LEG. FINANCE - BILLS 1977 - 1978 874

HCR 91 cont. 874

University of Alaska, Fairbanks

Fairbanks, Alaska 99701

HCR 54

February 25, 1977

Rep. Steve Cowper, Chairman
House Finance Committee
Pouch V
Juneau, Alaska 99801

Subject: Revenue Bonds for Utility Plant Expansion
Fairbanks Campus, University of Alaska

Dear Steve:

Thank you for your letter of February 21, 1977. (copy attached) Enclosed is a copy of the Mower report which was submitted in 1976. It was updated by the report in the back of the booklet on University Direct Appropriation Request (capital) that I sent to you and the members of your committee on February 17, 1977. I have paper clipped and highlighted some of the pertinent conclusions and summaries.

We have no additional correspondence from GVEA and they appear reluctant to be more lucid. I suppose this is understandable and while it may have certain public relations inferences, we would be remiss in not promoting actions which are in the best interest of the University and the state professionally and fiscally.

In the booklet sent to you on February 17th, we included our summary analysis of this matter.

The concept of a $4,000,000 revenue bond issue was discussed with the Governor's Division of Budget and Management in their efforts to advise the Governor. They requested that the University contact GVEA for discussion to determine the effect our anticipated expansion would have upon their long-range plans. There were extensive discussions resulting in their brief statement. It is important to note that their reluctance is based upon several assumptions;

1) That they will hold electrical rates at the current level for the next five years;

2) That they will have their Healy plant in operation on schedule by 1983 and will be burning coal;

3) That they will have a crude oil line from the Alyeska Pipeline to the North Pole Refinery which will allow them to "control" the price of oil for the Fairbanks plant.

Each of these assumptions is not without the probability of extenuating circumstances which could delay or negate any one of them. If the University waits for the outcome which might very well be different than assumed they will have only delayed the opportunity for savings.

UNIVERSITY OF ALASKA

The anticipated expansion of the Fairbanks plant is not expected to have negative environmental impact. The plant now burns coal within acceptable omission limits and the new turbine would not change that.

Campus growth is spoken to in the Mower report on Phase II, page 4, and appears to be reasonably close to your own thinking.

The current revenue bonds for the latest plant expansion were sold through the Alaska Heating Corporation, a private corporation established for that purpose. This allows and provides for the issue of revenue bonds contingent upon a legislative resolution, rather than by legislative bill, affirming the State's intention to fund the University at an adequate level to meet the debt service.

Thanks again for your interest, and best wishes to you at this legislative session.

Very truly yours,

Ken D. Garrison

Kenneth D. Garrison, Director
Facilities Planning and Construction

KDG:lz

Attachment

cc: T. Tilsworth
M. Arth
T. Gruenig
S. Brown

UNIVERSITY OF ALASKA, FAIRBANKS

CAMPUS ENERGY UTILIZATION STUDY

PHASE I

1976

Prepared For:
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I. INTRODUCTION

The University of Alaska, Fairbanks campus is faced with a continuing upwards spiral of fuel and utilities costs. The University of Alaska's power plant has the ability to provide a portion of the electrical power and all the heating required for the existing campus.

The objective of this study was to determine current and future fuel and utilities costs to enable the University to properly plan for expansion and to minimize current utilities costs. In addition, this study examined the possible methods of reducing current utilities operating expenses and examined the most economical type of thermal energy for current and future use.

II. SUMMARY AND CONCLUSIONS

This study has examined the current and future steam and electrical energy requirements for the University of Alaska, Fairbanks campus. Three types of thermal energy - coal, oil and electricity - have been examined as possible sources of energy for present and future University use.

The University power plant has been reviewed for its efficiency in operation and methods were examined to increase power plant efficiency. The following are our conclusions.

1. For the short and long run, coal can be expected to cost approximately one-third that of fuel oil. This is a minimum figure and very probably, the differential will be larger. The University should take advantage of coal as an energy source. Future planning should provide the physical plant facilities to utilize coal as an energy source.

2. Campus power plant is being operated in an efficient manner. Modifications in the physical plant itself to improve efficiency are not warranted.

3. The recently installed steam condenser should be utilized as a peak shaving tool. This would maximize present plant efficiency and minimize current energy costs.

4. The University, considering the long run, must add additional power plant electrical capacity. The minimum addition required would be five megawatts. The maximum could go as high as fifteen megawatts depending on market development.

At the current utility rates, the University should have additional steam generated electrical power in operation. The faster additional power can be installed, the greater the amount of economical benefit the University will realize.

