 | 0.81 | 0.63 | 2.26 | 7.09 | 15.24 |

### INDIRECT DISCHARGERS

| SUBCATEGORY LOAD SUMMARY (TONS/YEAR) | RAW WASTE | PSES-1 | PSES-2 | PSES-3 | PSES-4 | PSES-5 | PSES-6 |
|---|---|---|---|---|---|---|---|
| Flow (MGD) | 5.8 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 |
| Ammonia (N) | 53.3 | 5.1 | 5.1 | 5.1 | 4.4 | 4.4 | - |
| Cyanide (Total) | 1.8 | 0.1 | 0.1 | 0.1 | 0.02 | 0.02 | - |
| Fluoride | 53.3 | 18.3 | 14.6 | 14.6 | 14.6 | 14.6 | - |
| Oil and Grease | 2,133.3 | 5.1 | 2.6 | 5.1 | 5.1 | 2.6 | - |
| Phenols (4AAP) | 1.8 | 0.1 | 0.1 | 0.1 | 0.01 | 0.01 | - |
| Residual Chlorine | - | - | - | - | 0.4 | 0.4 | - |
| Total Suspended Solids | 54,221.5 | 28.5 | 7.3 | 16.1 | 16.1 | 7.3 | - |
| Total Toxic Metals | 18.7 | 0.9 | 0.3 | 0.2 | 0.2 | 0.2 | - |
| Total Organics[2] | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.02 | - |
| **SUBCATEGORY COST SUMMARY ($X10$^{-6}$)** | | | | | | | |
| Investment | - | 3.23 | 0.36 | 0.28 | 0.58 | 2.79 | 4.41 |
| Annual | - | 0.87 | 0.054 | 0.042 | 0.15 | 0.47 | 1.02 |

(1) The raw waste load and BPT cost contributions of the zero discharge operation are included in the direct discharger data. As this plant has no wastewater discharge, it does not contribute to BAT costs or to the BPT and BAT effluent waste loads.

(2) Individual phenolic compounds (e.g., 2,4-dinitrophenol, pentachlorophenol) are not included in total organics.

Source: EGD, EPA

# EXHIBIT I-2

SUBCATEGORY SUMMARY DATA
BASIS 7/1/78 DOLLARS

S( TEGORY: Sintering

MODEL SIZE (TPD): 4000
OPER. DAYS/YEAR : 365
TURNS/DAY : 3

RAW WASTE FLOWS

| | | |
|---|---|---|
| Model Plant | | 5.8 MGD |
| 15 | Direct Dischargers | 87.6 MGD |
| 1 | Indirect Discharger | 5.8 MGD |
| 1 | Zero Discharger | 5.8 MGD |
| 17 | Active Plants | 99.3 MGD |

| MODEL COSTS ($\$X10^{-3}$) | PSES-1 BPT | PSES-2 BAT-1 | PSES-3 BAT-2 | PSES-4 BAT-3 | PSES-5 BAT-4 | PSES-6 BAT-5 |
|---|---|---|---|---|---|---|
| Investment | 3615 | 401 | 316 | 647 | 3127 | 4936 |
| Annual | 874 | 53.9 | 42.2 | 151 | 473 | 1016 |
| $/Ton of Production | 0.60 | 0.037 | 0.029 | 0.10 | 0.32 | 0.70 |

| WASTEWATER CHARACTERISTICS | RAW WASTE (1) | PSES-1 BPT | PSES-2 BAT-1 | PSES-3 BAT-2 | PSES-4 BAT-3 | PSES-5 BAT-4 | PSES-6 BAT-5 |
|---|---|---|---|---|---|---|---|
| Flow (GPT) | 1460 | 120 | 120 | 120 | 120 | 120 | 0 |
| pH (SU) | 6-12 | 6-9 | 6-9 | 6-9 | 6-9 | 6-9 | - |
| Ammonia (N) | 6 | 7 | (10**)7 | (10**)7 | (10**)6 | (10**)6 | - |
| Fluoride | 6 | 25 | 20 | 20 | 20 | 20 | - |
| Oil and Grease | 240 | (10)7 | (5)(2)3.5 | (10)7 | (10)7 | (5)(2)3.5 | - |
| Phenols (4AAP) | 0.2 | 0.2 | (0.1**)0.1 | (0.1**)0.1 | (0.1**)0.015 | (0.1**)0.015 | - |
| Residual Chlorine (Max. Only) | - | - | (0.5) | (0.5) | (0.5**) | (0.5**) | - |
| Total Suspended Solids | 6100 | (50)39 | (15)10 | (25)22 | (25)22 | (15)10 | - |
| 3. Fluoranthene | 0.01 | 0.1 | 0.1 | 0.1 | 0.1 | 0.01 | - |
| 65 Phenol* | 0.03 | 0.05 | 0.05 | 0.05 | 0.01 | 0.01 | - |
| 76 Chrysene | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | - |
| 84 Pyrene* | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | - |
| 118 Cadmium* | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | - |
| 119 Chromium* | 0.7 | 0.6 | 0.2 | 0.15 | 0.15 | 0.15 | - |
| 120 Copper* | 0.1 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | - |
| 121 Cyanide (Total)* | 0.2 | 0.2 | (1)0.1 | (1)0.1 | (1**)0.03 | (1**)0.03 | - |
| 122 Lead | 0.15 | 0.12 | (0.15)0.02 | (0.15)0.02 | (0.15)0.02 | (0.15)0.02 | - |
| 124 Nickel* | 0.1 | 0.02 | 0.01 | 0.015 | 0.015 | 0.01 | - |
| 128 Zinc* | 1 | 0.5 | (0.2)0.18 | (0.1)0.04 | (0.1)0.04 | (0.1)0.01 | - |

Notes: All concentrations are in mg/l unless otherwise noted.
: BAT and PSES-2 through PSES-6 costs are incremental over BPT/PSES-1 costs.
: Values in parentheses represent the concentrations used to develop the limitations/standards for the various levels of treatment. All other values represent long term average values or predicted average performance levels.

* Toxic pollutant found in all raw waste samples analyzed.
** When co-treated with ironmaking wastewaters.
(1) Raw wastewater quality reflects the discharge of a once-through system.
(2) Limit for oil and grease is based on 10 mg/l (maximum only).

Source: EGD, EPA

# EXHIBIT I-3

**SUMMARY OF EFFLUENT LOADINGS (KG/YEAR)**
**SINTERING SUBCATEGORY: DIRECT DISCHARGERS[1]**

| | Subcategory Load Summary | Raw Waste | BPT Removed | BPT Discharged | BAT-1 Removed | BAT-1 Discharged | BAT-2 Removed | BAT-2 Discharge |
|---|---|---|---|---|---|---|---|---|
| | Flow (liters/year x $10^{-9}$) | 129.3 | 119.3 | 10.0 | 119.3 | 10.0 | 119.3 | 10.0 |
| | Ammonia (N) | 775,561.3 | 705,840.5 | 69,720.8 | 705,840.5 | 69,720.8 | 705,840.5 | 69,[illegible].8 |
| | Fluoride | 775,561.3 | 526,558.3 | 249,003.0 | 576,358.9 | 199,202.4 | 576,358.9 | 199,202.4 |
| | Oil & Grease | 31,022,452.8 | 30,952,732.0 | 69,720.8 | 30,987,592.4 | 34,860.4 | 30,952,732.0 | 69,720.8 |
| | Phenols (4AAP) | 25,852.0 | 23,860.0 | 1,992.0 | 24,856.0 | 996.0 | 24,856.0 | 996.0 |
| | Residual Chlorine | - | - | - | - | - | - | - |
| | Total Suspended Solids | 788,487,342.0 | 788,098,897.3 | 388,444.7 | 788,387,740.8 | 99,601.2 | 788,268,219.4 | 219,122.6 |
| 31 | Fluoranthene | 1,292.6 | 296.6 | 996.0 | 296.6 | 996.0 | 296.6 | 996.0 |
| 65 | Phenol | 3,877.8 | 3,379.8 | 498.0 | 3,379.8 | 498.0 | 3,379.8 | 498.0 |
| 76 | Chrysene | 1,292.6 | 1,193.0 | 99.6 | 1,193.0 | 99.6 | 1,193.0 | 99.6 |
| 84 | Pyrene | 1,292.6 | 1,193.0 | 99.6 | 1,193.0 | 99.6 | 1,193.0 | 99.6 |
| 118 | Cadmium | 6,463.0 | 6,363.4 | 99.6 | 6,363.4 | 99.6 | 6,363.4 | 99.6 |
| 119 | Chromium | 90,482.2 | 84,506.1 | 5,976.1 | 88,490.2 | 1,992.0 | 88,988.2 | 1,494.0 |
| 120 | Copper | 12,926.0 | 12,627.2 | 298.8 | 12,726.8 | 199.2 | 12,726.8 | 199.2 |
| 121 | Cyanide (Total) | 25,852.0 | 23,860.0 | 1,992.0 | 24,856.0 | 996.0 | 24,856.0 | 996.0 |
| 122 | Lead | 19,389.0 | 18,193.8 | 1,195.2 | 19,189.8 | 199.2 | 19,189.8 | 199.2 |
| 124 | Nickel | 12,926.0 | 12,726.8 | 199.2 | 12,826.4 | 99.6 | 12,776.6 | 149.4 |
| 128 | Zinc | 129,260.2 | 124,280.1 | 4,980.1 | 127,467.4 | 1,792.8 | 128,861.8 | 398.4 |
| | Regulated Toxic Organics[2] | 51,704.0 | 47,720.0 | 3,984.0 | 49,712.0 | 1,992.0 | 49,712.0 | 1,992.0 |
| | Regulated Toxic Metals | 148,649.2 | 142,473.9 | 6,175.3 | 146,657.2 | 1,992.0 | 148,051.6 | 59[illegible] |
| | Regulated Conventionals | 819,509,794.8 | 819,051,629.3 | 458,165.5 | 819,375,333.2 | 134,461.6 | 819,220,951.4 | 28[illegible]3.4 |
| | Total Regulated Pollutants | 820,485,709.3 | 819,947,663.7 | 538,045.6 | 820,277,542.9 | 208,166.4 | 820,124,555.5 | 361,153.8 |
| | Total Toxic Organics[2] | 55,581.8 | 50,402.6 | 5,179.2 | 52,394.6 | 3,187.2 | 52,394.6 | 3,187.2 |
| | Total Toxic Metals | 271,446.4 | 258,697.4 | 12,749 | 267,064.0 | 4,382.4 | 268,906.6 | 2,539.8 |
| | Total Conventionals | 819,509,794.8 | 819,051,629.3 | 458,165.5 | 819,375,333.2 | 134,461.6 | 819,220,951.4 | 288,843.4 |
| | Total Pollutants | 821,387,945.6 | 820,593,128.1 | 794,817.5 | 820,976,991.2 | 410,954.4 | 820,824,452.0 | 563,493.6 |

EXHIBIT I-4

IRON AND STEEL INDUSTRY
COST SUMMARY

| Subcategory | Treatment Level | Costs (Millions of 7/1/78 Dollars) In-Place Capital | Required Capital | Total Annual |
|---|---|---|---|---|
| A. Cokemaking | | | | |
| 1. Iron and Steel | BPT | 86.80 | 40.55 | 51.57 |
| | BAT-1 | 9.87 | 36.46 | 14.12 |
| | PSES-2 | 25.08 | 4.81 | 9.86 |
| 2. Merchant | BPT | 21.71 | 2.71 | 10.25 |
| | BAT-1 | 2.40 | 6.98 | 2.96 |
| | PSES-2 | 1.26 | 9.95 | 2.91 |
| B. Sintering | BPT | 59.27 | 4.22 | 17.23 |
| | BAT-1 | 0.40 | 6.42 | 1.26 |
| | PSES | 3.13 | 0.45 | 1.13 |
| C. Ironmaking | BPT | 418.69 | 20.57 | 73.83 |
| | BAT-4 | 3.50 | 24.34 | 9.21 |
| | PSES | 12.92 | 1.06 | 4.05 |
| D. Steelmaking | | | | |
| 1. BOF | | | | |
| a. Semi-Wet | BPT | 2.74 | 1.61 | 1.17 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 0.43 | 0.00 | 0.13 |
| b. Wet-Suppressed Combustion | BPT | 15.81 | 0.00 | 5.04 |
| | BAT-2 | 0.75 | 0.79 | 0.30 |
| | PSES | 3.06 | 0.00 | 1.07 |
| c. Wet-Open Combustion | BPT | 57.32 | 1.42 | 17.50 |
| | BAT-2 | 0.47 | 5.69 | 1.23 |
| | PSES | 4.36 | 0.00 | 1.44 |
| 2. Electric Arc | | | | |
| a. Semi-Wet | BPT | 0.79 | 0.22 | 0.18 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 0.00 | 0.00 | 0.00 |
| b. Wet | BPT | 17.21 | 0.00 | 4.98 |
| | BAT-2 | 0.18 | 0.79 | 0.19 |
| | PSES | 0.00 | 0.00 | 0.00 |
| 3. Open Hearth | BPT | 17.80 | 0.00 | 4.76 |
| | BAT-2 | 0.00 | 1.81 | 0.38 |
| | PSES | 0.00 | 0.00 | 0.00 |
| E. Vacuum Degassing | BPT | 20.36 | 6.78 | 7.12 |
| | BAT-1 | 0.03 | 0.93 | 0.18 |
| | PSES | 0.00 | 0.00 | 0.00 |

| Subcategory | Treatment Level | Costs (Millions of 7/1/78 Dollars) In-Place Capital | Required Capital | Total Annual |
|---|---|---|---|---|
| F. Continuous Casting | BPT | 86.38 | 2.07 | 20.37 |
| | BAT-1 | 0.18 | 0.81 | 0.18 |
| | PSES | 11.64 | 0.00 | 2.65 |
| G. Hot Forming | | | | |
| 1. Primary | BPT | 200.19 | 24.99(1) | -10.37 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 2.68 | 0.00 | 0.00 |
| 2. Section | BPT | 183.42 | 28.62(1) | 35.67 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 10.57 | 0.00 | 0.00 |
| 3. Flat | | | | |
| a. Hot Strip | BPT | 192.49 | 22.88(1) | 22.75 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 3.22 | 0.00 | 0.00 |
| b. Plate | BPT | 23.07 | 7.19(1) | 2.72 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 1.44 | 0.00 | 0.00 |
| 4. Pipe & Tube | BPT | 31.54 | 6.94(1) | 8.43 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 1.16 | 0.00 | 0.00 |
| H. Salt Bath Descaling | BPT | 4.69 | 1.15 | 1.44 |
| | BAT-1 | 0.04 | 0.81 | 0.16 |
| | PSES | 0.43 | 0.05 | 0.10 |
| I. Acid Pickling | | | | |
| 1. Sulfuric | BPT | 124.40 | 11.95 | 47.89 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 9.92 | 9.45 | 16.52 |
| 2. Hydrochloric | BPT | 155.41 | 4.60 | 39.07 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 8.54 | 3.17 | 7.38 |
| 3. Combination | BPT | 53.48 | 2.37 | 18.70 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 2.51 | 4.45 | 5.82 |
| J. Cold Forming | | | | |
| 1. Cold Rolling | BPT | 41.78 | 5.04 | 10.32 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 1.08 | 0.08 | 0.36 |
| 2. CW-Pipe & Tube | BPT | 7.03 | 0.76 | 2.68 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 0.08 | 0.06 | 0.18 |

| Subcategory | Treatment Level | Costs (Millions of 7/1/78 Dollars) In-Place Capital | Required Capital | Total Annual |
|---|---|---|---|---|
| K. Alkaline Cleaning | BPT | 20.05 | 0.94 | 7.66 |
| | BAT* | 0.00 | 0.00 | 0.00 |
| | PSES | 0.47 | 0.00 | 0.00 |
| L. Hot Coatings | BPT | 32.47 | 3.53 | 7.58 |
| | BAT-1 | 0.65 | 0.81 | 0.28 |
| | PSES | 3.74 | 3.19 | 2.72 |
| Totals(2) | BPT | 1918.71 | 24.74 | 408.54 |
| | BAT | 18.47 | 86.64 | 30.45 |
| | PSES | 111.19 | 37.78 | 56.32 |

*: No BAT system is being promulgated.
(1): Comingled required cost.
(2): Total includes costs for confidential plants.

Source: EGD, EPA

APPENDIX II

- INDIRECT DISCHARGERS
- "POUNDS EQUIVALENT ANALYSIS

Exhibit II-1

SUBCATEGORIZATION OF THE IRON AND STEEL INDUSTRY
INDIRECT DISCHARGERS

| Phase | Subdivision | Selected Option | Subcategory |
|---|---|---|---|
| I | Iron and Steel Cokemaking | PSES 1 | Iron and Steel Cokemaking |
| | Merchant Cokemaking | PSES 1 | Merchant Cokemaking |
| | Sintering | PSES 2 | Sintering |
| | Ironmaking | PSES 5 | Ironmaking |
| | Basic Oxygen Furnace-Wet-Suppressed Combustion | PSES 3 | Wet--Suppressed Combustion |
| | Basic Oxygen Furnace-Open Combustion | PSES 3 | Wet-Open Combustion |
| | Continuous Casting | PSES 2 | Continuous Casting |
| II | Hot Forming-Primary | PSES 1 | Primary--No Scarfers--Carbon<br>Primary--Scarfers--Carbon<br>Primary--No Scarfers--Specialty<br>Primary--Scarfers--Specialty |
| | Hot Forming-Section | PSES 1 | Section--Carbon<br>Section--Specialty |
| | Hot Forming-Strip/Sheet | PSES 1 | Flat--Carbon--Strip/Sheet<br>Flat--Specialty--Strip/Sheet |
| | Hot Forming-Plate | PSES 1 | Flat--Carbon--Plate |
| | Hot Forming-Pipe and Tube | PSES 1 | Pipe and Tube--Carbon |
| | Scale Removal | PSES 2 | Oxidizing--Batch--Rod/Wire<br>Reducing--Batch |
| | Alkaline Cleaning | Current | Batch<br>Continuous |
| | Cold Rolling | PSES 1 | Single Stand<br>Multi Stand |
| | Cold Rolling-Pipe and Tube | PSES 1 | Cold Pipe and Tube--Water |
| | Pickling--Sulfuric Acid | PSES 1 | Strip/Sheet/Plate[1]<br>Rod/Wire/Coil[1]<br>Bar/Billet/Bloom[2]<br>Pipe and Tube[1] |
| | Pickling--Hydrochloric Acid | PSES 1 | Strip/Sheet[1]<br>Rod/Wire[2]<br>Pipe and Tube[2] |

Continued

Exhibit II-1 (continued)

| Phase | Subdivision | Selected Option | Subcategory |
|---|---|---|---|
| II | Pickling--Combination Acid | PSES 1 | Continuous--Strip/Sheet/Plate[2]<br>Rod/Wire/Coil[2]<br>Bar/Billet/Bloom[2]<br>Pipe and Tube[2] |
| | Hot Coating-No Scrubbers | PSES 1 | Galvanizing--Strip/Sheet/Misc<br>Galvanizing--Wire Prod/Fasteners<br>Terne--Strip/Sheet/Misc<br>Other Metals--Wire Prod/Fasteners |
| | Hot Coating-With Scrubbers | PSES 2 | Galvanizing--Strip/Sheet/Misc<br>Galvanizing--Wire Prod/Fasteners |

[1]Includes two subcategories Neutralization and Acid Recovery.
[2]Neutralization only.