III. DISCUSSION

A. FUEL/UTILITY COSTS AND PROJECTIONS

The University of Alaska utilizes either coal or oil as a source of thermal energy. Electrical energy is either produced in their own power plant or purchased from Golden Valley Electric Association. At the moment there is no natural gas available in Fairbanks. Of primary importance to the University is predicting the future cost of fuels and utilities.

1. COAL

We will discuss the current and the future cost of coal first as this is the simplest to determine. Coal is the least-controlled fuel and has the largest reserves available. The current reserves in the Nenana area consist of approximately 95 million tons with less than 200 foot overburden. There are demonstrated reserves of two billion tons and hypothetical reserves of eight to nine billion tons in the area. The present output of the Usebelli mine in Healy is approximately 730,000 tons a year. The mine estimates that there are 200 years worth of reserves in the immediate area accessible with their present equipment. They also indicated that they see an undiminished supply for any foreseeable increase in demand.

At the present time, the University has a short-term contract with the Usebelli mine to provide coal at a cost of approximately $11.40 a ton. This coal is purchased on a BTU per ton basis with one ton equal to 17,400,000 BTU. The railroad freight rates are established at $4.93 a ton. Thus, the total cost for coal in Fairbanks at the University storage area is approximately $16.33 a ton or $ .94 per therm.

The shipping rates are expected to increase with inflation. Mr. Hoefler of the Alaska Railroad indicated the railroad had not had a freight rate increase for 20 years as of October 1968, and since then their rates have increased steadily at approximately the rate of inflation. These increases were nine percent in 1968; fifteen percent in 1972; three percent in 1973; two percent in 1974; and ten percent in July 1975. Mr. Hoefler indicates that for the next two to four years the Alaska Railroad is using a seven percent inflationary figure for their budget. He also indicated that since at the present time both coal and petroleum products are shipped to Fairbanks by rail, the increase in the freight rate for one product would be similar to that of any other product. The rail- [illegible] ...tion [illegible] engines in the [illegible] opinion is that with the increased use of the Alaska Railroad in the past few years that some input for additional maintenance on the line and rehabilitation of engines and cars should be included in estimating any increase in rates.

The Usebelli mine does not anticipate any increase in the cost of coal other than to follow the general inflationary trend across the country. Joe Usebelli indicated that he would prefer a longer term contract (approximately ten years) with the University, so that he could more easily plan plant expansion, hiring, budget, etc. The Golden Valley Electric Association is on a long-term contract for the coal that they use in their Healy power plant. Mr. Usebelli also indicated that he is in negotiations with the Amax Corp. for the purchase of his mine. Amax Corp. indicates that there is a possibility of exportation of coal to the West Coast. Any increased demand at the mine would level off or possibly reduce the coal prices. Joe Usebelli indicated that with fifty percent more demand he could reduce the price of coal approximately twenty percent due to more efficient utilization of the present physical plant. The prime users of coal are Ft. Wainwright, Golden Valley Electric Association, City Power Plant, Eilson Air Force Base, Clear and the University of Alaska. None of these plants expect to increase their usage by fifty percent so a price reduction cannot be contemplated unless there is exportation to the West Coast.

In conclusion, we can expect that in the future coal prices in Fairbanks will rise at approximately the general inflationary rate so that the cost would be approximately $1.10 to $1.20 per therm by the end of 1977. (See Figure 1).

2. <u>OIL</u>

Oil is the most heavily used fuel for heating and is becoming the major electrical-producing fuel in the Fairbanks area. At the present time all oil for the Fairbanks area is brought up from Anchorage on the Alaska Railroad, with Tesoro being the prime supplier in Fairbanks. The posted price of Arctic diesel fuel in Fairbanks now is $ .5195 per gallon and number two fuel oil is $ .4459 per gallon. Any price less than posted must be negotiated. Golden Valley Electric Association pays between $ .37 and $ .40 per gallon for diesel fuel used in their generation facilities.

At the present time crude oil is controlled by the crude oil entitlement which subsidizes those refineries which must purchase crude oil from foreign producers. The [illegible] price [illegible] the entitlement for "old crude" is [illegible] the entitlement this goes up [illegible] the price below entitlement is for "old crude" from areas that were producing crude oil before the controls went into effect. "New crude" is from areas developed after controls and is approximately $2.00 above the "old crude" price.

There is the possibility that the various controls on oil may be eliminated. Then the price is expected to stabilize at approximately $11.00 to $12.00 a barrel, or approximately the same as the present price with entitlements. Current controls produce price flucuations and shortages.

Another variable in the Fairbanks area is the proposed Energy Company of Alaska-North Pole Topping Plant. This plant will come on line sometime in mid-1977 with a 15,000 barrel a day capacity. At that time, it is expected to provide heating oil, diesel fuel, turbine fuel, military jet fuel and asphalt. The Golden Valley Electric Association is going to use the turbine fuel for 2 - 60 mw gas turbine generators. A portion of the waste heat from these turbines will go to the Topping Plant for their production facilities. The Topping Plant will also provide fuel for the Alyeska Pipeline Pumping Station No. 8; and in the future, would be expected to produce gasoline and commercial jet fuel.

The Topping Plant would remove approximately 25,000 barrels a day of crude oil and return 10,000 barrels a day of residuals to the pipeline. All their planned production will be sold only on a contract basis. At the moment it is very difficult to predict what prices may be; however, they can be expected to be still competitive with imported liquid fuels.

In conclusion it can be expected that petroleum prices will go up in the next two years at probably the inflationary rate with perhaps a leveling off when the North-Pole Topping Plant comes on line. The other possibility is that removal of controls may cause the price to escalate further. Our best estimate is that the price of diesel fuel which is now approximately $3.00 per therm to contract users will go up to approximately $3.60 a therm in the next two years. Predicting future cost of oil is considerably harder than predicting the future cost of coal because of the large number of variables effecting crude oil cost.

3. OTHER FUELS

Natural gas is not available now in the Fairbanks area. There are several possibilities in the future. One is that the natural gas reserves on the North Slope will be piped through Fairbanks along the oil pipeline route. If [illegible] Canada, a [illegible] line to Fairb[illegible] [illegible]ilities [illegible] years; therefore, we are discounting Natural Gas as a potential fuel in the Fairbanks area.

4. ELECTRICITY

Electricity in Fairbanks is generated by either coal or oil. At the present time, there is no hydro power available and there is no natural gas for turbine generation. Golden Valley Electric Association provides electrical power to the University and is tied in with the military sites in the area and the City Power Company. There are coal-fired steam generation plants in the Fairbanks area with prime electrical generation at the Golden Valley plant in Healy. Other major coal users were listed in the coal section of this report. The large demand for electricity in the Fairbanks area has caused Golden Valley Electric Association to install gas turbine generators running on diesel fuel to meet the demand peaks.

The University is on Golden Valley's rate number seven which consists of energy charges starting at $ .0375 per kilowatt hour for the first 10,000 kwhr per month and going to $ .013 kwhr for use over 500,000 kwhr per month. In addition, there are demand charges from $3.00 a kilowatt hour for the first 100 kw of demand to $2.75 a kwhr for anything over 500 kw demand per month. There is also a fuel cost rate adjustment which varies according to Golden Valley's fuel costs for power generation. This has been around $ .008 to $ .015 per kilowatt hour. With their present usage, the University is paying Golden Valley Electric Association between $ .027 and $ .0375 per kwhr for purchased power.

Golden Valley is expected to submit a rate increase on the order of fifty percent. This should absorb the present fuel cost rate adjustment, but leave the option to use this adjustment if fuel costs continue to climb. One of the reasons that the fuel cost adjustment is so severe is that in Fairbanks, the fuel cost of generating electricity with oil is approximately eight to nine times the cost of generating electricity with coal. This does not take into account the cost of purchasing and maintaining additional equipment running on diesel fuel to meet peaks.

The cost of electricity will go up with the increased fuel prices. The only leveling off would come about if demand were reduced sufficiently so that fuel would not have to be used as much. Unfortunately, the present trend is towards increased use of diesel fuel for power generation, especially with the 2 - 6[illegible] mw combustion turbine generators planned for North Pole.

The proposed Susitna Hydro-Electric power plant could effect the electricity rates in Fairbanks, but expecta- [illegible] power [illegible] involve one [illegible] to get [illegible] years to investigate sites and design; and three to six years for construction. Therefore, no hydro-electric power is expected, even if authorized, within the next ten years. It is expected that such a project would produce power for about $ .02 per kwhr before distribution. Due to these factors, we are discounting possible hydro-electric power.

In conclusion, we can expect electrical rates to rise over the next few years. They will rise faster than fuel costs due to the larger proportion of more expensive fuel needed to meet the demand. We estimate that in two years, the cost to the University of Alaska for electricity, including demand and fuel charges, would be somewhere between $ .038 and $ .045 per kwhr.

5. SUMMARY

The foregoing predictions (summarized in Figure 1, Appendix) are based on current data and cannot take into account the possibilities of increased or lessened governmental control, shortages in other parts of the country or general increases or decreases in demand. Of the above figures, the coal price appears to be the most stable due to steady demand and minimal controls, with oil prices flucuating greatly due to governmental controls and demands or heavy inputs from projects that are expected to be completed within the next few years. Since electrical rates are based on both coal and oil prices in addition to amortization of new equipment, they are the least predictable.