APPENDIX IV

- INDIRECT DISCHARGERS
- POUNDS ANALYSIS

FOR EXHIBITS IV-1, IV-2, AND IV-3,
SEE EXHIBITS II-1, II-2, AND II-3

EXHIBIT IV-4

IRON AND STEEL - INDIRECTS
COST-EFFECTIVENESS

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000 P/E) | #CE INC |
|---|---|---|---|---|---|---|
| FURNACE. COKE | CURRENT | - | 0.00 | 0.0 | 4629.3 | - |
| | *PSES1 | 0.5146 | 56.34 | 1342.4 | 2020.9 | CURRENT |
| | PSES2 | 1.2151 | 55.24 | 3107.2 | 2072.2 | CURRENT |
| | PSES3 | 0.3942 | 96.53 | 1761.6 | 160.7 | CURRENT |
| | PSES4 | 40.0665 | 96.58 | 1851.2 | 158.4 | PSES3 |
| | PSES5 | 8.1046 | 97.54 | 2139.2 | 114.1 | PSES3 |
| MERCHANT. COKE | CURRENT | - | 0.00 | 0.0 | 3503.6 | - |
| | *PSES1 | 0.6775 | 88.49 | 2100.4 | 403.2 | CURRENT |
| | PSES2 | 1.5795 | 87.65 | 4850.5 | 432.7 | CURRENT |
| | PSES3 | 1.6676 | 99.00 | 2714.5 | 34.9 | PSES1 |
| | PSES4 | 277.8422 | 99.02 | 2839.1 | 34.5 | PSES3 |
| | PSES5 | 43.0556 | 99.29 | 3150.6 | 24.8 | PSES3 |
| SINTERING | CURRENT | - | 0.00 | 0.0 | 24.9 | - |
| | PSES1 | 7.9841 | 56.83 | 113.1 | 10.8 | CURRENT |
| | *PSES2 | 124.3791 | 57.05 | 120.1 | 10.7 | PSES1 |
| | PSES3 | 48.7278 | 57.28 | 118.6 | 10.6 | PSES1 |
| | PSES4 | 118.8065 | 60.57 | 216.1 | 9.8 | PSES3 |
| | PSES5 | 431.8649 | 61.16 | 536.1 | 9.7 | PSES3 |
| | PSES6 | 90.8510 | 100.00 | 1086.1 | 0.0 | PSES3 |
| BLAST. FURNACE | CURRENT | - | 0.00 | 0.0 | 328.4 | - |
| | PSES1 | 0.8875 | 88.38 | 257.6 | 38.1 | CURRENT |
| | PSES3 | 0.8803 | 91.22 | 263.7 | 28.8 | CURRENT |
| | PSES4 | 191.5021 | 91.22 | 267.2 | 28.8 | PSES3 |
| | *PSES5 | 2.4788 | 95.09 | 295.2 | 16.1 | PSES3 |
| | PSES6 | 3804.2444 | 95.13 | 835.2 | 16.0 | PSES5 |
| | PSES7 | 82.4718 | 100.00 | 1625.2 | 0.0 | PSES5 |
| BOF. SUPPRESSED. COMBUSTIO | CURRENT | - | 0.00 | 0.0 | 0.3 | - |
| | PSES1 | 0.0000 | 0.00 | 0.0 | 0.3 | CURRENT |
| | PSES2 | 0.0000 | 0.00 | 0.0 | 0.3 | CURRENT |
| | *PSES3 | 0.0000 | 0.00 | 0.0 | 0.3 | CURRENT |
| | PSES4 | 2229.6353 | 100.00 | 777.0 | 0.0 | CURRENT |
| BOF. OPENCOMBUSTION | CURRENT | - | 0.00 | 0.0 | 1.2 | - |
| | PSES1 | 0.0000 | 0.00 | 0.0 | 1.2 | CURRENT |
| | PSES2 | 0.0000 | 0.00 | 0.0 | 1.2 | CURRENT |
| | *PSES3 | 0.0000 | 0.00 | 0.0 | 1.2 | CURRENT |
| | PSES4 | 1397.4553 | 100.00 | 1700.0 | 0.0 | CURRENT |
| CONTINUOUS. CASTING | CURRENT | - | 0.00 | 0.0 | 0.1 | - |
| | PSES1 | 0.0000 | 0.00 | 0.0 | 0.1 | CURRENT |
| | *PSES2 | 0.0000 | 0.00 | 0.0 | 0.1 | CURRENT |
| | PSES3 | 16285.7334 | 100.00 | 1500.0 | 0.0 | CURRENT |
| HOT. FORMING. PRIMARY | CURRENT | - | 0.00 | 0.0 | 1.0 | - |
| | *PSES1 | 0.0000 | 0.00 | 0.0 | 1.0 | CURRENT |
| | PSES2 | 1454.4457 | 89.76 | 1254.8 | 0.1 | CURRENT |
| | PSES3 | 49076.6602 | 100.00 | 6087.0 | 0.0 | PSES2 |

- Am. "pounds equivalent"

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E 1000 P/E | INC. TO |
|---|---|---|---|---|---|---|
| HOT. FORMING. SECTION | CURRENT | - | 0.00 | 0.0 | 2.0 | - |
| | *PSES1 | 0.0000 | 0.00 | 0.0 | 2.0 | CURRENT |
| | PSES2 | 1306.8264 | 91.54 | 2418.0 | 0.2 | CURRENT |
| | PSES3 | 49070.9063 | 100.00 | 10806.0 | 0.0 | PSES2 |
| HOT. FORMING. STRIP. SHEET | CURRENT | - | 0.00 | 0.0 | 1.4 | - |
| | *PSES1 | 0.0000 | 0.00 | 0.0 | 1.4 | CURRENT |
| | PSES2 | 1064.1606 | 90.01 | 1382.0 | 0.1 | CURRENT |
| | PSES3 | 43628.9609 | 100.00 | 7674.0 | 0.0 | PSES2 |
| HOT. FORMING. PLATE | CURRENT | - | 0.00 | 0.0 | 0.2 | - |
| | *PSES1 | 0.0000 | 0.00 | 0.0 | 0.2 | CURRENT |
| | PSES2 | 1490.1884 | 89.95 | 210.0 | 0.0 | CURRENT |
| | PSES3 | 37612.8477 | 100.00 | 802.0 | 0.0 | PSES2 |
| HOT. FORMING. PIPE. AND. TUB | CURRENT | - | 0.00 | 0.0 | 0.0 | - |
| | *PSES1 | 0.0000 | 0.00 | 0.0 | 0.0 | CURRENT |
| | PSES2 | 2432.9302 | 83.33 | 84.6 | 0.0 | CURRENT |
| | PSES3 | 68645.4531 | 100.00 | 562.0 | 0.0 | PSES2 |
| ALKALINE. CLEANING | CURRENT | - | 0.00 | 0.0 | 1.2 | - |
| | PSES1 | 6.0795 | 91.82 | 6.7 | 0.1 | CURRENT |
| | *PSES2 | 106.8399 | 97.28 | 13.7 | 0.0 | PSES1 |
| | PSES3 | 11069.0029 | 100.00 | 375.7 | 0.0 | PSES2 |
| DESCALING | *CURRENT | - | 0.00 | 0.0 | 7.0 | - |
| | PSES1 | 0.0000 | 0.00 | 0.0 | 7.0 | CURRENT |
| COLD. ROLLING | CURRENT | - | 0.00 | 0.0 | 1.4 | - |
| | *PSES1 | 20.9949 | 37.63 | 11.2 | 0.9 | CURRENT |
| | PSES2 | 37.7035 | 82.52 | 35.2 | 0.2 | PSES1 |
| | PSES3 | 95518.0547 | 82.88 | 521.2 | 0.2 | PSES2 |
| | PSES4 | 4302.5796 | 100.00 | 1101.2 | 0.0 | PSES2 |
| COLD. ROLLING. PIPE. TUBE | CURRENT | - | 0.00 | 0.0 | 0.4 | - |
| | *PSES1 | 0.0000 | 0.00 | 0.0 | 0.4 | CURRENT |
| PICKLING. H2SO4 | CURRENT | - | 0.00 | 0.0 | 43816.1 | - |
| | *PSES1 | 0.1634 | 99.96 | 7158.9 | 16.1 | CURRENT |
| | PSES2 | 73.0882 | 99.99 | 7998.9 | 4.6 | PSES1 |
| | PSES3 | 71.3514 | 100.00 | 8228.9 | 1.1 | PSES1 |
| | PSES4 | 7402.6519 | 100.00 | 16338.9 | 0.0 | PSES3 |
| PICKLING. HCL | CURRENT | - | 0.00 | 0.0 | 12138.6 | - |
| | *PSES1 | 0.1490 | 99.88 | 1806.3 | 14.7 | CURRENT |
| | PSES2 | 47.4992 | 99.98 | 2381.3 | 2.6 | PSES1 |
| | PSES3 | 62.5277 | 99.99 | 2496.3 | 0.8 | PSES2 |
| | PSES4 | 4533.9238 | 100.00 | 5936.3 | 0.0 | PSES3 |
| PICKLING. COMBINATION | CURRENT | - | 0.00 | 0.0 | 3474.6 | - |
| | *PSES1 | 0.8377 | 99.83 | 2905.6 | 5.9 | CURRENT |
| | PSES2 | 35.6318 | 99.96 | 3068.6 | 1.3 | PSES1 |
| | PSES3 | 119.0713 | 99.99 | 3182.6 | 0.4 | PSES2 |
| | PSES4 | 11175.7305 | 100.00 | 7415.6 | 0.0 | PSES3 |

P/E: "pounds equivalent"

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/ P/E) | PERCENT REMOVED | COST ($1000'S) | P/E .1000 P/E | #INC. TO |
|---|---|---|---|---|---|---|
| HOT. COATING. NO. SCRUB | CURRENT | - | 0.00 | 0.0 | 151.4 | - |
| | *PSES1 | 6.0127 | 94.01 | 855.5 | 9.1 | CURRENT |
| | PSES2 | 5.9296 | 95.33 | 855.5 | 7.1 | CURRENT |
| | PSES3 | 40.3138 | 99.42 | 1105.5 | 0.9 | PSES2 |
| | PSES4 | 4018.7380 | 100.00 | 4609.5 | 0.0 | PSES3 |
| HOT. COATING. SCRUBBER | CURRENT | - | 0.00 | 0.0 | 61.8 | - |
| | PSES1 | 7.2614 | 82.85 | 371.7 | 10.6 | CURRENT |
| | *PSES2 | 17.5380 | 85.24 | 397.6 | 9.1 | PSES1 |
| | PSES3 | 23.5111 | 97.90 | 581.6 | 1.3 | PSES2 |
| | PSES4 | 2081.7993 | 100.00 | 3281.6 | 0.0 | PSES3 |
| TOTALS | CURRENT | - | 0.00 | 0.0 | 68144.9 | - |
| | PSES1 | 0.2581 | 96.27 | 16929.4 | 2544.1 | - |
| | PSES2 | 2.7217 | 96.25 | 28178.0 | 2542.6 | - |
| | PSES3 | 5.2830 | 99.65 | 48781.2 | 241.3 | - |
| | PSES4 | 2653.8066 | 99.66 | 46333.7 | 231.6 | - |
| | PSES5 | 17.9367 | 98.06 | 6121.1 | 164.7 | - |
| | PSES6 | 139.6935 | 95.48 | 1921.3 | 16.0 | - |
| | PSES7 | 82.4718 | 100.00 | 1625.2 | 0.0 | - |
| SELECTED OPTIONS | * | 0.2490 | 96.30 | 17006.9 | 2520.5 | - |

* SELECTED OPTIONS
\# INDICATES INCREMENT FROM WHICH COST-EFFECTIVENESS IS CALCULATED.

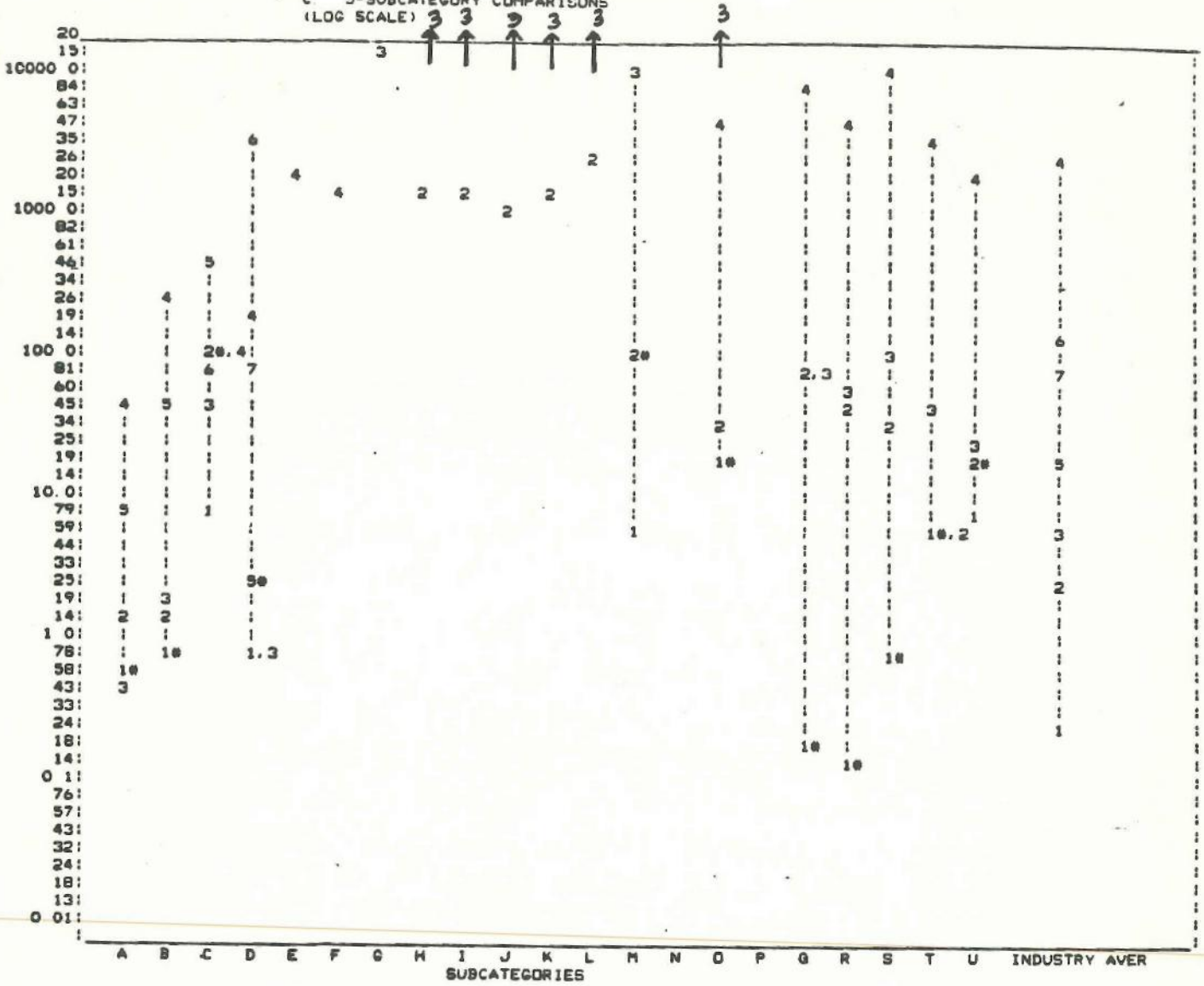
P/E: "pounds equivalent"

EXHIBIT IV-5

AND STEEL - INDIRECTS

S-SUBCATEGORY COMPARISONS

(LOG SCALE)

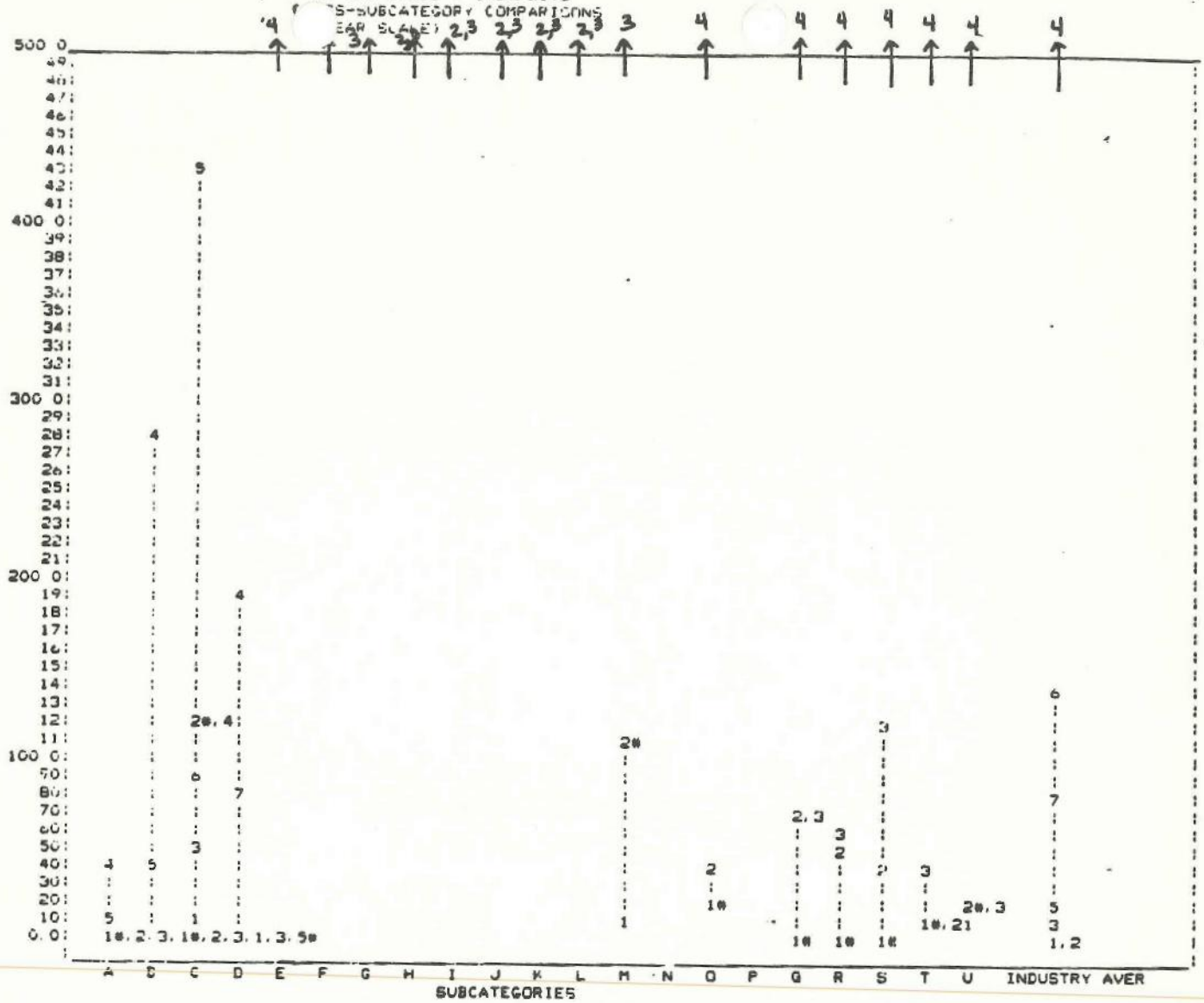



| SUBCATEGORIES (COST-EFF) | | |
|---|---|---|
| A | FURNACE. COKE | ( 0.514648) |
| B | MERCHANT. COKE | ( 0.677470) |
| C | SINTERING | (124.379105) |
| D | BLAST. FURNACE | ( 2.478829) |
| E | BOF. SUPPRESSED. COMBUSTION | (.....) |
| F | BOF. OPENCOMBUSTION | (.....) |
| G | CONTINUOUS. CASTING | (.....) |
| H | HOT. FORMING. PRIMARY | (.....) |
| I | HOT. FORMING. SECTION | (.....) |
| J | HOT. FORMING. STRIP. SHEET | (.....) |
| K | HOT. FORMING. PLATE | (.....) |
| L | HOT. FORMING. PIPE. AND. TUBE | (.....) |
| M | ALKALINE. CLEANING | (106.839897) |
| N | DESCALING | (.....) |
| O | COLD. ROLLING | ( 20.994925) |
| P | COLD. ROLLING. PIPE. TUBE | (.....) |
| Q | PICKLING. H2SO4 | ( 0.163445) |
| R | PICKLING. HCL | ( 0.148987) |
| S | PICKLING. COMBINATION | ( 0.837661) |
| T | HOT. COATING. NO. SCRUB | ( 6.012737) |
| U | HOT. COATING. SCRUBBER | ( 17.537966) |
| + | INDUSTRY AVERAGE | |

CONTROL OPTIONS

1 PSES1
2 PSES2
3 PSES3
4 PSES4
5 PSES5
6 PSES6
7 PSES7
* SELECTED OPTION

IRON AND STEEL - INDIRECTS
(COSTS-SUBCATEGORY COMPARISONS
(LINEAR SCALE)




SUBCATEGORIES (COST-EFF)

| | | |
|---|---|---|
| A | FURNACE COKE | ( 0.514648) |
| B | MERCHANT COKE | ( 0.677470) |
| C | SINTERING | (124.379105) |
| D | BLAST FURNACE | ( 2.478829) |
| E | BOF SUPPRESSED COMBUSTION | (.....) |
| F | BOF OPENCOMBUSTION | (.....) |
| G | CONTINUOUS CASTING | (.....) |
| H | HOT FORMING PRIMARY | (.....) |
| I | HOT FORMING SECTION | (.....) |
| J | HOT FORMING STRIP SHEET | (.....) |
| K | HOT FORMING PLATE | (.....) |
| L | HOT FORMING PIPE AND TUBE | (.....) |
| M | ALKALINE CLEANING | (106.839897) |
| N | DESCALING | (.....) |
| O | COLD ROLLING | ( 20.994925) |
| P | COLD ROLLING PIPE TUBE | (.....) |
| Q | PICKLING H2SO4 | ( 0.163445) |
| R | PICKLING HCL | ( 0.148987) |
| S | PICKLING COMBINATION | ( 0.837661) |
| T | HOT COATING NO SCRUB | ( 6.012737) |
| U | HOT COATING SCRUBBER | ( 17.537966) |
| + | INDUSTRY AVERAGE | |

CONTROL OPTIONS

1 PSES1
2 PSES2
3 PSES3
4 PSES4
5 PSES5
6 PSES6
7 PSES7
* SELECTED OPTION

EXHIBIT IV-7

INDIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LOG SCALE)

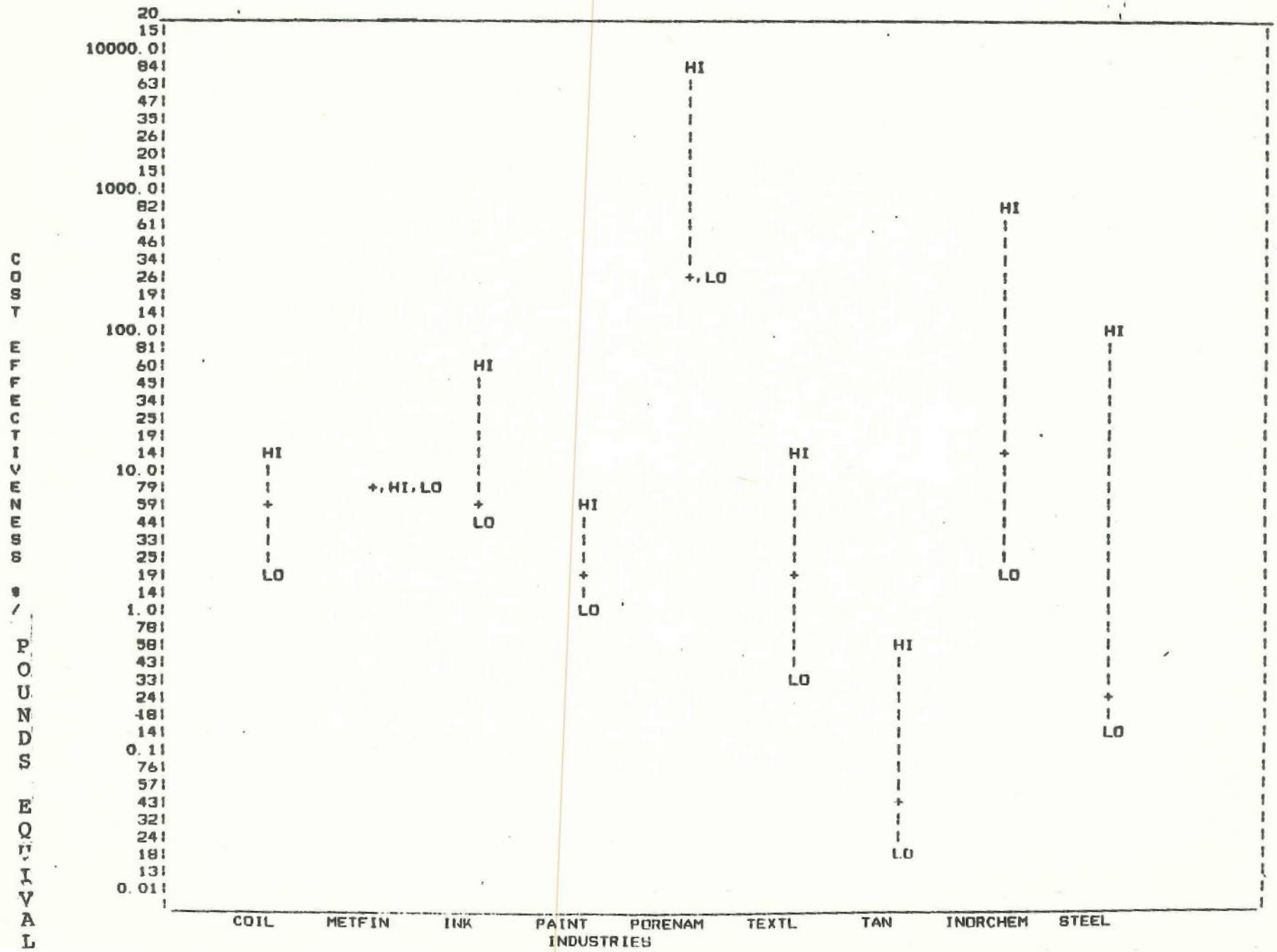


EXHIBIT IV-8

INDIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LINEAR SCALE)

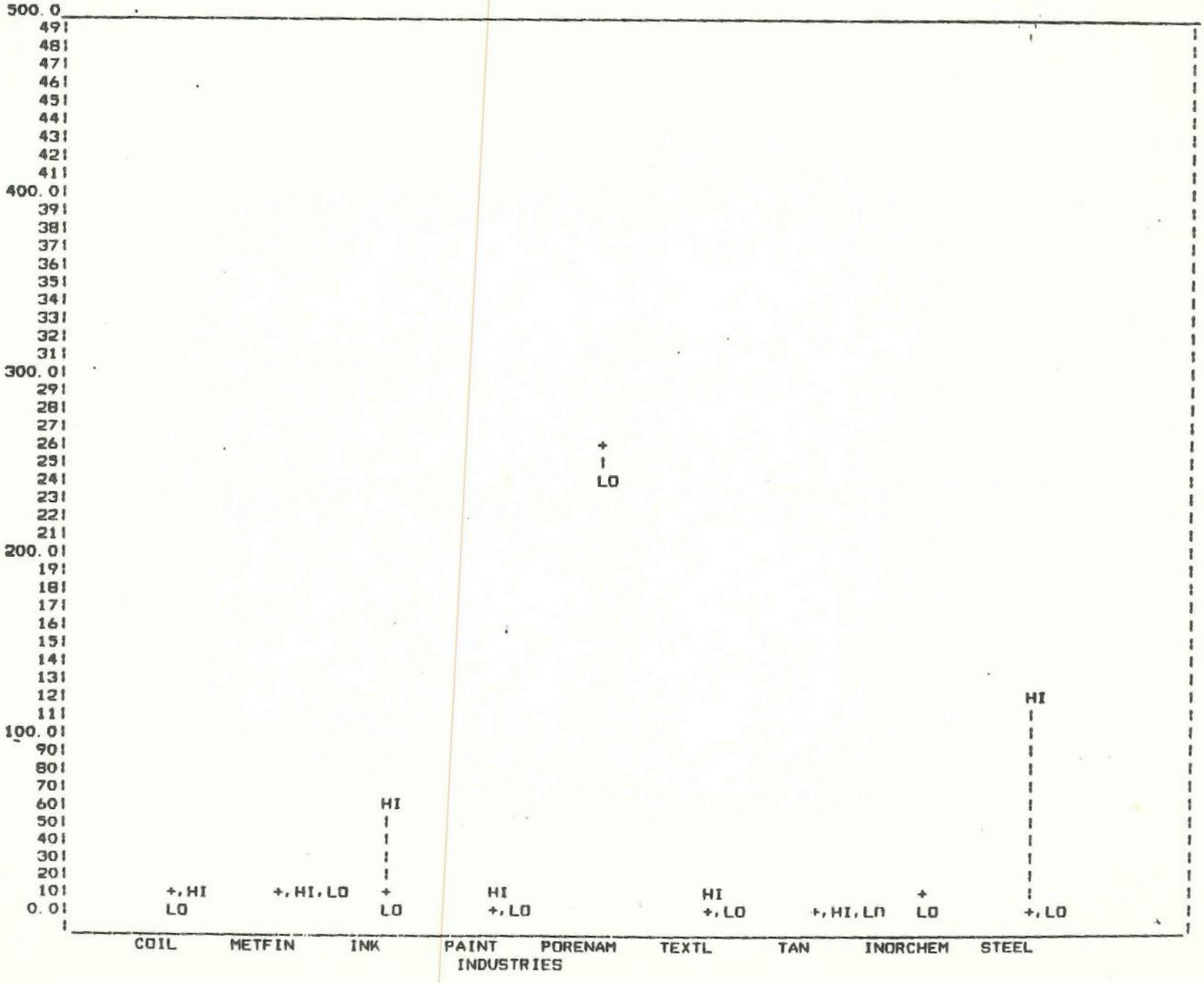


Exhibit IV-9

CROSS INDUSTRY COMPARISON
COST-EFFECTIVENESS OF SELECTED OPTIONS
INDIRECT DISCHARGERS

(1978 dollars per hazard unit)

| Industry | Low | Average | High |
|---|---|---|---|
| Coil Coating | $ 1.99 | $ 6.35 | $ 12.93 |
| Ink | 4.24 | 6.64 | 64.18 |
| Inorganic Chemicals | 1.71 | 13.69 | 804.23 |
| Metal Finishing | 8.59 | 8.59 | 8.59 |
| Paint | .94 | 1.75 | 5.93 |
| Porcelain Enameling | 242.29 | 260.65 | 8,052.59 |
| Steel | .15 | .25 | 124.38 |
| Tanning | .02 | .04 | .59 |
| Textiles | .32 | 1.79 | 14.71 |

EXHIBIT IV-10

INCREMENTAL COST-EFFECTIVENESS ANALYSIS

| NO. | INDUSTRY | SUB-CATEGORY | INCREMENTAL OPTION | COST-EFF ($/HU) | EFFLUENT (MM HU) | COST ($MM) |
|---|---|---|---|---|---|---|
| 0 | ALL INDUSTRY | | CURRENT | 0.000 | 68.1434 | 0.0000 |
| 1 | STEEL INDIR | PICKLING. HCL | *PSES1 | 0.149 | 56.0181 | 1.8060 |
| 2 | STEEL INDIR | PICKLING. H2SO4 | *PSES1 | 0.163 | 12.2142 | 8.9650 |
| 3 | STEEL INDIR | FURNACE. COKE | PSES3 | 0.394 | 7.7459 | 10.7270 |
| 4 | STEEL INDIR | MERCHANT. COKE | *PSES1 | 0.678 | 4.6451 | 12.8270 |
| 5 | STEEL INDIR | PICKLING. COMBINATI | *PSES1 | 0.838 | 1.1760 | 15.7330 |
| 6 | STEEL INDIR | BLAST. FURNACE | PSES3 | 0.880 | 0.8765 | 15.9967 |
| 7 | STEEL INDIR | MERCHANT. COKE | PSES3 | 1.668 | 0.5082 | 16.6117 |
| 8 | STEEL INDIR | BLAST. FURNACE | *PSES5 | 2.479 | 0.4955 | 16.6432 |
| 9 | STEEL INDIR | HOT. COATING. NO. SCR | PSES2 | 5.930 | 0.3512 | 17.4987 |
| 10 | STEEL INDIR | ALKALINE. CLEANING | PSES1 | 6.080 | 0.3501 | 17.5054 |
| 11 | STEEL INDIR | HOT. COATING. SCRUBB | PSES1 | 7.261 | 0.2989 | 17.8771 |
| 12 | STEEL INDIR | SINTERING | PSES1 | 7.984 | 0.2847 | 17.9902 |
| 13 | STEEL INDIR | FURNACE. COKE | PSES5 | 8.105 | 0.2381 | 18.3672 |
| 14 | STEEL INDIR | HOT. COATING. SCRUBB | *PSES2 | 17.540 | 0.2366 | 18.3931 |
| 15 | STEEL INDIR | COLD. ROLLING | *PSES1 | 20.990 | 0.2361 | 18.4043 |
| 16 | STEEL INDIR | HOT. COATING. SCRUBB | PSES3 | 23.510 | 0.2283 | 18.5883 |
| 17 | STEEL INDIR | PICKLING. COMBINATI | PSES2 | 35.630 | 0.2237 | 18.7513 |
| 18 | STEEL INDIR | COLD. ROLLING | PSES2 | 37.700 | 0.2231 | 18.7753 |
| 19 | STEEL INDIR | HOT. COATING. NO. SCR | PSES3 | 40.310 | 0.2169 | 19.0258 |
| 20 | STEEL INDIR | MERCHANT. COKE | PSES5 | 43.060 | 0.2067 | 19.4618 |
| 21 | STEEL INDIR | PICKLING. HCL | PSES2 | 47.500 | 0.1946 | 20.0368 |
| 22 | STEEL INDIR | SINTERING | PSES3 | 48.730 | 0.1945 | 20.0423 |
| 23 | STEEL INDIR | PICKLING. HCL | PSES3 | 62.530 | 0.1927 | 20.1573 |
| 24 | STEEL INDIR | PICKLING. H2SO4 | PSES3 | 71.350 | 0.1777 | 21.2273 |
| 25 | STEEL INDIR | BLAST. FURNACE | PSES7 | 82.470 | 0.1615 | 22.5571 |
| 26 | STEEL INDIR | SINTERING | PSES6 | 90.850 | 0.1509 | 23.5245 |
| 27 | STEEL INDIR | ALKALINE. CLEANING | *PSES2 | 106.800 | 0.1508 | 23.5315 |
| 28 | STEEL INDIR | PICKLING. COMBINATI | PSES3 | 119.100 | 0.1499 | 23.6455 |
| 29 | STEEL INDIR | HOT. FORMING. STRIP. | PSES2 | 1064.000 | 0.1486 | 25.0275 |
| 30 | STEEL INDIR | HOT. FORMING. SECTIO | PSES2 | 1307.000 | 0.1467 | 27.4455 |
| 31 | STEEL INDIR | BOF. OPENCOMBUSTION | PSES4 | 1397.000 | 0.1455 | 29.1455 |
| 32 | STEEL INDIR | HOT. FORMING. PRIMAR | PSES2 | 1454.000 | 0.1446 | 30.4005 |
| 33 | STEEL INDIR | HOT. FORMING. PLATE | PSES2 | 1490.000 | 0.1445 | 30.6105 |
| 34 | STEEL INDIR | HOT. COATING. SCRUBB | PSES4 | 2082.000 | 0.1432 | 33.3109 |
| 35 | STEEL INDIR | BOF. SUPPRESSED. COM | PSES4 | 2230.000 | 0.1429 | 34.0879 |
| 36 | STEEL INDIR | HOT. FORMING. PIPE. A | PSES2 | 2433.000 | 0.1428 | 34.1725 |
| 37 | STEEL INDIR | HOT. COATING. NO. SCR | PSES4 | 4019.000 | 0.1420 | 37.6765 |
| 38 | STEEL INDIR | COLD ROLLING | PSES4 | 4303.000 | 0.1417 | 38.7423 |
| 39 | STEEL INDIR | PICKLING. HCL | PSES4 | 4534.000 | 0.1409 | 42.1823 |
| 40 | STEEL INDIR | PICKLING. H2SO4 | PSES4 | 7403.000 | 0.1398 | 50.2933 |
| 41 | STEEL INDIR | ALKALINE. CLEANING | PSES3 | 11070.000 | 0.1398 | 50.6553 |
| 42 | STEEL INDIR | PICKLING. COMBINATI | PSES4 | 11180.000 | 0.1394 | 54.8883 |
| 43 | STEEL INDIR | CONTINUOUS. CASTING | PSES3 | 16290.000 | 0.1393 | 56.3883 |
| 44 | STEEL INDIR | HOT. FORMING. PLATE | PSES3 | 37610.000 | 0.1393 | 56.9803 |
| 45 | STEEL INDIR | HOT. FORMING. STRIP. | PSES3 | 43630.000 | 0.1392 | 63.2723 |
| 46 | STEEL INDIR | HOT. FORMING. SECTIO | PSES3 | 49070.000 | 0.1390 | 71.6643 |
| 47 | STEEL INDIR | HOT. FORMING. PRIMAR | PSES3 | 49080.000 | 0.1389 | 76.4963 |
| 48 | STEEL INDIR | HOT. FORMING PIPE. A | PSES3 | 68650.000 | 0.1389 | 76.9737 |

* SELECTED OPTION

EXHIBIT 19-11

STEEL INDIR

COMPARISONS OF SELEC ) AND OPTIMAL OPTIONS

| PROCESS | SELECTED | 5 | 9 |
|---|---|---|---|
| FURNACE. COKE | PSES1 | *PSES3 | *PSES3 |
| MERCHANT. COKE | PSES1 | PSES1 | *PSES3 |
| SINTERING | PSES2 | *CURRENT | *CURRENT |
| BLAST. FURNACE | PSES5 | *CURRENT | PSES5 |
| BOF. SUPPRESSED. COMBU | PSES3 | *CURRENT | *CURRENT |
| BOF. OPENCOMBUSTION | PSES3 | *CURRENT | *CURRENT |
| CONTINUOUS. CASTING | PSES2 | *CURRENT | *CURRENT |
| HOT. FORMING. PRIMARY | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. SECTION | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. STRIP. SH | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. PLATE | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. PIPE. AND | PSES1 | *CURRENT | *CURRENT |
| ALKALINE. CLEANING | PSES2 | *CURRENT | *CURRENT |
| DESCALING | CURRENT | * | * |
| COLD. ROLLING | PSES1 | *CURRENT | *CURRENT |
| COLD. ROLLING. PIPE. TU | PSES1 | * | * |
| PICKLING. H2SO4 | PSES1 | PSES1 | PSES1 |
| PICKLING. HCL | PSES1 | PSES1 | PSES1 |
| PICKLING. COMBINATION | PSES1 | PSES1 | PSES1 |
| HOT. COATING. NO. SCRUB | PSES1 | *CURRENT | *PSES2 |
| HOT. COATING. SCRUBBER | PSES2 | *CURRENT | *CURRENT |
| TOTAL COST($MM) | 17.01 | 15.73 | 17.50 |
| TOTAL HAZARD(MM HU) | 2.52 | 1.18 | 0.35 |
| COST-EFFECTIVENESS($/HU) | - | 0.84 | 5.93 |

EXHIBIT IV-12

IRON AND STEEL - INDIRECT DISCHARGERS
OPTIMAL COST-EFFLUENT FRONTIER

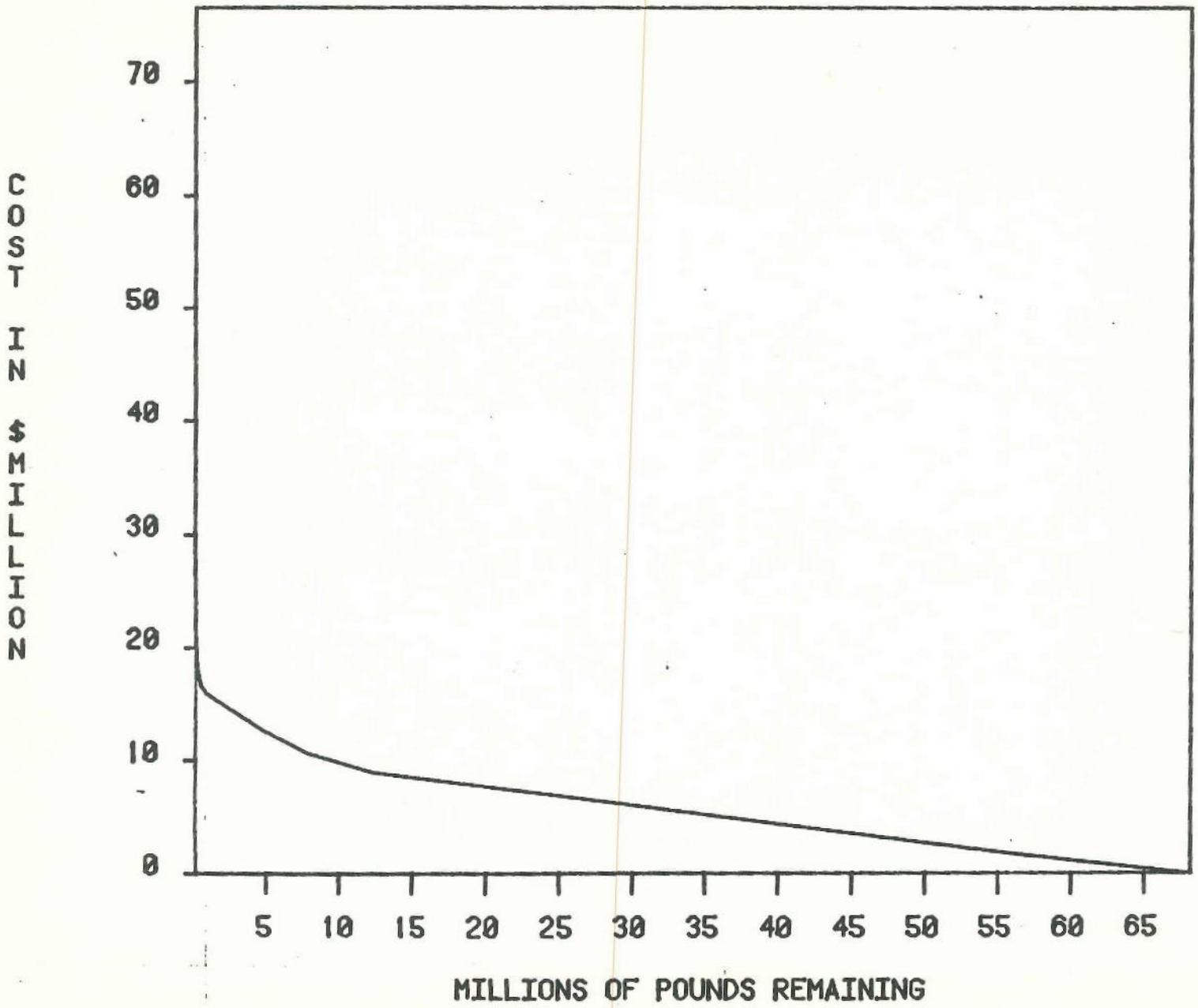


EXHIBIT IV-13

IRON AND STEEL - INDIRECT DISCHARGERS
OPTIMAL COST-EFFLUENT FRONTIER

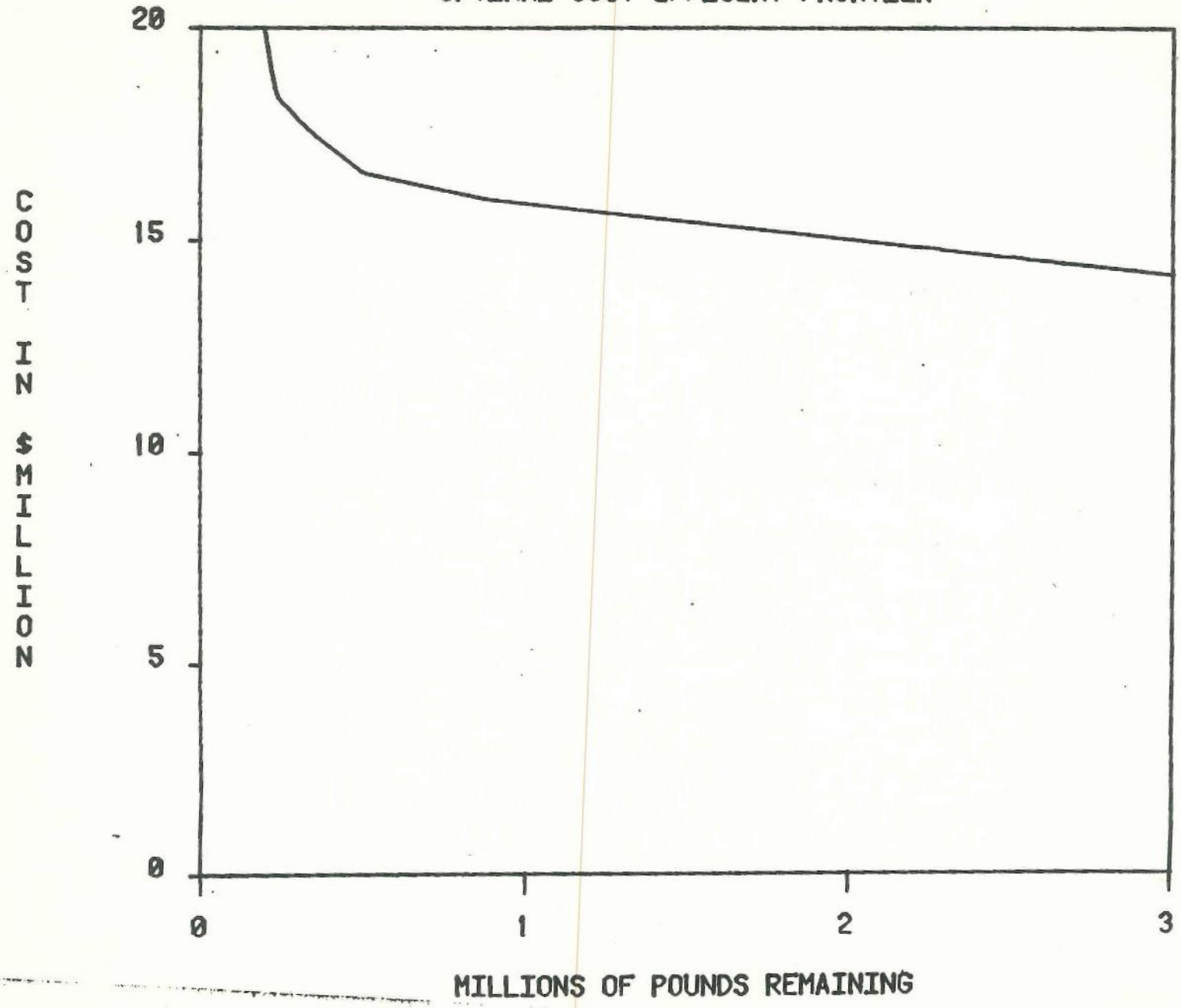


EXHIBIT II-2

IDUSTRY: IRON AND STEEL - INDIRECTS - NO PCE IN PLACE

| POLLUTANT | P/E WEIGHT | LOAD (CURRENT) | LOAD (SELECTED) | P/E (CURRENT) | P/E (SELECTED) | PERCENT REMOVAL |
|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.011000 | 0.0359 | 0.0060 | 0.0004 | 0.0001 | 83.3333 |
| ACRYLONITRILE | 0.000740 | 27.0790 | 3.6251 | 0.0200 | 0.0027 | 86.6127 |
| AMMONIA | 0.280000 | 15987.8643 | 895.6462 | 4476.6021 | 250.7809 | 94.3980 |
| ANTIMONY | 0.003500 | 18.3508 | 3.1653 | 0.0642 | 0.0111 | 82.7510 |
| ARSENIC | 0.000650 | 86.3295 | 18.5911 | 0.0561 | 0.0121 | 78.4650 |
| BENZENE | 0.000550 | 789.8027 | 145.0058 | 0.4344 | 0.0798 | 81.6403 |
| BERYLLIUM | 1.100000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CADMIUM | 7.000000 | 33.3616 | 0.7860 | 233.5311 | 5.5017 | 97.6441 |
| CARBONTETRACHLORIDE | 0.000160 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| 1.1.1. TRICHLOROETHANE | 0.000043 | 0.0419 | 0.0419 | 0.0000 | 0.0000 | 0.0000 |
| CHLORINE | 2.800000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CHLOROFORM | 0.002250 | 9.8137 | 4.5526 | 0.0221 | 0.0102 | 53.6095 |
| 2 CHLOROPHENOL | 0.002800 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| 3CHROMIUM. TRIVALENT | 0.035100 | 1600.0695 | 13.7150 | 56.1624 | 0.4814 | 99.1428 |
| 6CHROMIUM. HEXAVALENT | 5.130000 | 99.9963 | 0.1335 | 512.9808 | 0.6849 | 99.8665 |
| COPPER | 0.180000 | 3030.5413 | 10.1335 | 545.4974 | 1.8240 | 99.6656 |
| CYANIDE | 0.736000 | 2538.5295 | 233.9554 | 1868.3578 | 172.1912 | 90.7838 |
| 2.4. DICHLOROPHENOL | 0.015000 | 1.1708 | 0.0511 | 0.0176 | 0.0008 | 95.6325 |
| 2 4 DIMETHYLPHENOL | 0.002600 | 118.6828 | 14.5517 | 0.3086 | 0.0378 | 87.7390 |
| 2.4. DINITROTOLUENE | 0.024000 | 6.8846 | 2.2899 | 0.1652 | 0.0550 | 66.7383 |
| ETHYLBENZENE | 0.000034 | 338.5167 | 55.1321 | 0.0116 | 0.0019 | 83.7136 |
| FLUORANTHENE | 0.001400 | 18.4951 | 3.1674 | 0.0259 | 0.0044 | 82.8744 |
| IRON | 0.005600 | 139110.2813 | 43.9716 | 779.0175 | 0.2462 | 99.9684 |
| ISOPHORONE | 0.000048 | 11.2827 | 4.3500 | 0.0005 | 0.0002 | 61.4452 |
| LEAD | 0.705000 | 3239.1206 | 7.0975 | 2283.5801 | 5.0037 | 99.7809 |
| MANGANESE | 0.003700 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| MERCURY | 12.599999 | 0.6223 | 0.0151 | 7.8405 | 0.1897 | 97.5802 |
| NAPHTHALENE | 0.009000 | 677.9912 | 72.5090 | 6.1019 | 0.6526 | 89.3053 |
| NICKEL | 0.039440 | 4116.2769 | 14.0586 | 162.3460 | 0.5545 | 99.6585 |
| NITRATES | 0.093000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| NITROPHENOLS | 0.037000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| OIL AND GREASE | 0.000000 | 50904.6250 | 2098.2327 | 0.0000 | 0.0000 | 95.8781 |
| PENTACHLOROPHENOL | 0.126000 | 2.7081 | 1.1600 | 0.3412 | 0.1462 | 57.1661 |
| PHENOL | 0.000506 | 13406.8057 | 957.3699 | 6.7838 | 0.4844 | 92.8591 |
| PHTHALATE ESTERS | 1.330000 | 112.8289 | 29.0011 | 150.0625 | 38.5715 | 74.2964 |
| SELENIUM | 0.032000 | 20.2786 | 3.0496 | 0.6489 | 0.0976 | 84.9614 |
| SILVER | 12.690000 | 3.5063 | 0.3748 | 44.4944 | 4.7565 | 89.3100 |
| SULFIDES | 2.800000 | 3384.8682 | 725.0292 | 9477.6309 | 2030.0818 | 78.5803 |
| TETRACHLOROETHYLENE | 0.001206 | 0.2655 | 0.2596 | 0.0003 | 0.0003 | 2.2542 |
| THALLIUM | 0.140000 | 1.8398 | 0.1875 | 0.2576 | 0.0262 | 89.8088 |
| TOLUENE | 0.000026 | 564.1686 | 72.5269 | 0.0144 | 0.0019 | 87.1445 |
| TRICHLOROETHYLENE | 0.000036 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| TSS | 0.000000 | 1913963.2500 | 6696.9097 | 0.0000 | 0.0000 | 99.5577 |
| ZINC | 0.024000 | 6313.0947 | 15.2728 | 151.5143 | 0.3665 | 99.7581 |
| TOTAL LOAD | | 1760539.3750 | 12145.9258 | | | 99.3101 |
| TOTAL HAZARD | | | | 20764.8926 | 2512.8599 | 87.8985 |

Source: TBS CE Model

*P/E: "pounds equivalent"

EXHIBIT II-3

INDUSTRY: IRON AND STEEL - INDIRECTS - WITH PCE IN PLACE

| POLLUTANT | P/E WEIGHT | LOAD (CURRENT) | LOAD (SELECTED) | P/E (CURRENT) | P/E (SELECTED) | PERCENT REMOVAL |
|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.011000 | 0.0081 | 0.0060 | 0.0001 | 0.0001 | 25.9259 |
| ACRYLONITRILE | 0.000740 | 8.9448 | 2.1844 | 0.0066 | 0.0016 | 75.5787 |
| AMMONIA | 0.280000 | 5809.5205 | 1952.1967 | 1626.6658 | 546.6151 | 66.3966 |
| ANTIMONY | 0.003500 | 8.7021 | 4.3698 | 0.0305 | 0.0153 | 49.7838 |
| ARSENIC | 0.000650 | 36.8720 | 17.2801 | 0.0240 | 0.0112 | 53.1349 |
| BENZENE | 0.000550 | 235.1007 | 49.5359 | 0.1293 | 0.0272 | 78.9299 |
| BERYLLIUM | 1.100000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CADMIUM | 7.000000 | 2.3878 | 0.7860 | 16.7143 | 5.5017 | 67.0835 |
| CARBONTETRACHLORIDE | 0.000160 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| 1 1 1 TRICHLOROETHANE | 0.000043 | 0.0419 | 0.0419 | 0.0000 | 0.0000 | 0.0000 |
| CHLORINE | 2.800000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| CHLOROFORM | 0.002250 | 8.0633 | 6.9614 | 0.0181 | 0.0157 | 13.6660 |
| 2 CHLOROPHENOL | 0.002800 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| 3CHROMIUM. TRIVALENT | 0.035100 | 421.5833 | 13.7150 | 14.7976 | 0.4814 | 96.7468 |
| 6CHROMIUM. HEXAVALENT | 5.130000 | 36.1897 | 0.1335 | 185.6532 | 0.6849 | 99.6311 |
| COPPER | 0.180000 | 121.2046 | 10.1335 | 21.8168 | 1.8240 | 91.6394 |
| CYANIDE | 0.736000 | 552.3950 | 181.8151 | 406.5627 | 133.8159 | 67.0860 |
| 2 4 DICHLOROPHENOL | 0.015000 | 0.1407 | 0.0511 | 0.0021 | 0.0008 | 63.6591 |
| 2 4 DIMETHYLPHENOL | 0.002600 | 33.5925 | 4.7823 | 0.0873 | 0.0124 | 85.7639 |
| 2 4 DINITROTOLUENE | 0.024000 | 2.9633 | 1.6483 | 0.0711 | 0.0396 | 44.3768 |
| ETHYLBENZENE | 0.000034 | 103.4903 | 21.8808 | 0.0035 | 0.0007 | 78.8571 |
| FLUORANTHENE | 0.001400 | 6.6154 | 2.2374 | 0.0093 | 0.0031 | 66.1782 |
| IRON | 0.005600 | 39110.2383 | 43.9716 | 331.0173 | 0.2462 | 99.9256 |
| ISOPHORONE | 0.000048 | 5.4890 | 3.5116 | 0.0003 | 0.0002 | 36.0250 |
| LEAD | 0.705000 | 105.8039 | 7.0975 | 74.5918 | 5.0037 | 93.2919 |
| MANGANESE | 0.003700 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| MERCURY | 12.599999 | 0.0151 | 0.0151 | 0.1897 | 0.1897 | 0.0000 |
| NAPHTHALENE | 0.009000 | 196.9810 | 22.5482 | 1.7728 | 0.2029 | 88.5531 |
| NICKEL | 0.039440 | 374.3150 | 14.0586 | 14.7630 | 0.5545 | 96.2442 |
| NITRATES | 0.093000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| NITROPHENOLS | 0.037000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| OIL AND GREASE | 0.000000 | 4130.3496 | 2123.0842 | 0.0000 | 0.0000 | 48.5980 |
| PENTACHLOROPHENOL | 0.126000 | 1.0058 | 0.5653 | 0.1267 | 0.0712 | 43.7923 |
| PHENOL | 0.000506 | 3805.4871 | 301.0034 | 1.9256 | 0.1523 | 92.0903 |
| PHTHALATE. ESTERS | 1.330000 | 54.8909 | 30.8306 | 73.0049 | 41.0047 | 43.8329 |
| SELENIUM | 0.032000 | 4.2407 | 3.2326 | 0.1357 | 0.1034 | 23.7709 |
| SILVER | 12.690000 | 0.5177 | 0.3748 | 6.5696 | 4.7565 | 27.5983 |
| SULFIDES | 2.800000 | 1001.2146 | 236.5503 | 2803.4009 | 662.3415 | 76.3736 |
| TETRACHLOROETHYLENE | 0.001206 | 0.2600 | 0.2596 | 0.0003 | 0.0003 | 0.1612 |
| THALLIUM | 0.140000 | 0.1879 | 0.1875 | 0.0263 | 0.0262 | 0.2310 |
| TOLUENE | 0.000026 | 169.8609 | 28.1308 | 0.0043 | 0.0007 | 83.4389 |
| TRICHLOROETHYLENE | 0.000036 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 100.0000 |
| TSS | 0.000000 | 41614.2969 | 7144.5376 | 0.0000 | 0.0000 | 82.8315 |
| ZINC | 0.024000 | 781.7322 | 15.4557 | 18.7616 | 0.3709 | 98.0229 |
| TOTAL LOAD | | 118744.7031 | 12245.1758 | | | 89.6878 |
| TOTAL HAZARD | | | | 5598.8838 | 1404.0762 | 74.9222 |

Source: TBS CE Model

*P/E: "pounds equivalent"

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/ P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000 P/E) | #INC. TO |
|---|---|---|---|---|---|---|
| HOT. FORMING. SECTION | CURRENT | - | 0.00 | 0.0 | 1.0 | - |
| | *PSES1 | - | 0.00 | 0.0 | 1.0 | - |
| | PSES2 | 2519.7881 | 91.54 | 2418.0 | 0.1 | CURRENT |
| | PSES3 | 94617.2734 | 100.00 | 10806.0 | 0.0 | PSES2 |
| HOT. FORMING. STRIP. SHEET | CURRENT | - | 0.00 | 0.0 | 0.7 | - |
| | *PSES1 | - | 0.00 | 0.0 | 0.7 | - |
| | PSES2 | 2051.8870 | 90.01 | 1382.0 | 0.1 | CURRENT |
| | PSES3 | 84124.2969 | 100.00 | 7674.0 | 0.0 | PSES2 |
| HOT. FORMING. PLATE | CURRENT | - | 0.00 | 0.0 | 0.1 | - |
| | *PSES1 | - | 0.00 | 0.0 | 0.1 | - |
| | PSES2 | 2873.3435 | 89.95 | 210.0 | 0.0 | CURRENT |
| | PSES3 | 72524.0703 | 100.00 | 802.0 | 0.0 | PSES2 |
| HOT. FORMING. PIPE. AND. TUB | CURRENT | - | 0.00 | 0.0 | 0.0 | - |
| | *PSES1 | - | 0.00 | 0.0 | 0.0 | - |
| | PSES2 | 4691.1123 | 83.33 | 84.6 | 0.0 | CURRENT |
| | PSES3 | ********** | 100.00 | 562.0 | 0.0 | PSES2 |
| ALKALINE. CLEANING | CURRENT | - | 0.00 | 0.0 | 9.1 | - |
| | PSES1 | 0.7449 | 99.26 | 6.7 | 0.1 | CURRENT |
| | *PSES2 | 752.0871 | 99.36 | 13.7 | 0.1 | PSES1 |
| | PSES3 | 6221.5703 | 100.00 | 375.7 | 0.0 | PSES2 |
| DESCALING | *CURRENT | - | 0.00 | 0.0 | 1.9 | - |
| | PSES1 | - | 0.00 | 0.0 | 1.9 | - |
| COLD. ROLLING | CURRENT | - | 0.00 | 0.0 | 0.9 | - |
| | *PSES1 | 71.7410 | 16.65 | 11.2 | 0.8 | CURRENT |
| | PSES2 | 695.3914 | 20.32 | 35.2 | 0.7 | PSES1 |
| | PSES3 | ********** | 20.33 | 521.2 | 0.7 | PSES2 |
| | PSES4 | 1426.4967 | 100.00 | 1101.2 | 0.0 | PSES2 |
| COLD. ROLLING. PIPE. TUBE | CURRENT | - | 0.00 | 0.0 | 0.2 | - |
| | *PSES1 | - | 0.00 | 0.0 | 0.2 | - |
| PICKLING. H2SO4 | CURRENT | - | 0.00 | 0.0 | 267.1 | - |
| | *PSES1 | 27.5700 | 97.20 | 7158.9 | 7.5 | CURRENT |
| | PSES2 | 156.1776 | 99.22 | 7998.9 | 2.1 | PSES1 |
| | PSES3 | 1962.5111 | 99.26 | 8228.9 | 2.0 | PSES2 |
| | PSES4 | 4108.9751 | 100.00 | 16338.9 | 0.0 | PSES3 |
| PICKLING. HCL | CURRENT | - | 0.00 | 0.0 | 99.2 | - |
| | *PSES1 | 18.5433 | 98.16 | 1806.3 | 1.8 | CURRENT |
| | PSES2 | 382.9099 | 99.68 | 2381.3 | 0.3 | PSES1 |
| | PSES3 | 1851.6814 | 99.74 | 2496.3 | 0.3 | PSES2 |
| | PSES4 | 13272.6387 | 100.00 | 5936.3 | 0.0 | PSES3 |
| PICKLING. COMBINATION | CURRENT | - | 0.00 | 0.0 | 42.7 | - |
| | *PSES1 | 69.0435 | 98.45 | 2905.6 | 0.7 | CURRENT |
| | PSES2 | 311.0258 | 99.68 | 3068.6 | 0.1 | PSES1 |
| | PSES3 | 5009.9199 | 99.73 | 3182.6 | 0.1 | PSES2 |
| | PSES4 | 36754.6914 | 100.00 | 7415.6 | 0.0 | PSES3 |

*P/E: "pounds equivalent"

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000 P/) | #INC. TO |
|---|---|---|---|---|---|---|
| HOT. COATING. NO. SCRUB | CURRENT | - | 0.00 | 0.0 | 33.5 | - |
| | *PSES1 | 27.3186 | 93.39 | 855.5 | 2.2 | CURRENT |
| | PSES2 | 27.1127 | 94.10 | 855.5 | 2.0 | CURRENT |
| | PSES3 | 143.0249 | 99.31 | 1105.5 | 0.2 | PSES2 |
| | PSES4 | 15158.8477 | 100.00 | 4609.5 | 0.0 | PSES3 |
| HOT. COATING. SCRUBBER | CURRENT | - | 0.00 | 0.0 | 180.7 | - |
| | PSES1 | 2.0715 | 99.30 | 371.7 | 1.3 | CURRENT |
| | *PSES2 | 147.1243 | 99.40 | 397.6 | 1.1 | PSES1 |
| | PSES3 | 215.9439 | 99.87 | 581.6 | 0.2 | PSES2 |
| | PSES4 | 11467.8066 | 100.00 | 3281.6 | 0.0 | PSES3 |
| TOTALS | CURRENT | - | 0.00 | 0.0 | 5598.9 | - |
| | PSES1 | 4.0430 | 74.79 | 16929.4 | 1411.5 | - |
| | PSES2 | 6.6103 | 83.18 | 28178.0 | 910.2 | - |
| | PSES3 | 9.2753 | 97.71 | 48781.2 | 128.2 | - |
| | PSES4 | 2890.8926 | 97.78 | 46333.7 | 124.2 | - |
| | PSES5 | 38.0245 | 98.15 | 6121.1 | 91.6 | - |
| | PSES6 | 483.4392 | 97.55 | 1921.3 | 4.7 | - |
| | PSES7 | 282.1372 | 100.00 | 1625.2 | 0.0 | - |
| SELECTED OPTIONS | * | 4.2479 | 74.92 | 17006.9 | 1404.1 | - |

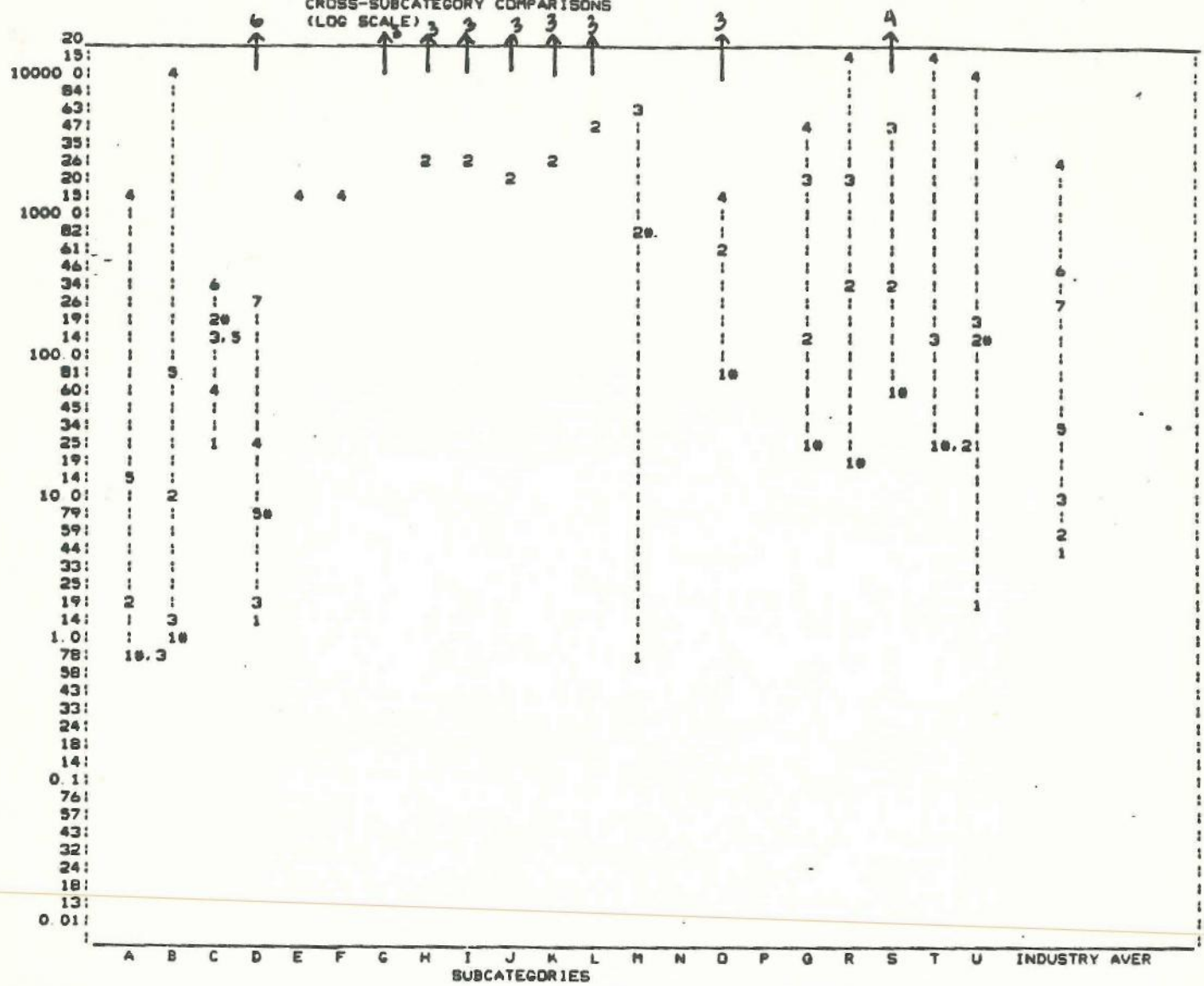
* SELECTED OPTIONS
\# INDICATES INCREMENT FROM WHICH COST-EFFECTIVENESS IS CALCULATED.

Source: TBS CE Model

*P/E: "pounds equivalent"

EXHIBIT II-5

IRO D STEEL - INDIRECTS
CROSS-SUBCATEGORY COMPARISONS
(LOG SCALE)




Source: TBS CE Model

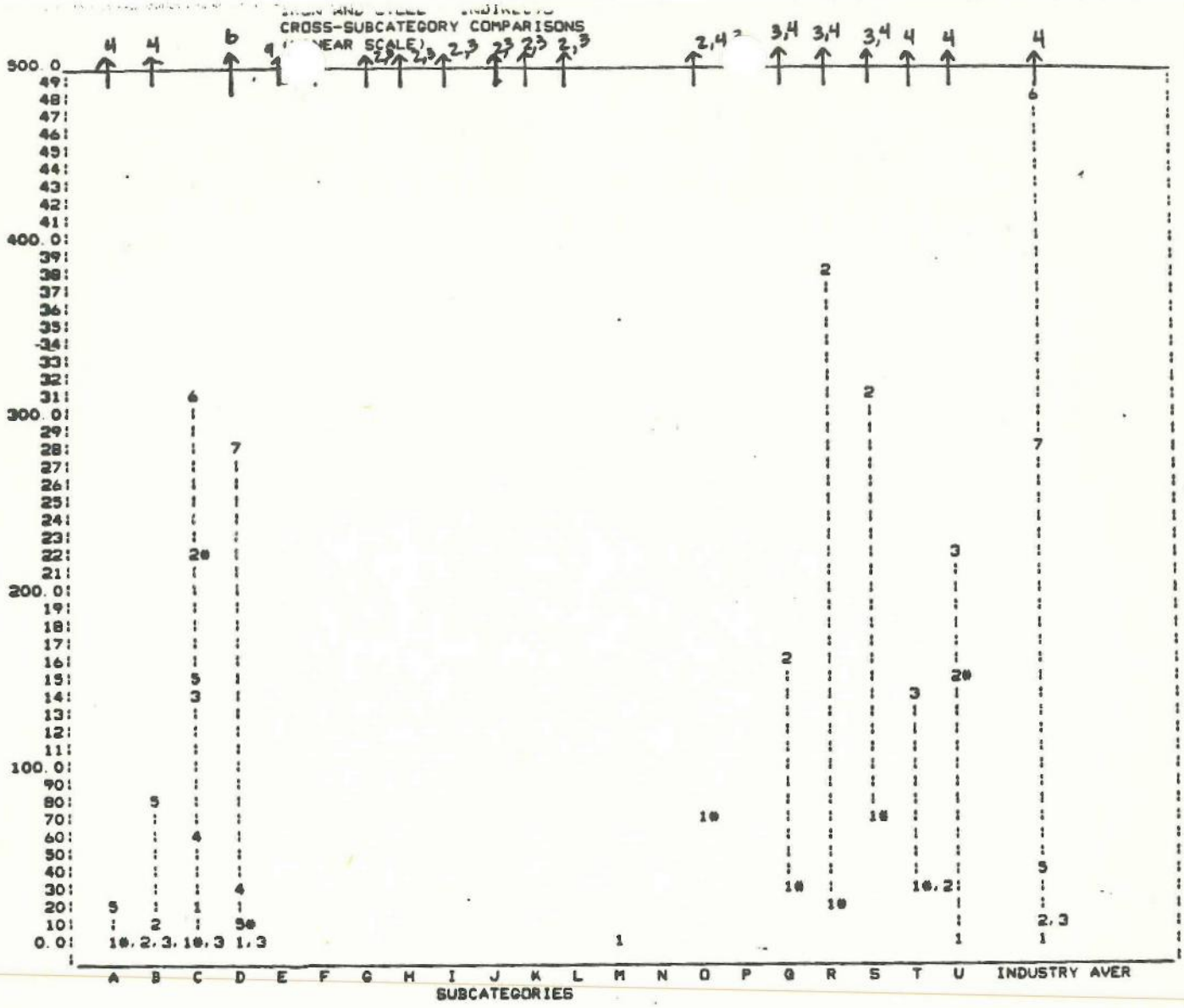
SUBCATEGORIES (COST-EFF)

| | | |
|---|---|---|
| A | FURNACE. COKE | ( 0.863573) |
| B | MERCHANT. COKE | ( 1.143785) |
| C | SINTERING | (219.962698) |
| D | BLAST. FURNACE | ( 7.655822) |
| E | BOF SUPPRESSED. COMBUSTION | (.....) |
| F | BOF. OPENCOMBUSTION | (.....) |
| G | CONTINUOUS. CASTING | (.....) |
| H | HOT. FORMING. PRIMARY | (.....) |
| I | HOT FORMING SECTION | (.....) |
| J | HOT. FORMING. STRIP SHEET | (.....) |
| K | HOT. FORMING. PLATE | (.....) |
| L | HOT. FORMING. PIPE AND TUBE | (.....) |
| M | ALKALINE. CLEANING | (752 087585) |
| N | DESCALING | (.....) |
| O | COLD. ROLLING | ( 71.740990) |
| P | COLD. ROLLING PIPE. TUBE | (.....) |
| Q | PICKLING. H2SO4 | ( 27.570023) |
| R | PICKLING. HCL | ( 18.943318) |
| S | PICKLING. COMBINATION | ( 69.043480) |
| T | HOT. COATING NO SCRUB | ( 27.318640) |
| U | HOT COATING. SCRUBBER | (147.124359) |
| + | INDUSTRY AVERAGE | |

CONTROL OPTIONS

| | |
|---|---|
| 1 | PSES1 |
| 2 | PSES2 |
| 3 | PSES3 |
| 4 | PSES4 |
| 5 | PSES5 |
| 6 | PSES6 |
| 7 | PSES7 |
| 0 | SELECTED OPTION |

CROSS-SUBCATEGORY COMPARISONS




Source: TBS CE Model

| | | |
|---|---|---|
| SUBCATEGORIES (COST-EFF) | | |
| A | FURNACE. COKE | ( 0.863573) |
| B | MERCHANT. COKE | ( 1.143785) |
| C | SINTERING | (219.562698) |
| D | BLAST. FURNACE | ( 7.655822) |
| E | BOF SUPPRESSED. COMBUSTION | (.....) |
| F | BOF. OPENCOMBUSTION | (.....) |
| G | CONTINUOUS. CASTING | (.....) |
| H | HOT. FORMING. PRIMARY | (.....) |
| I | HOT. FORMING. SECTION | (.....) |
| J | HOT. FORMING. STRIP. SHEET | (.....) |
| K | HOT. FORMING. PLATE | (.....) |
| L | HOT. FORMING. PIPE. AND. TUBE | (.....) |
| M | ALKALINE. CLEANING | (792.087585) |
| N | DESCALING | (.....) |
| O | COLD. ROLLING | ( 71.740990) |
| P | COLD. ROLLING. PIPE. TUBE | (.....) |
| Q | PICKLING. H2SO4 | ( 27.570023) |
| R | PICKLING. HCL | ( 18.943319) |
| S | PICKLING COMBINATION | ( 69.043480) |
| T | HOT COATING NO. SCRUB | ( 27.318640) |
| U | HOT COATING SCRUBBER | (147.124359) |
| * | INDUSTRY AVERAGE | |
| CONTROL OPTIONS | | |
| 1 | PSES1 | |
| 2 | PSES2 | |
| 3 | PSES3 | |
| 4 | PSES4 | |
| 5 | PSES5 | |
| 6 | PSES6 | |
| 7 | PSES7 | |
| 0 | SELECTED OPTION | |

EXHIBIT II-7

INDIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LOG SCALE)

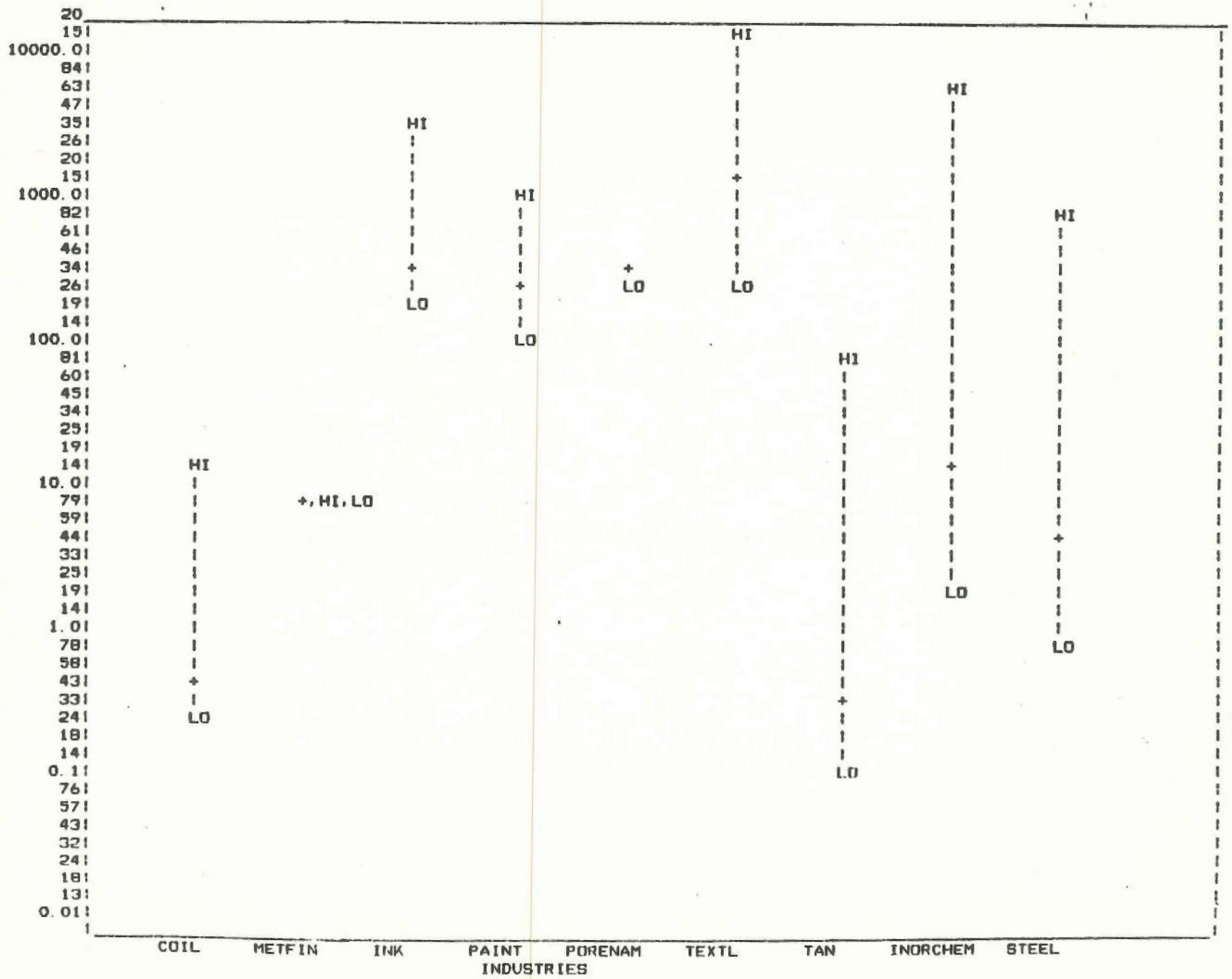


EXHIBIT II-8

INDIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LINEAR SCALE)

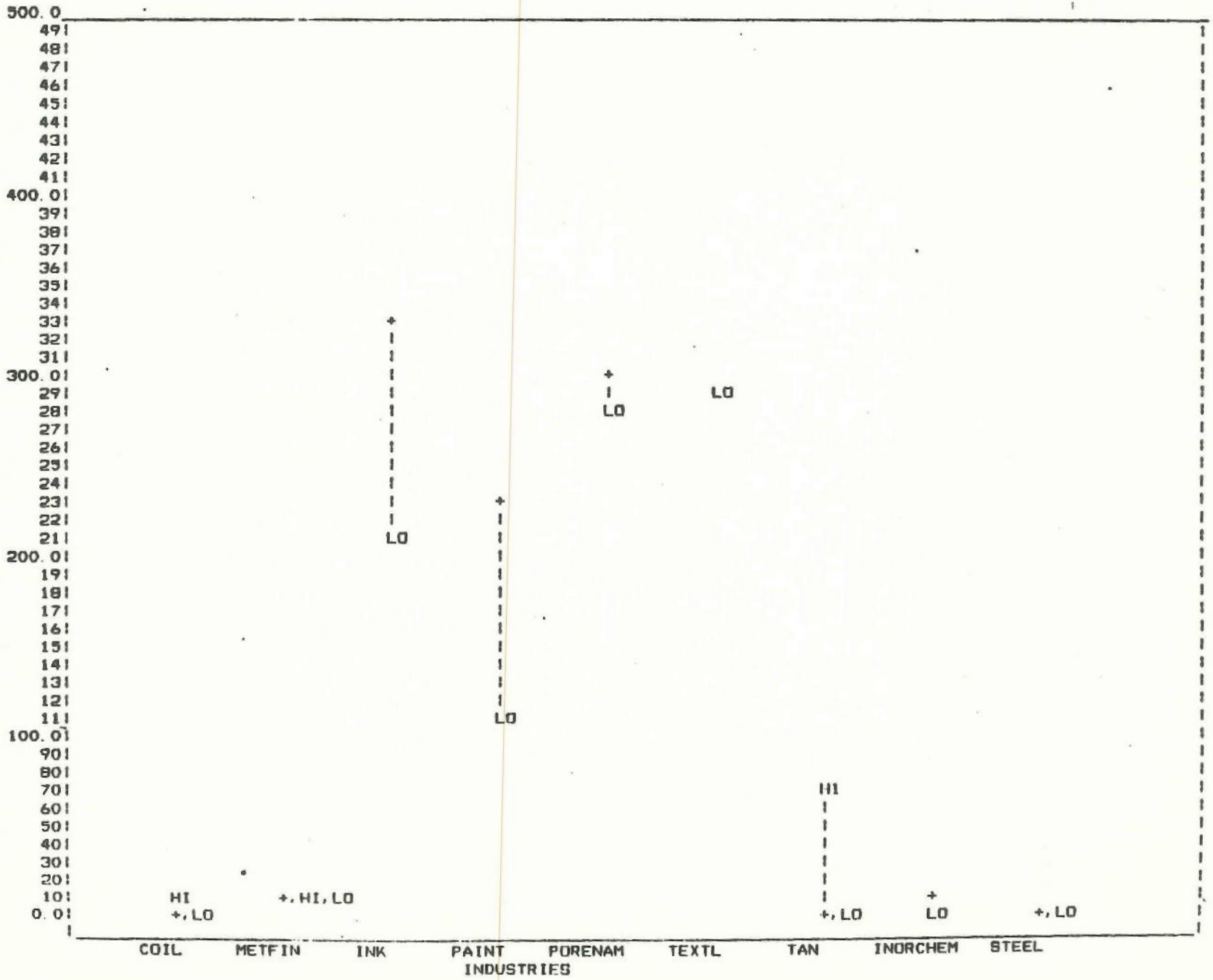


Exhibit II-9

CROSS INDUSTRY COMPARISON
COST-EFFECTIVENESS OF SELECTED OPTIONS
INDIRECT DISCHARGERS

(1978 dollars per hazard unit)

| Industry | Low | Average | High |
|---|---|---|---|
| Coil Coating | $ .25 | $ .45 | $ 14.92 |
| Ink | 209.87 | 329.07 | 3,156.45 |
| Inorganic Chemicals | 1.99 | 13.33 | 7,047.81 |
| Metal Finishing | 7.09 | 7.09 | 7.09 |
| Paint | 112.96 | 228.51 | 1142.06 |
| Porcelain Enameling | 277.34 | 302.80 | 24,316.89 |
| Steel | .86 | 4.25 | 752.09 |
| Tanning | .10 | .32 | 74.15 |
| Textiles | 289.15 | 1,631.79 | 13,370.84 |

EXHIBIT II-10

INCREMENTAL COST-EFFECTIVENESS ANALYSIS

| NO. | INDUSTRY | SUB-CATEGORY | INCREMENTAL OPTION | COST-EFF ($/HU) | EFFLUENT (MM HU) | COST ($MM) |
|---|---|---|---|---|---|---|
| 0 | ALL INDUSTRY | | CURRENT | 0.000 | 5.5971 | 0.0000 |
| 1 | STEEL INDIR | FURNACE. COKE | PSES3 | 0.730 | 3.1852 | 1.7620 |
| 2 | STEEL INDIR | ALKALINE. CLEANING | PSES1 | 0.745 | 3.1762 | 1.7687 |
| 3 | STEEL INDIR | MERCHANT. COKE | *PSES1 | 1.144 | 1.3399 | 3.8687 |
| 4 | STEEL INDIR | BLAST. FURNACE | PSES1 | 1.494 | 1.1674 | 4.1263 |
| 5 | STEEL INDIR | MERCHANT. COKE | PSES3 | 1.505 | 0.7595 | 4.7413 |
| 6 | STEEL INDIR | BLAST. FURNACE | PSES3 | 1.944 | 0.7564 | 4.7474 |
| 7 | STEEL INDIR | HOT. COATING. SCRUBB | PSES1 | 2.071 | 0.5770 | 5.1191 |
| 8 | STEEL INDIR | BLAST. FURNACE | *PSES5 | 7.656 | 0.5729 | 5.1506 |
| 9 | STEEL INDIR | FURNACE. COKE | PSES5 | 16.010 | 0.5493 | 5.5276 |
| 10 | STEEL INDIR | PICKLING. HCL | *PSES1 | 18.540 | 0.4519 | 7.3336 |
| 11 | STEEL INDIR | SINTERING | PSES1 | 22.570 | 0.4469 | 7.4467 |
| 12 | STEEL INDIR | HOT. COATING. NO. SCR | PSES2 | 27.110 | 0.4153 | 8.3022 |
| 13 | STEEL INDIR | PICKLING. H2SO4 | *PSES1 | 27.570 | 0.1557 | 15.4612 |
| 14 | STEEL INDIR | PICKLING. COMBINATI | *PSES1 | 69.040 | 0.1136 | 18.3672 |
| 15 | STEEL INDIR | COLD. ROLLING | *PSES1 | 71.740 | 0.1134 | 18.3784 |
| 16 | STEEL INDIR | MERCHANT. COKE | PSES5 | 85.000 | 0.1083 | 18.8144 |
| 17 | STEEL INDIR | SINTERING | PSES3 | 139.400 | 0.1083 | 18.8199 |
| 18 | STEEL INDIR | HOT. COATING. NO. SCR | PSES3 | 143.000 | 0.1065 | 19.0704 |
| 19 | STEEL INDIR | HOT. COATING. SCRUBB | *PSES2 | 147.100 | 0.1063 | 19.0963 |
| 20 | STEEL INDIR | PICKLING. H2SO4 | PSES2 | 156.200 | 0.1010 | 19.9363 |
| 21 | STEEL INDIR | HOT. COATING. SCRUBB | PSES3 | 215.900 | 0.1001 | 20.1203 |
| 22 | STEEL INDIR | BLAST. FURNACE | PSES7 | 282.100 | 0.0954 | 21.4501 |
| 23 | STEEL INDIR | SINTERING | PSES6 | 310.700 | 0.0923 | 22.4175 |
| 24 | STEEL INDIR | PICKLING. COMBINATI | PSES2 | 311.000 | 0.0918 | 22.5805 |
| 25 | STEEL INDIR | PICKLING. HCL | PSES2 | 382.900 | 0.0903 | 23.1555 |
| 26 | STEEL INDIR | COLD. ROLLING | PSES2 | 695.400 | 0.0902 | 23.1795 |
| 27 | STEEL INDIR | ALKALINE. CLEANING | *PSES2 | 752.100 | 0.0902 | 23.1865 |
| 28 | STEEL INDIR | BOF. SUPPRESSED. COM | PSES4 | 1406.000 | 0.0897 | 23.9635 |
| 29 | STEEL INDIR | COLD. ROLLING | PSES4 | 1426.000 | 0.0889 | 25.0293 |
| 30 | STEEL INDIR | BOF. OPENCOMBUSTION | PSES4 | 1445.000 | 0.0877 | 26.7293 |
| 31 | STEEL INDIR | PICKLING. HCL | PSES3 | 1852.000 | 0.0877 | 26.8443 |
| 32 | STEEL INDIR | PICKLING. H2SO4 | PSES3 | 1963.000 | 0.0876 | 27.0743 |
| 33 | STEEL INDIR | HOT. FORMING. STRIP. | PSES2 | 2052.000 | 0.0869 | 28.4563 |
| 34 | STEEL INDIR | HOT. FORMING. SECTIO | PSES2 | 2520.000 | 0.0859 | 30.8743 |
| 35 | STEEL INDIR | HOT. FORMING. PRIMAR | PSES2 | 2804.000 | 0.0855 | 32.1293 |
| 36 | STEEL INDIR | HOT. FORMING. PLATE | PSES2 | 2873.000 | 0.0854 | 32.3393 |
| 37 | STEEL INDIR | PICKLING. H2SO4 | PSES4 | 4109.000 | 0.0834 | 40.4503 |
| 38 | STEEL INDIR | HOT. FORMING. PIPE. A | PSES2 | 4691.000 | 0.0834 | 40.5349 |
| 39 | STEEL INDIR | PICKLING. COMBINATI | PSES3 | 5010.000 | 0.0834 | 40.6489 |
| 40 | STEEL INDIR | ALKALINE. CLEANING | PSES3 | 6222.000 | 0.0833 | 41.0109 |
| 41 | STEEL INDIR | HOT. COATING. SCRUBB | PSES4 | 11470.000 | 0.0831 | 43.7113 |
| 42 | STEEL INDIR | PICKLING. HCL | PSES4 | 13220.000 | 0.0828 | 47.1513 |
| 43 | STEEL INDIR | HOT. COATING. NO. SCR | PSES4 | 15160.000 | 0.0826 | 50.6553 |
| 44 | STEEL INDIR | CONTINUOUS. CASTING | PSES3 | 22330.000 | 0.0825 | 52.1553 |
| 45 | STEEL INDIR | PICKLING. COMBINATI | PSES4 | 36750.000 | 0.0824 | 56.3883 |
| 46 | STEEL INDIR | HOT. FORMING. PLATE | PSES3 | 72520.000 | 0.0824 | 56.9803 |
| 47 | STEEL INDIR | HOT. FORMING STRIP. | PSES3 | 84120.000 | 0.0823 | 63.2723 |
| 48 | STEEL INDIR | HOT. FORMING. SECTIO | PSES3 | 94620.000 | 0.0822 | 71.6643 |
| 49 | STEEL INDIR | HOT. FORMING. PRIMAR | PSES3 | 94630.000 | 0.0822 | 76.4963 |
| 50 | STEEL INDIR | HOT. FORMING. PIPE. A | PSES3 | 132400.000 | 0.0822 | 76.9737 |

* SELECTED OPTION

EXHIBIT II-11 STEEL INDIR
COMPARISONS OF SELECTED ND OPTIMAL OPTIONS

| PROCESS | SELECTED | 3 | 14 |
|---|---|---|---|
| FURNACE. COKE | PSES1 | *PSES3 | *PSES5 |
| MERCHANT. COKE | PSES1 | PSES1 | *PSES3 |
| SINTERING | PSES2 | *CURRENT | *PSES1 |
| BLAST. FURNACE | PSES5 | *CURRENT | PSES5 |
| BOF. SUPPRESSED. COMBU | PSES3 | *CURRENT | *CURRENT |
| BOF. OPENCOMBUSTION | PSES3 | *CURRENT | *CURRENT |
| CONTINUOUS. CASTING | PSES2 | *CURRENT | *CURRENT |
| HOT. FORMING. PRIMARY | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. SECTION | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. STRIP. SH | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. PLATE | PSES1 | *CURRENT | *CURRENT |
| HOT. FORMING. PIPE. AND | PSES1 | *CURRENT | *CURRENT |
| ALKALINE. CLEANING | PSES2 | *PSES1 | *PSES1 |
| DESCALING | CURRENT | * | * |
| COLD. ROLLING | PSES1 | *CURRENT | *CURRENT |
| COLD. ROLLING. PIPE. TU | PSES1 | * | * |
| PICKLING. H2SO4 | PSES1 | *CURRENT | PSES1 |
| PICKLING. HCL | PSES1 | *CURRENT | PSES1 |
| PICKLING. COMBINATION | PSES1 | *CURRENT | PSES1 |
| HOT. COATING. NO. SCRUB | PSES1 | *CURRENT | *PSES2 |
| HOT. COATING. SCRUBBER | PSES2 | *CURRENT | *PSES1 |
| TOTAL COST($MM) | 17.01 | 3.87 | 18.37 |
| TOTAL HAZARD(MM HU) | 1.40 | 1.34 | 0.11 |
| COST-EFFECTIVENESS($/HU) | - | 1.14 | 69.04 |

EXHIBIT II-12

IRON AND STEEL - INDIRECT DISCHARGERS
OPTIMAL POUNDS EQUIVALENT FRONTIER

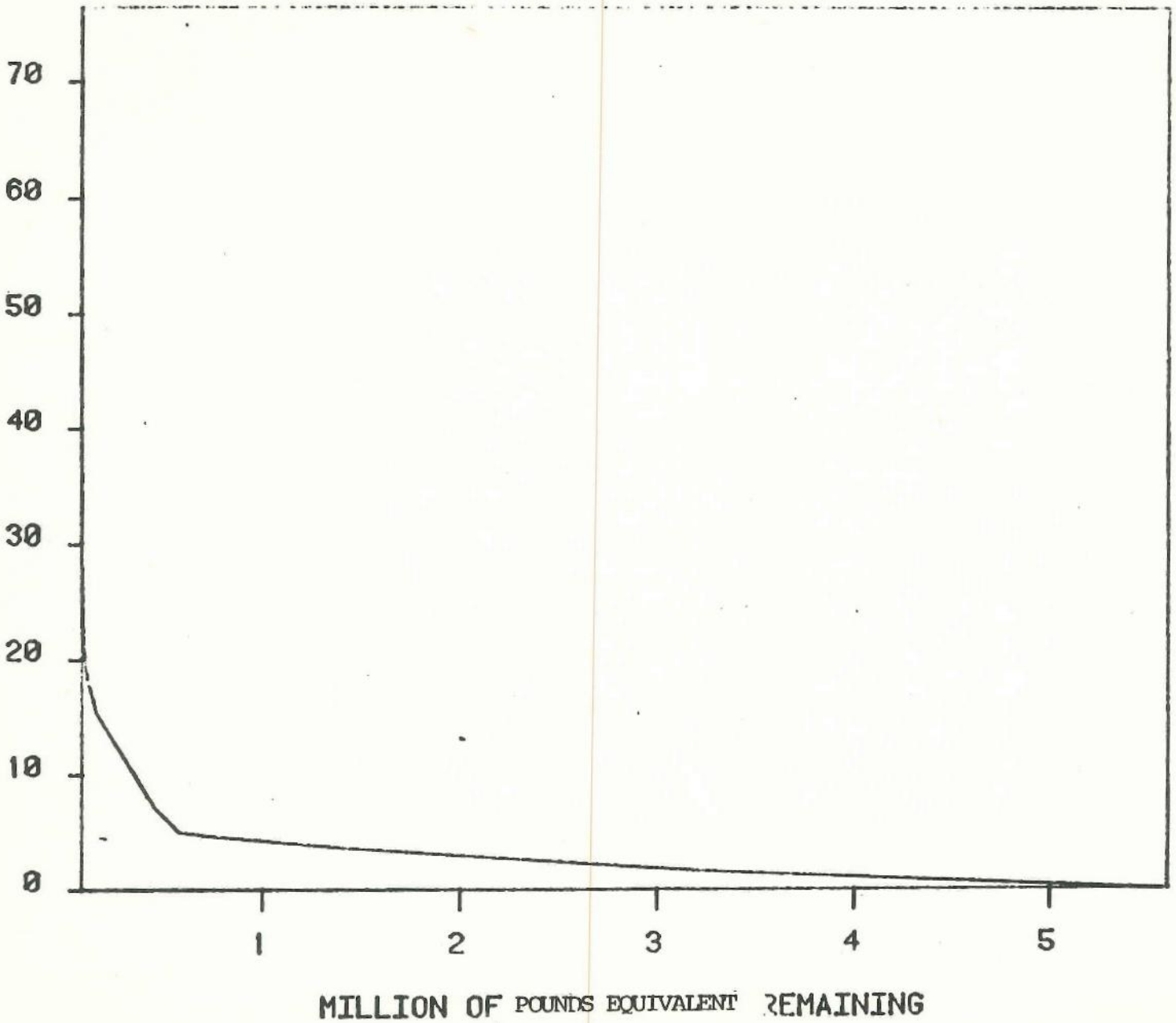
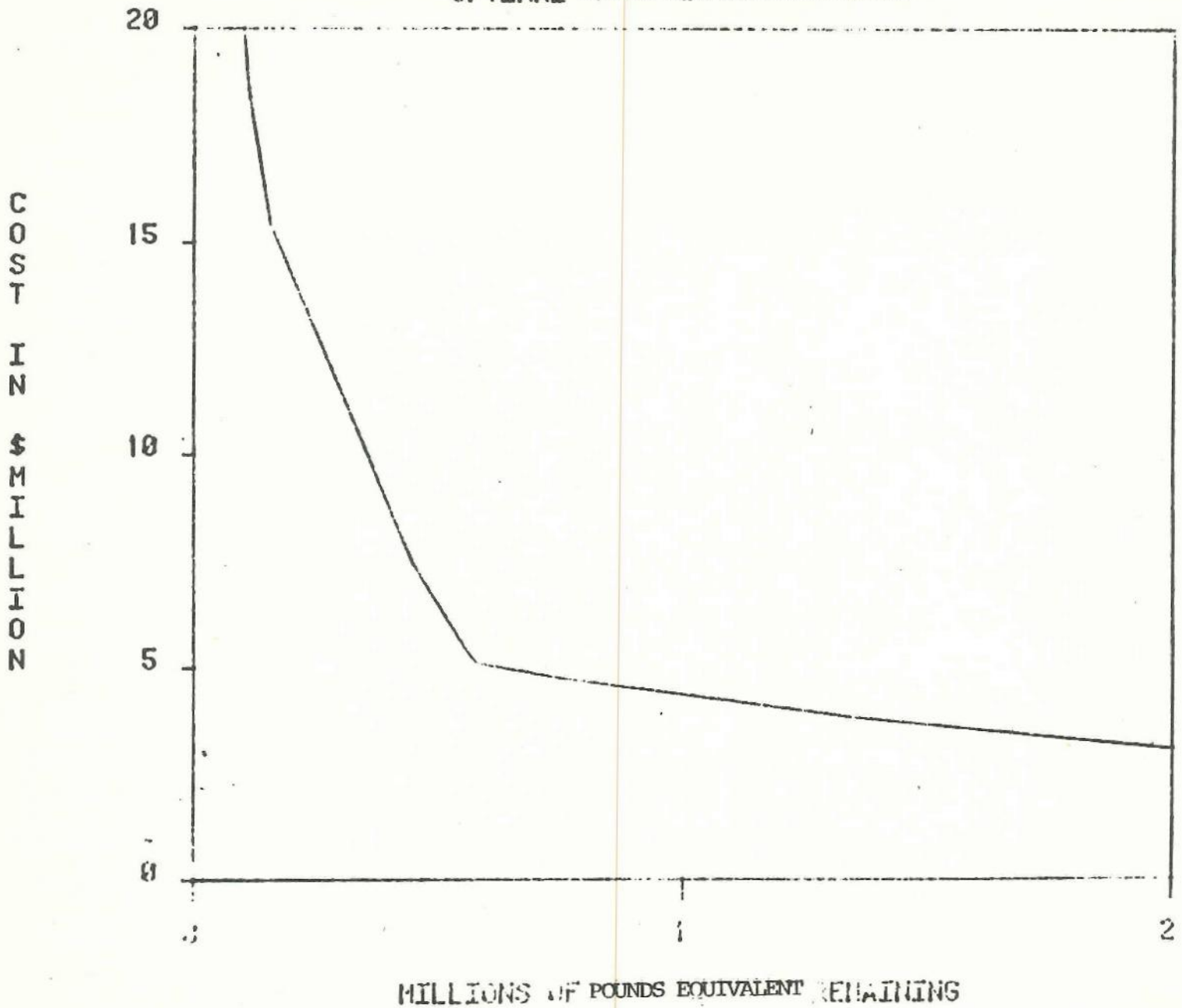


EXHIBIT II-13

IRON AND STEEL - INDIRECT DISCHARGERS
OPTIMAL POUNDS EQUIVALENT FRONTIER



APPENDIX III

- DIRECT DISCHARGERS
- POUNDS ANALYSIS

FOR EXHIBITS III-1, III-2, AND III-3,
SEE EXHIBITS 1, 2, AND 3

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000P/E) | #INC. TO |
|---|---|---|---|---|---|---|
| EAF. SEMI. WET | CURRENT | - | 0.00 | 0.0 | 145.4 | - |
| | *BPT | 0.2723 | 100.00 | 39.6 | 0.0 | CURRENT |
| EAF. WET | CURRENT | - | 0.00 | 0.0 | 91.2 | - |
| | BPT | 0.0000 | 0.00 | 0.0 | 91.2 | CURRENT |
| | BAT1 | 15.7761 | 8.44 | 121.5 | 83.5 | CURRENT |
| | *BAT2 | 2.5445 | 87.22 | 202.5 | 11.7 | CURRENT |
| | BAT3 | 285.5153 | 100.00 | 3532.5 | 0.0 | BAT2 |
| VACUUM. DEGASSING | CURRENT | - | 0.00 | 0.0 | 556.3 | - |
| | BPT | 2.2215 | 97.30 | 1202.5 | 15.0 | CURRENT |
| | *BAT1 | 12.3748 | 98.99 | 1318.9 | 5.6 | BPT |
| | BAT2 | 1016.9759 | 100.00 | 7028.9 | 0.0 | BAT1 |
| CONTINUOUS. CASTING | CURRENT | - | 0.00 | 0.0 | 76.3 | - |
| | BPT | 15.4268 | 74.44 | 876.0 | 19.5 | CURRENT |
| | *BAT1 | 13.1137 | 98.23 | 982.6 | 1.4 | CURRENT |
| | BAT2 | 4269.0967 | 100.00 | 6762.6 | 0.0 | BAT1 |
| HOT. FORMING. PRIMARY | CURRENT | - | 0.00 | 0.0 | 6498.9 | - |
| | *BPT | 0.0000 | 99.30 | -2410.0 | 45.6 | CURRENT |
| | BAT1 | 375.3492 | 99.91 | 12590.0 | 5.6 | BPT |
| | BAT2 | 12256.3008 | 100.00 | 81665.5 | 0.0 | BAT1 |
| HOT. FORMING. SECTION | CURRENT | - | 0.00 | 0.0 | 4680.1 | - |
| | *BPT | 0.4671 | 99.13 | 2167.1 | 40.5 | CURRENT |
| | BAT1 | 330.2766 | 99.90 | 13995.8 | 4.7 | BPT |
| | BAT2 | 12395.8438 | 100.00 | 72425.8 | 0.0 | BAT1 |
| HOT. FORMING. STRIP. SHEET | CURRENT | - | 0.00 | 0.0 | 1887.4 | - |
| | *BPT | 0.5818 | 96.67 | 1061.5 | 62.9 | CURRENT |
| | BAT1 | 282.5620 | 99.59 | 16639.6 | 7.8 | BPT |
| | BAT2 | 11784.8477 | 100.00 | 108719.6 | 0.0 | BAT1 |
| HOT. FORMING. PLATE | CURRENT | - | 0.00 | 0.0 | 1022.1 | - |
| | *BPT | 0.2146 | 99.56 | 218.4 | 4.5 | CURRENT |
| | BAT1 | 441.4200 | 99.94 | 1934.5 | 0.6 | BPT |
| | BAT2 | 11523.2929 | 100.00 | 9314.6 | 0.0 | BAT1 |
| HOT. FORMING. PIPE. TUBE | CURRENT | - | 0.00 | 0.0 | 357.4 | - |
| | *BPT | 2.7838 | 98.96 | 984.6 | 3.7 | CURRENT |
| | BAT1 | 702.0751 | 99.79 | 3072.1 | 0.8 | BPT |
| | BAT2 | 17294.6738 | 100.00 | 16142.1 | 0.0 | BAT1 |
| DESCALING | CURRENT | - | 0.00 | 0.0 | 755.0 | - |
| | *BPT | 0.2826 | 98.78 | 210.8 | 9.2 | CURRENT |
| | BAT1 | 19.1212 | 99.51 | 317.2 | 3.7 | BPT |
| | BAT2 | 1344.3280 | 100.00 | 5261.2 | 0.0 | BAT1 |
| ALKALINE. CLEANING | CURRENT | - | 0.00 | 0.0 | 24.8 | - |
| | *BPT | 1126.4355 | 0.52 | 145.6 | 24.6 | CURRENT |
| | BAT1 | 49.9913 | 90.96 | 1125.6 | 2.2 | CURRENT |
| | BAT2 | 3029.7644 | 100.00 | 7905.6 | 0.0 | BAT1 |

P/E: "pounds equivalent"

EXHIBIT III-4

IRON AND STEEL - DIRECTS
COST-EFFECTIVENESS

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000 P/E) | %CE INC |
|---|---|---|---|---|---|---|
| FURNACE. COKE | CURRENT | - | 0.00 | 0.0 | 34931.4 | - |
| | BPT | 0.3843 | 82.18 | 11033.6 | 6223.3 | CURRENT |
| | *BAT1 | 1.1692 | 98.01 | 17495.8 | 696.2 | BPT |
| | BAT2 | 72.0826 | 98.08 | 19265.8 | 671.6 | BAT1 |
| | BAT3 | 36.5280 | 98.59 | 24895.8 | 493.6 | BAT1 |
| MERCHANT. COKE | CURRENT | - | 0.00 | 0.0 | 1981.8 | - |
| | BPT | 0.4219 | 63.41 | 530.2 | 725.2 | CURRENT |
| | *BAT1 | 1.2337 | 95.49 | 1314.6 | 89.4 | BPT |
| | BAT2 | 61.7882 | 95.64 | 1504.6 | 86.3 | BAT1 |
| | BAT3 | 32.3363 | 96.80 | 2154.6 | 63.4 | BAT1 |
| SINTERING | CURRENT | - | 0.00 | 0.0 | 350.0 | - |
| | BPT | 5.9304 | 44.89 | 931.7 | 192.9 | CURRENT |
| | *BAT1 | 35.4791 | 51.02 | 1693.1 | 171.4 | BPT |
| | BAT2 | 23.2039 | 52.18 | 1523.9 | 167.4 | BPT |
| | BAT3 | 106.1316 | 56.54 | 3143.1 | 152.1 | BAT2 |
| | BAT4 | 358.2783 | 57.32 | 7973.1 | 149.4 | BAT2 |
| | BAT5 | 87.2195 | 100.00 | 16123.1 | 0.0 | BAT2 |
| BLAST. FURNACES | CURRENT | - | 0.00 | 0.0 | 10929.8 | - |
| | BPT | 0.3008 | 68.41 | 2249.5 | 3452.3 | CURRENT |
| | BAT2 | 4.7652 | 70.77 | 3476.2 | 3194.9 | BPT |
| | BAT3 | 6.8924 | 70.87 | 4102.6 | 3183.5 | BPT |
| | *BAT4 | 2.4771 | 97.01 | 9992.5 | 326.5 | BPT |
| | BAT5 | 2386.2495 | 97.05 | 19862.5 | 322.4 | BAT4 |
| | BAT6 | 74.7292 | 100.00 | 34392.5 | 0.0 | BAT4 |
| BOF. SEMI. WET | CURRENT | - | 0.00 | 0.0 | 42.0 | - |
| | *BPT | 7.0394 | 100.00 | 296.0 | 0.0 | CURRENT |
| BOF. SUPPRESSED. COMBUSTIO | CURRENT | - | 0.00 | 0.0 | 7.7 | - |
| | BPT | 0.0000 | 0.00 | 0.0 | 7.7 | CURRENT |
| | BAT1 | 51.5775 | 20.56 | 81.6 | 6.1 | CURRENT |
| | *BAT2 | 39.1927 | 35.51 | 107.1 | 5.0 | CURRENT |
| | BAT3 | 779.6372 | 100.00 | 3977.1 | 0.0 | BAT2 |
| BOF. OPEN. COMBUSTION | CURRENT | - | 0.00 | 0.0 | 274.9 | - |
| | BPT | 1.3236 | 72.73 | 264.6 | 74.9 | CURRENT |
| | BAT1 | 49.3680 | 79.37 | 1092.6 | 56.7 | BPT |
| | *BAT2 | 23.2439 | 84.68 | 1028.2 | 42.1 | BPT |
| | BAT3 | 486.0399 | 100.00 | 21488.2 | 0.0 | BAT2 |
| OPEN. HEARTH. WET | CURRENT | - | 0.00 | 0.0 | 231.4 | - |
| | BPT | 0.0000 | 0.00 | 0.0 | 231.4 | CURRENT |
| | BAT1 | 5.1491 | 23.50 | 280.0 | 177.1 | CURRENT |
| | *BAT2 | 1.2854 | 97.48 | 290.0 | 5.8 | CURRENT |
| | BAT3 | 912.3371 | 100.00 | 5620.0 | 0.0 | BAT2 |

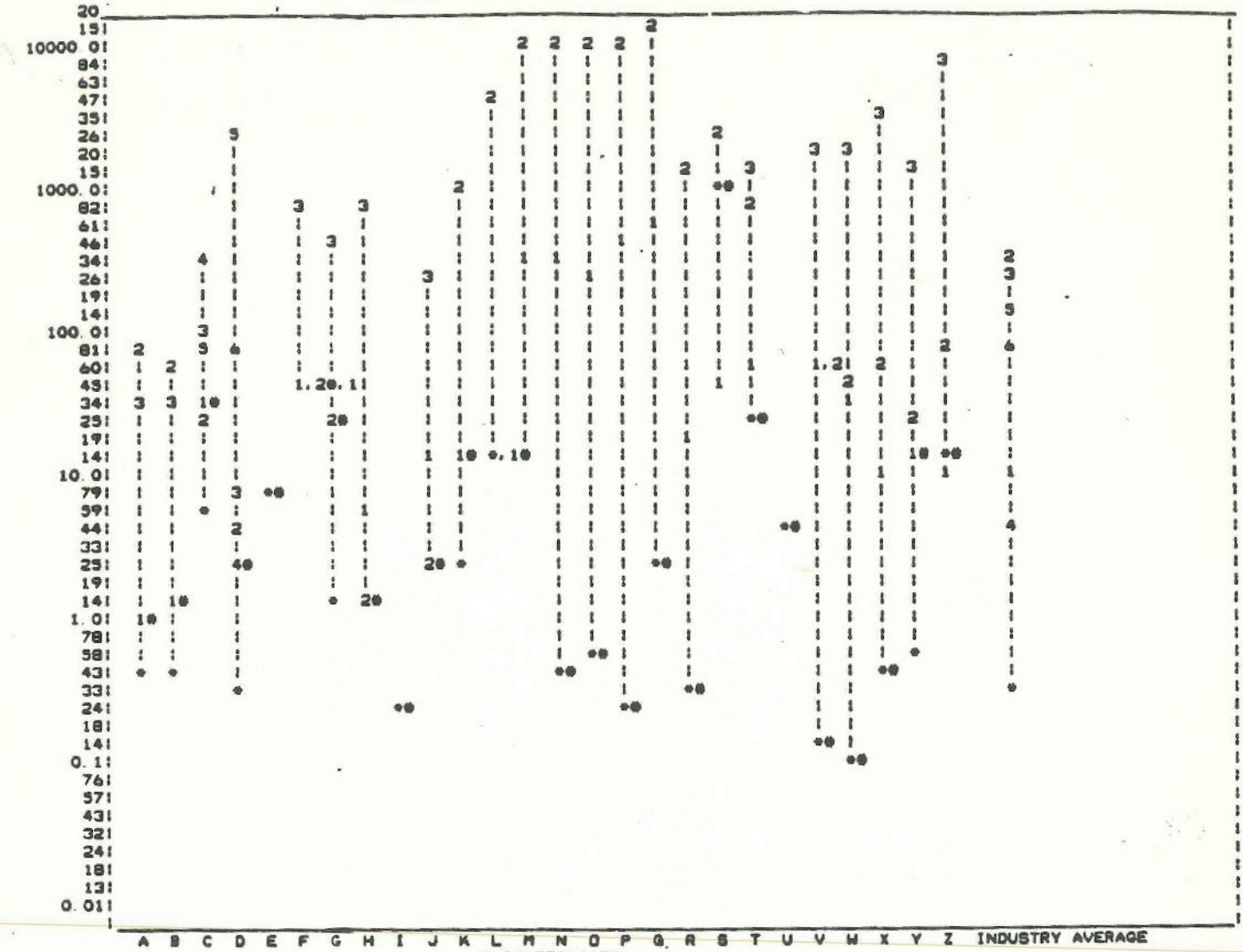
P/E: "pounds equivalent"

| PROCESS | LEVEL OF CONTROL | COST-EFF ($/P/E) | PERCENT REMOVED | COST ($1000'S) | P/E (1000 P/E) | #INC. TO |
|---|---|---|---|---|---|---|
| COLD. ROLLING | CURRENT | - | 0.00 | 0.0 | 91.9 | - |
| | *BPT | 24.2911 | 37.02 | 826.1 | 57.9 | CURRENT |
| | BAT1 | 69.3833 | 64.60 | 2583.9 | 32.5 | BPT |
| | BAT2 | 782.7502 | 59.12 | 16713.9 | 37.6 | BPT |
| | BAT3 | 1616.1246 | 100.00 | 55133.9 | 0.0 | BAT1 |
| COLD. ROLLING. PIPE. TUBE | CURRENT | - | 0.00 | 0.0 | 38.9 | - |
| | *BPT | 4.7942 | 100.00 | 185.0 | 0.0 | CURRENT |
| PICKLING. H2SO4 | CURRENT | - | 0.00 | 0.0 | 28166.2 | - |
| | *BPT | 0.1372 | 99.78 | 3857.4 | 60.8 | CURRENT |
| | BAT1 | 55.0733 | 99.94 | 6315.0 | 16.2 | BPT |
| | BAT2 | 54.5322 | 99.98 | 6885.0 | 5.3 | BPT |
| | BAT3 | 1879.3630 | 100.00 | 16885.0 | 0.0 | BAT2 |
| PICKLING. HCL | CURRENT | - | 0.00 | 0.0 | 10247.0 | - |
| | *BPT | 0.1045 | 98.60 | 1056.3 | 143.5 | CURRENT |
| | BAT1 | 34.8202 | 99.78 | 5264.5 | 22.7 | BPT |
| | BAT2 | 39.9324 | 99.92 | 5844.5 | 8.1 | BAT1 |
| | BAT3 | 1768.5516 | 100.00 | 20254.5 | 0.0 | BAT2 |
| PICKLING. COMBINATION | CURRENT | - | 0.00 | 0.0 | 1478.8 | - |
| | *BPT | 0.4565 | 95.63 | 645.6 | 64.6 | CURRENT |
| | BAT1 | 9.9393 | 99.29 | 1183.0 | 10.6 | BPT |
| | BAT2 | 56.7684 | 99.76 | 1577.9 | 3.6 | BAT1 |
| | BAT3 | 3538.1560 | 100.00 | 14297.9 | 0.0 | BAT2 |
| HOT. COATING. SCRUBBER | CURRENT | - | 0.00 | 0.0 | 515.9 | - |
| | BPT | 0.6525 | 90.12 | 303.4 | 51.0 | CURRENT |
| | *BAT1 | 15.0090 | 91.26 | 392.0 | 45.1 | BPT |
| | BAT2 | 22.2243 | 98.95 | 1273.0 | 5.4 | BAT1 |
| | BAT3 | 1523.8121 | 100.00 | 9564.0 | 0.0 | BAT2 |
| HOT. COATING. NO. SCRUB | CURRENT | - | 0.00 | 0.0 | 37.9 | - |
| | *BPT | 13.0147 | 60.64 | 299.5 | 14.9 | CURRENT |
| | BAT1 | 11.6846 | 67.54 | 299.5 | 12.3 | CURRENT |
| | BAT2 | 85.6266 | 96.78 | 1249.5 | 1.2 | BAT1 |
| | BAT3 | 7486.7695 | 100.00 | 10395.5 | 0.0 | BAT2 |
| TOTALS | CURRENT | - | 0.00 | 0.0 | 105420.7 | - |
| | BPT | 0.2876 | 88.98 | 26975.0 | 11617.6 | - |
| | BAT1 | 9.8940 | 98.46 | 90093.4 | 1452.2 | - |
| | BAT2 | 348.7653 | 95.96 | 376167.8 | 4246.0 | - |
| | BAT3 | 239.6568 | 95.64 | 195444.6 | 3892.6 | - |
| | BAT4 | 4.5143 | 95.78 | 17965.6 | 475.9 | - |
| | BAT5 | 142.6603 | 97.14 | 35985.6 | 322.4 | - |
| | BAT6 | 74.7292 | 100.00 | 34392.5 | 0.0 | - |
| SELECTED OPTIONS | * | 0.4311 | 98.17 | 44400.7 | 1933.1 | - |

* SELECTED OPTIONS
\# INDICATES INCREMENT FROM WHICH COST-EFFECTIVENESS IS CALCULATED.

P/E: "pounds equivalent"

IRON AND STEEL - DIRECTS
C[illegible]-SUBCATEGORY COMPARISONS
( SCALE)



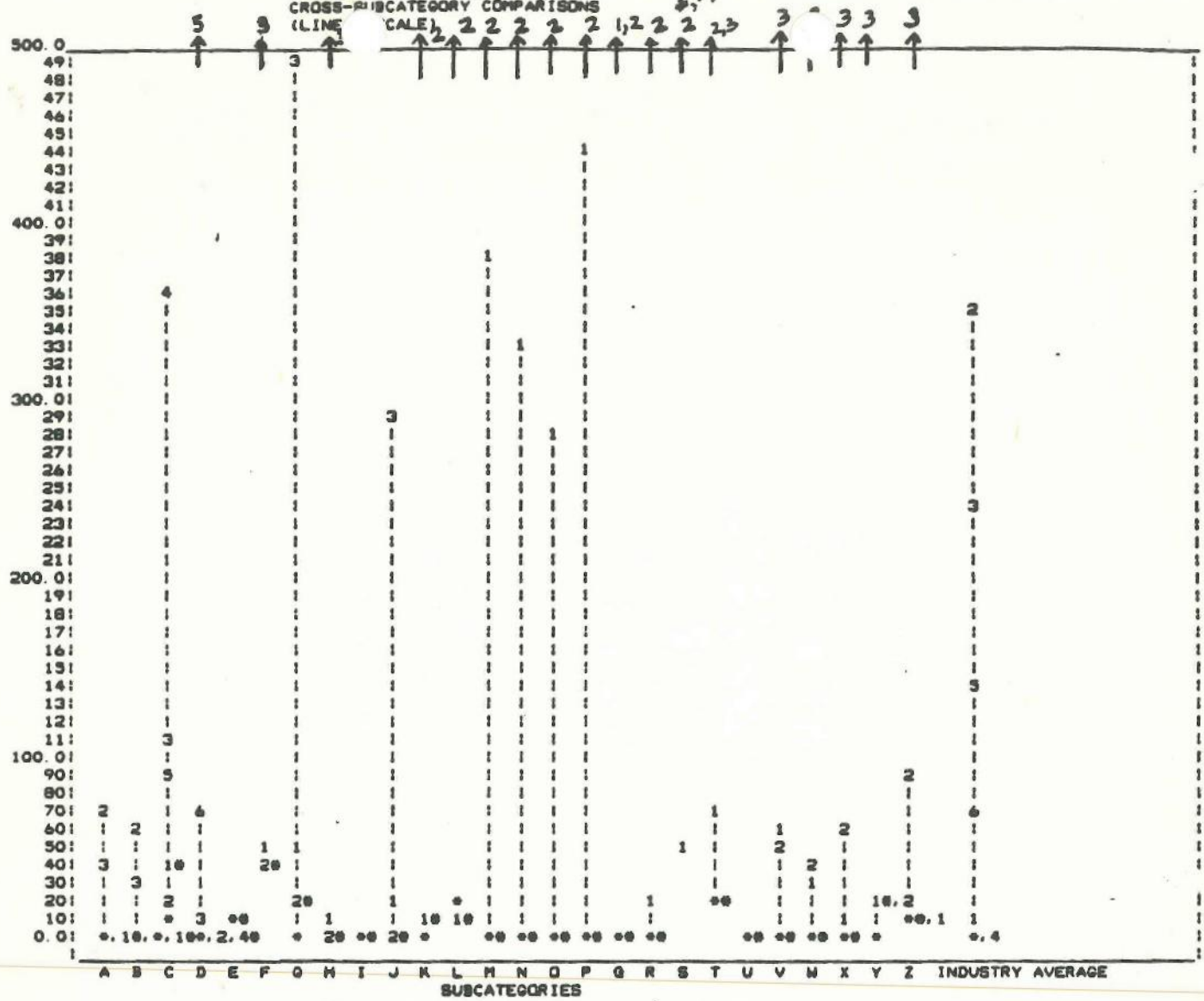

SUBCATEGORIES (COST-EFF)

| | | |
|---|---|---|
| A | FURNACE. COKE | ( 1. 169166) |
| B | MERCHANT COKE | ( 1. 233725) |
| C | SINTERING | ( 39. 479080) |
| D | BLAST. FURNACES | ( 2. 477115) |
| E | BOF SEMI. WET | ( 7. 039352) |
| F | BOF. SUPPRESSED. COMBUSTION | ( 39. 192688) |
| G | BOF. OPEN. COMBUSTION | ( 23. 243885) |
| H | OPEN. HEARTH. WET | ( 1. 285444) |
| I | EAF. SEMI. WET | ( 0. 272339) |
| J | EAF. WET | ( 2. 544543) |
| K | VACUUM. DEGASSING | ( 12. 374763) |
| L | CONTINUOUS. CASTING | ( 13. 113688) |
| M | HOT. | (.....) |
| N | HOT. FORMING SECTION | ( 0. 467087) |
| O | HOT FORMING. STRIP SHEET | ( 0. 581809) |
| P | HOT. FORMING. PLATE | ( 0. 214625) |
| Q | HOT FORMING. PIPE. TUBE | ( 2. 783842) |
| R | DESCALING | ( 0. 282648) |
| S | ALKALINE. CLEANING | (.....) |
| T | COLD. ROLLING | ( 24. 291134) |
| U | COLD. ROLLING. PIPE. TUBE | ( 4. 754199) |
| V | PICKLING. H2SO4 | ( 0. 137248) |
| W | PICKLING HCL | ( 0. 104548) |
| X | PICKLING. COMBINATION | ( 0. 456529) |
| Y | HOT. COATING. SCRUBBER | ( 19. 008973) |
| Z | HOT. COATING. NO. SCRUB | ( 13. 014695) |
| * | INDUSTRY AVERAGE | |

CONTROL OPTIONS

| | |
|---|---|
| * | BPT |
| 1 | BAT1 |
| 2 | BAT2 |
| 3 | BAT3 |
| 4 | BAT4 |
| 5 | BAT5 |
| [illegible] | BAT6 |

IRON AND STEEL - DIRECTS
CROSS-SUBCATEGORY COMPARISONS
(LINE SCALE)




SUBCATEGORIES (COST-EFF)

| | | |
|---|---|---|
| A | FURNACE. COKE | ( 1.169166) |
| B | MERCHANT. COKE | ( 1.233725) |
| C | SINTERING | ( 35.479080) |
| D | BLAST. FURNACES | ( 2.477115) |
| E | BOF. SEMI. WET | ( 7.039352) |
| F | BOF. SUPPRESSED. COMBUSTION | ( 39.192688) |
| G | BOF. OPEN. COMBUSTION | ( 23.243885) |
| H | OPEN. HEARTH. WET | ( 1.285444) |
| I | EAF. SEMI. WET | ( 0.272339) |
| J | EAF. WET | ( 2.544543) |
| K | VACUUM. DEGASSING | ( 12.374763) |
| L | CONTINUOUS. CASTING | ( 13.113680) |
| M | HOT. | (.....) |
| N | HOT. FORMING. SECTION | ( 0.467087) |
| O | HOT. FORMING. STRIP. SHEET | ( 0.981809) |
| P | HOT. FORMING. PLATE | ( 0.214625) |
| Q | HOT. FORMING. PIPE. TUBE | ( 2.783842) |
| R | DESCALING | ( 0.282648) |
| S | ALKALINE. CLEANING | (.....) |
| T | COLD. ROLLING | ( 24.291134) |
| U | COLD. ROLLING. PIPE. TUBE | ( 4.754195) |
| V | PICKLING. H2SO4 | ( 0.137248) |
| W | PICKLING. HCL | ( 0.104548) |
| X | PICKLING. COMBINATION | ( 0.456525) |
| Y | HOT COATING. SCRUBBER | ( 15.008973) |
| Z | HOT. COATING. NO. SCRUB | ( 13.014695) |
| * | INDUSTRY AVERAGE | |

CONTROL OPTIONS

| | |
|---|---|
| * | BPT |
| 1 | BAT1 |
| 2 | BAT2 |
| 3 | BAT3 |
| 4 | BAT4 |
| 5 | BAT5 |
| 6 | BAT6 |

EXHIBIT III-7

DIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LOG SCALE)

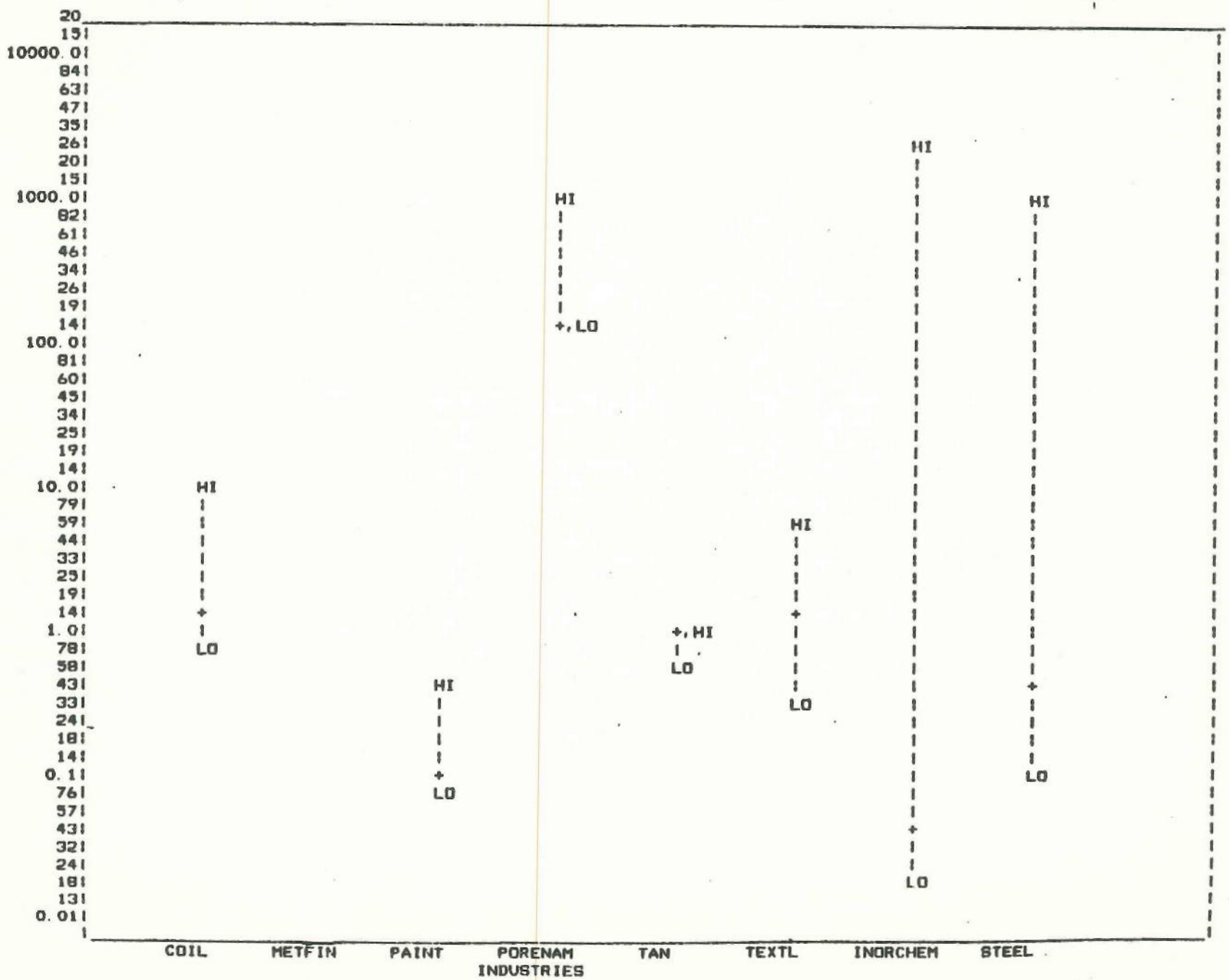


EXHIBIT III-8

DIRECT DISCHARGERS
CROSS-INDUSTRY COMPARISONS
COST EFFECTIVENESS OF SELECTED OPTIONS
BY INDUSTRY SUBCATEGORY
(LINEAR SCALE)

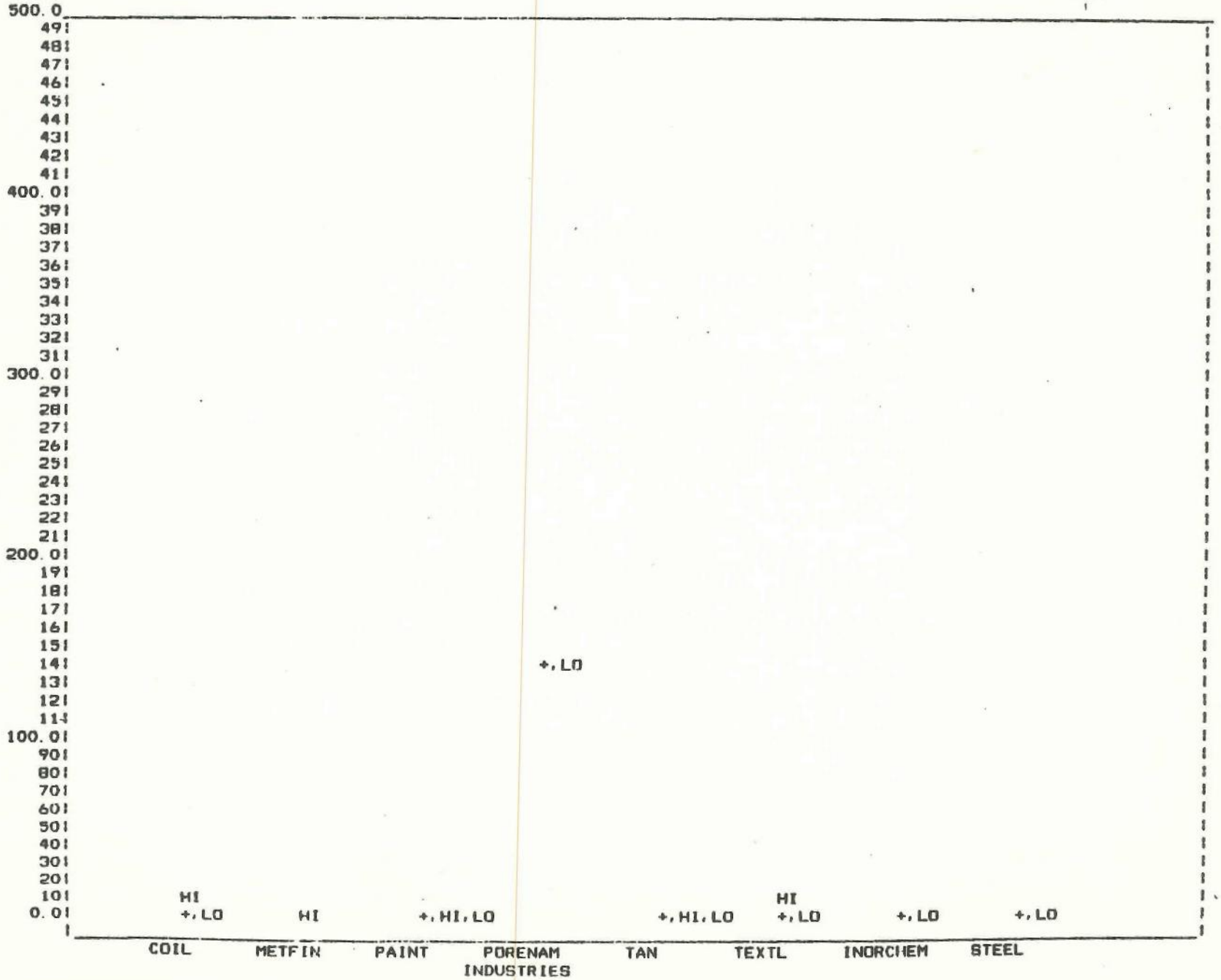


Exhibit III-9

CROSS INDUSTRY COMPARISON
COST-EFFECTIVENESS OF SELECTED OPTIONS
DIRECT DISCHARGERS

(1978 dollars per hazard unit)

| Industry | Low | Average | High |
|---|---|---|---|
| Coil Coating | $ .75 | $ 1.26 | $ 9.90 |
| Inorganic Chemicals | .02 | .05 | 2,377.26 |
| Metal Finishing | ------at selected option----- | | |
| Paint | .08 | .12 | .50 |
| Porcelain Enameling | 144.16 | 144.70 | 981.81 |
| Steel | .10 | .43 | 1,126.44 |
| Tanning | .59 | .90 | 1.02 |
| Textiles | .34 | 1.26 | 5.18 |

Source: TBS CE Model.

EXHIBIT III-10

INCREMENTAL COST-EFFECTIVENESS ANALYSIS

| NO. | INDUSTRY | SUB-CATEGORY | INCREMENTAL OPTION | COST-EFF ($/HU) | EFFLUENT (MM HU) | COST ($MM) |
|---|---|---|---|---|---|---|
| 0 | ALL INDUSTRY | | CURRENT | 0.000 | 105.4260 | 0.0000 |
| 1 | STEEL DIR | HOT. FORMING PRIMA | *BPT | -0.373 | 98.9726 | -2.4100 |
| 2 | STEEL DIR | PICKLING. HCL | *BPT | 0.105 | 88.8661 | -1.3540 |
| 3 | STEEL DIR | PICKLING. H2SO4 | *BPT | 0.137 | 60.7570 | 2.5030 |
| 4 | STEEL DIR | HOT FORMING. PLATE | *BPT | 0.215 | 59.7395 | 2.7214 |
| 5 | STEEL DIR | EAF. SEMI. WET | *BPT | 0.272 | 59.5941 | 2.7610 |
| 6 | STEEL DIR | DESCALING | *BPT | 0.283 | 58.8484 | 2.9718 |
| 7 | STEEL DIR | BLAST FURNACES | BPT | 0.301 | 51.3703 | 5.2208 |
| 8 | STEEL DIR | FURNACE. COKE | BPT | 0.384 | 22.6634 | 16.2508 |
| 9 | STEEL DIR | MERCHANT. COKE | BPT | 0.422 | 21.4066 | 16.7810 |
| 10 | STEEL DIR | PICKLING COMBINATI | *BPT | 0.456 | 19.9922 | 17.4266 |
| 11 | STEEL DIR | HOT. FORMING. SECTIO | *BPT | 0.467 | 15.3527 | 19.5936 |
| 12 | STEEL DIR | HOT. FORMING. STRIP. | *BPT | 0.582 | 13.5287 | 20.6546 |
| 13 | STEEL DIR | HOT. COATING. SCRUBB | BPT | 0.652 | 13.0637 | 20.9580 |
| 14 | STEEL DIR | FURNACE. COKE | *BAT1 | 1.169 | 7.5369 | 27.4280 |
| 15 | STEEL DIR | MERCHANT. COKE | *BAT1 | 1.234 | 6.9011 | 28.2128 |
| 16 | STEEL DIR | OPEN HEARTH. WET | *BAT2 | 1.285 | 6.6756 | 28.5028 |
| 17 | STEEL DIR | BOF OPEN COMBUSTIO | BPT | 1.324 | 6.4756 | 28.7674 |
| 18 | STEEL DIR | VACUUM. DEGASSING | BPT | 2.222 | 5.9343 | 29.9704 |
| 19 | STEEL DIR | BLAST FURNACES | *BAT4 | 2.477 | 2.8088 | 37.7134 |
| 20 | STEEL DIR | EAF. WET | *BAT2 | 2.545 | 2.7292 | 37.9159 |
| 21 | STEEL DIR | HOT. FORMING. PIPE. T | *BPT | 2.784 | 2.3756 | 38.9005 |
| 22 | STEEL DIR | COLD. ROLLING. PIPE. | *BPT | 4.754 | 2.3367 | 39.0855 |
| 23 | STEEL DIR | SINTERING | BPT | 5.930 | 2.1796 | 40.0172 |
| 24 | STEEL DIR | BOF. SEMI. WET | *BPT | 7.039 | 2.1375 | 40.3132 |
| 25 | STEEL DIR | PICKLING. COMBINATI | BAT1 | 9.939 | 2.0834 | 40.8506 |
| 26 | STEEL DIR | HOT COATING NO. SCR | BAT1 | 11.680 | 2.0578 | 41.1501 |
| 27 | STEEL DIR | VACUUM. DEGASSING | *BAT1 | 12.370 | 2.0484 | 41.2661 |
| 28 | STEEL DIR | CONTINUOUS. CASTING | *BAT1 | 13.110 | 1.9735 | 42.2487 |
| 29 | STEEL DIR | HOT. COATING. SCRUBB | *BAT1 | 15.010 | 1.9676 | 42.3373 |
| 30 | STEEL DIR | DESCALING | BAT1 | 19.120 | 1.9620 | 42.4437 |
| 31 | STEEL DIR | HOT. COATING. SCRUBB | BAT2 | 22.220 | 1.9224 | 43.3247 |
| 32 | STEEL DIR | SINTERING | BAT2 | 23.200 | 1.8969 | 43.9170 |
| 33 | STEEL DIR | BOF. OPEN. COMBUSTIO | *BAT2 | 23.240 | 1.8640 | 44.6804 |
| 34 | STEEL DIR | COLD ROLLING | *BPT | 24.290 | 1.8300 | 45.5065 |
| 35 | STEEL DIR | MERCHANT. COKE | BAT3 | 32.340 | 1.8040 | 46.3465 |
| 36 | STEEL DIR | PICKLING. HCL | BAT1 | 34.820 | 1.6832 | 50.5555 |
| 37 | STEEL DIR | FURNACE. COKE | BAT3 | 36.530 | 1.4806 | 57.9555 |
| 38 | STEEL DIR | BOF. SUPPRESSED. COM | *BAT2 | 39.190 | 1.4779 | 58.0626 |
| 39 | STEEL DIR | PICKLING. HCL | BAT2 | 39.930 | 1.4634 | 58.6426 |
| 40 | STEEL DIR | ALKALINE. CLEANING | BAT1 | 49.990 | 1.4408 | 59.7686 |
| 41 | STEEL DIR | PICKLING H2SO4 | BAT2 | 54.530 | 1.3853 | 62.7966 |
| 42 | STEEL DIR | PICKLING COMBINATI | BAT2 | 56.770 | 1.3784 | 63.1916 |
| 43 | STEEL DIR | COLD ROLLING | BAT1 | 69.380 | 1.3530 | 64.9495 |
| 44 | STEEL DIR | BLAST FURNACES | BAT6 | 74.730 | 1.0265 | 89.3475 |
| 45 | STEEL DIR | HOT COATING. NO. SCR | BAT2 | 85.630 | 1.0154 | 90.2970 |
| 46 | STEEL DIR | SINTERING | BAT5 | 87.220 | 0.8480 | 104.8930 |
| 47 | STEEL DIR | HOT. FORMING. STRIP. | BAT1 | 282.600 | 0.7929 | 120.4720 |
| 48 | STEEL DIR | EAF. WET | BAT3 | 285.500 | 0.7813 | 123.8025 |
| 49 | STEEL DIR | HOT. FORMING. SECTIO | BAT1 | 330.300 | 0.7454 | 135.6355 |
| 50 | STEEL DIR | HOT. FORMING PRIMA | BAT1 | 375.300 | 0.7055 | 150.6355 |
| 51 | STEEL DIR | HOT FORMING PLATE | BAT1 | 441.400 | 0.7016 | 152.3521 |
| 52 | STEEL DIR | BOF OPEN COMBUSTIO | BAT3 | 486.000 | 0.6595 | 172.8141 |
| 53 | STEEL DIR | HOT FORMING PIPE T | BAT1 | 702.100 | 0.6565 | 174.9015 |
| 54 | STEEL DIR | BOF SUPPRESSED. COM | BAT3 | 779.600 | 0.6516 | 178.7714 |
| 55 | STEEL DIR | OPEN HEARTH. WET | BAT3 | 912.300 | 0.6457 | 184.1014 |
| 56 | STEEL DIR | VACUUM DEGASSING | BAT2 | 1017.000 | 0.6401 | 189.8114 |
| 57 | STEEL DIR | DESCALING | BAT2 | 1344.000 | 0.6364 | 194.7552 |
| 58 | STEEL DIR | HOT. COATING. SCRUBB | BAT3 | 1524.000 | 0.6310 | 203.0462 |
| 59 | STEEL DIR | COLD. ROLLING | BAT3 | 1616.000 | 0.5985 | 235.5922 |
| 60 | STEEL DIR | PICKLING. HCL | BAT3 | 1769.000 | 0.5903 | 269.9972 |
| 61 | STEEL DIR | PICKLING. H2SO4 | BAT3 | 1879.000 | 0.5850 | 279.9922 |
| 62 | STEEL DIR | ALKALINE. CLEANING | BAT2 | 3030.000 | 0.5828 | 286.7722 |
| 63 | STEEL DIR | PICKLING COMBINATI | BAT3 | 3538.000 | 0.5792 | 299.4942 |
| 64 | STEEL DIR | CONTINUOUS. CASTING | BAT2 | 4269.000 | 0.5778 | 305.2746 |
| 65 | STEEL DIR | HOT COATING NO SCR | BAT3 | 7487.000 | 0.5766 | 314.4256 |
| 66 | STEEL DIR | HOT. FORMING. PLATE | BAT2 | 11520.000 | 0.5759 | 321.8056 |
| 67 | STEEL DIR | HOT. FORMING. STRIP. | BAT2 | 11780.000 | 0.5681 | 413.8656 |
| 68 | STEEL DIR | HOT. FORMING. PRIMA | BAT2 | 12260.000 | 0.5625 | 482.9456 |
| 69 | STEEL DIR | HOT FORMING SECTIO | BAT2 | 12400.000 | 0.5578 | 541.3756 |
| 70 | STEEL DIR | HOT. FORMING. PIPE. T | BAT2 | 17290.000 | 0.5570 | 554.4436 |

* SELECTED OPTION

EXHIBIT III-11

STEEL DIR

COMPARISONS OF SELECTED AND OPTIMAL OPTIONS

| PROCESS | SELECTED | 31 | 33 |
|---|---|---|---|
| FURNACE. COKE | BAT1 | BAT1 | BAT1 |
| MERCHANT. COKE | BAT1 | BAT1 | BAT1 |
| SINTERING | BAT1 | *BPT | *BAT2 |
| BLAST. FURNACES | PSES5 | *BAT4 | *BAT4 |
| BOF. SEMI. WET | PSES3 | *BPT | *BPT |
| BOF. SUPPRESSED. COMBU | PSES3 | *CURRENT | *CURRENT |
| BOF. OPEN. COMBUSTION | BAT2 | *BPT | BAT2 |
| OPEN. HEARTH. WET | BAT2 | BAT2 | BAT2 |
| EAF. SEMI. WET | BPT | BPT | BPT |
| EAF. WET | BAT2 | BAT2 | BAT2 |
| VACUUM DEGASSING | BAT1 | BAT1 | BAT1 |
| CONTINUOUS. CASTING | BAT1 | BAT1 | BAT1 |
| HOT. FORMING. PRIMARY | BPT | BPT | BPT |
| HOT. FORMING. SECTION | BPT | BPT | BPT |
| HOT. FORMING. STRIP. SH | BPT | BPT | BPT |
| HOT. FORMING. PLATE | BPT | BPT | BPT |
| HOT. FORMING. PIPE. TUB | BPT | BPT | BPT |
| DESCALING | BPT | *BAT1 | *BAT1 |
| ALKALINE. CLEANING | BPT | *CURRENT | *CURRENT |
| COLD. ROLLING | BPT | *CURRENT | *CURRENT |
| COLD. ROLLING. PIPE. TU | BPT | BPT | BPT |
| PICKLING. H2SO4 | BPT | BPT | BPT |
| PICKLING. HCL | BPT | BPT | BPT |
| PICKLING. COMBINATION | BPT | *BAT1 | *BAT1 |
| HOT. COATING. SCRUBBER | BAT1 | *BAT2 | *BAT2 |
| HOT. COATING. NO. SCRUB | BPT | *BAT1 | *BAT1 |
| TOTAL COST($MM) | 44.70 | 43.32 | 44.68 |
| TOTAL HAZARD(MM HU) | 1.94 | 1.92 | 1.86 |
| COST-EFFECTIVENESS($/HU) | - | 22.22 | 23.24 |

EXHIBIT III-12

IRON AND STEEL - DIRECT DISCHARGERS
OPTIMAL COST-EFFLUENT FRONTIER

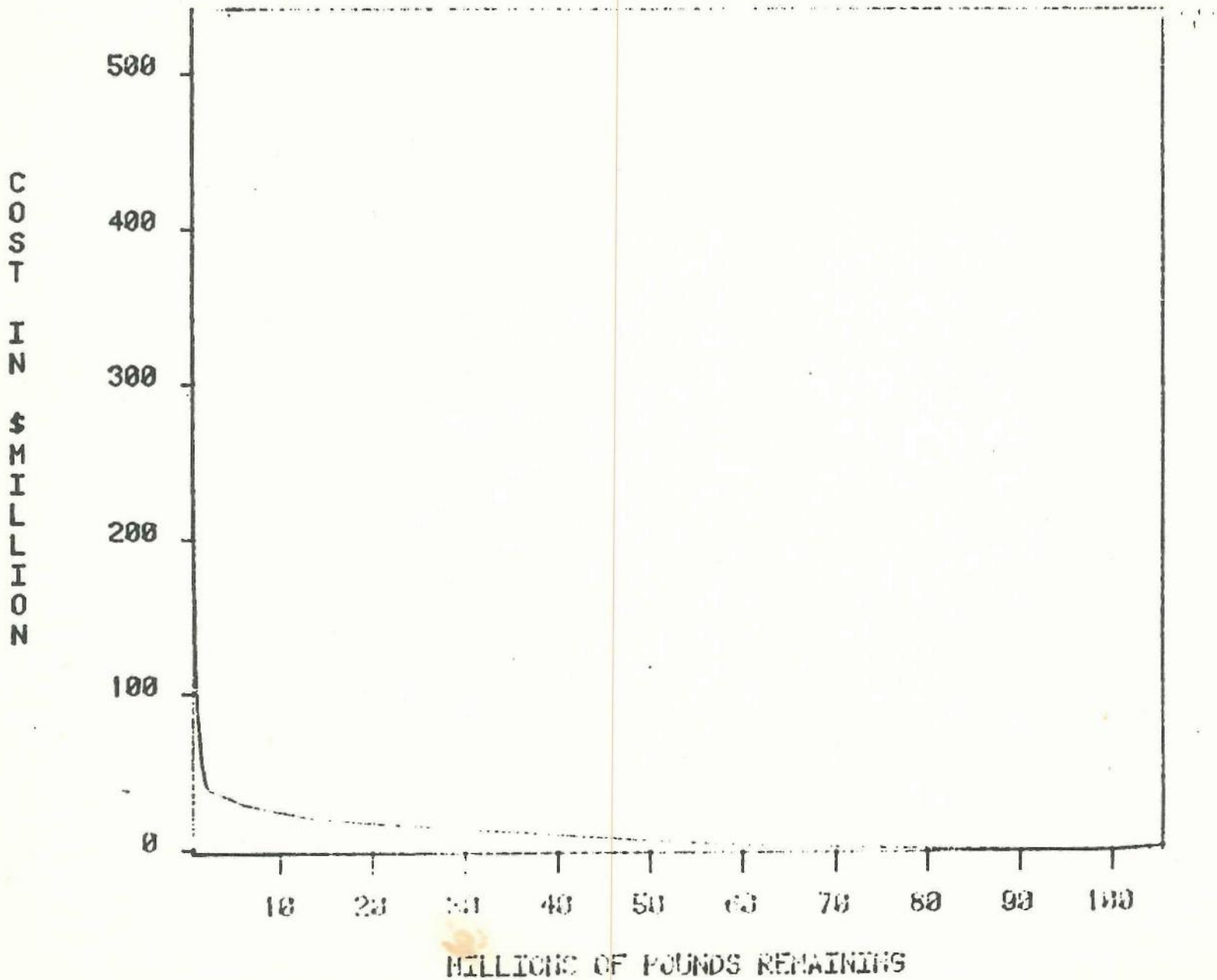
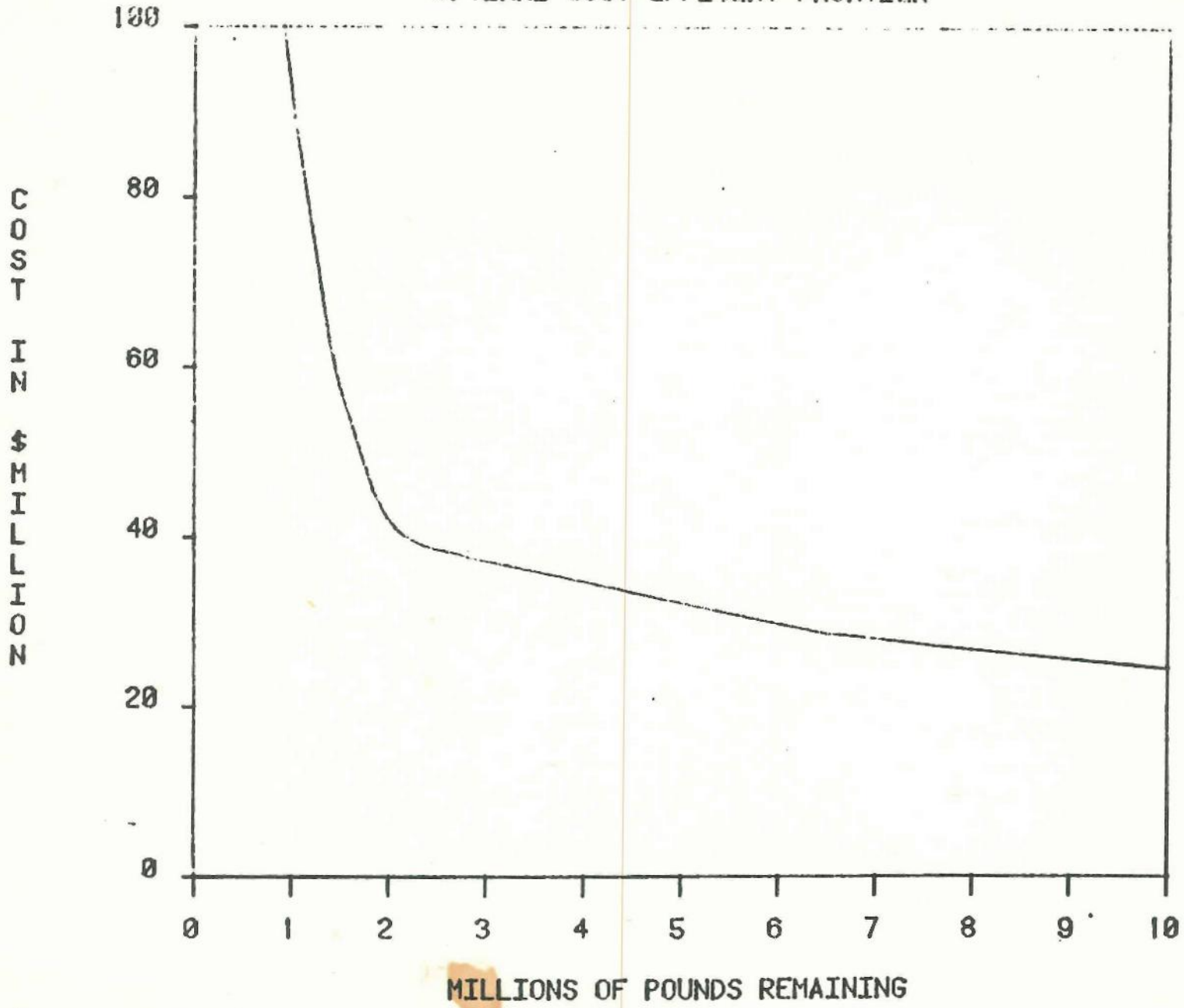


EXHIBIT III-13

IRON AND STEEL - DIRECT DISCHARGERS
OPTIMAL COST-EFFLUENT FRONTIER