B. EXISTING PLANT OPERATIONS AND EFFICIENCES

The power plant at the University of Alaska, Fairbanks produces steam for heating and electricity for the University. The plant uses coal or oil to produce steam and generates electricity with non-condensing steam turbine generators. The boilers produce steam at 600 psi, 700°F which goes through the turbines and is reduced to approximately 30 psi for winter steam heating production and 17 psi for summer steam production for absorption chillers and heating or to approximately five to seven psi when the new condenser is operating for the pure production of electricity.

1. PLANT CAPACITIES AND LOADS

a. STEAM

The steam plant can generate approximately 95,000 pounds per hour of steam with its coal-fired boilers, except for a six-week period each year when the boilers are out of commission for maintenance. During that time, the [illegible] boiler [illegible] used. [illegible] per [illegible] per day.

Present steam usage before the condenser operation is approximately 55 MM pounds of steam per month in the winter and drops as low as 16 MM pounds of steam per month in the summer. Maximum yearly steam usage has been 370 MM pounds.

With future expansion of the University, an additional coal-fired boiler will be required to meet maximum steam demands.

b. <u>ELECTRICAL</u>

The present University electrical usage is approximately 30 million kwhr per year. The University power plant has been producing about 10 million kwhr per year at an average steam rate of about 37 pounds of steam per kwhr. With the recently installed steam condenser in operation, the power plant should produce an additional 4.5 million kwhr per year. This assumes the condenser will operate six months per year.

2. <u>BOILERS</u>

The plant presently has two coal-fired boilers with name plate capacities of 50,000 pounds per hour of 600 psi 750^{o}F steam. There is one oil-fired boiler which has a name plate rating of 100,000 pounds per hour of 600 psi, 750^{o}F steam. The plant has coal-handling equipment to supply the existing coal-fired boilers and is designed for the addition of another coal-fired boiler in place of the oil-fired standby boiler.

The efficiences of the two coal-fired boilers have been found to vary from 70 to 80 percent. The variation has been assumed to come from the variable coal BTU value. This efficiency does not take into account boiler auxiliary equipment which is accounted for in total plant efficiency. There was not enough operating data to calculate the efficiency of the oil-fired boiler, but at the present difference in cost between coal and oil, it appears that it should be used as a standby boiler only. Therefore, for every ton of coal used in the plant, 11,000 to 12,000 pounds of steam are produced. For the purposes of this study, we have used 11,000 pounds per ton at $16.40 per ton. This gives a steam cost of $ .00149 per pound of steam (See Figures 2, 3, 4 and 5 of the Appendix).

The coal-fired boilers appear to be as efficient as can be expected. The equipment that could increase their efficiency such as re-heat and economizers is not compatible with the existing plant operation. Re-heat could increase the efficiency but re-heat turbines (which are a special item) would ha[illegible] to take advantage of this. An econo[illegible] not help efficiency greatly because the boiler feed water is already around 250^{o}F.

3. TURBINE GENERATORS

The turbine generators installed in the University power plant are two identical General Electric 1.75 mw units. They are rated at 600 psi, 750°F inlet conditions and operate with a variety of outlet conditions depending on the campus heating load and electrical energy requirement. During the winter under high heating conditions the outlet steam conditions are approximately 28 to 30 psi, 300 to 350°F exhaust. The high back pressure is required to transport larger steam quantities around the campus. In the summer outlet steam conditions are approximately 15 to 17 psi, 300 to 350°F. This outlet steam is used by the absorption chiller and various small heating loads around the campus. Another outlet condition is possible when the new steam condenser is operating. Then outlet conditions are approximately 4 to 7 psi, 230 to 260°F.

During winter operation, the turbines run most efficiently at a combined steam input of approximately 80,000 to 85,000 pounds per hour at which the maximum output of both turbines is 3.8 mw. This gives a steam rate of approximately 24 pounds per kwhr. Under summer conditions, the steam rate can drop down to 23 pounds of steam per kwhr. When the condenser is in operation, rates as low as 21 pounds of steam per kwhr are possible because of the lower back pressure on the turbine exhaust. The section on Economic Review of Alternatives should be consulted for a more complete review of condenser operations.

The steam rates are the best indication of a steam turbine generator's efficiencies and the above rates appear about right for a non-condensing turbine. It is interesting to note that the turbine is extremely inefficient at less than 20,000 pounds per hour steam input and becomes most efficient at the maximum steam input. Higher efficiencies would require condensing steam turbines which operate at very low back pressure in the vacuum range. (See Figure 6 & 7).

4. CONDENSER

The air-cooled condenser recently installed in the plant is not of the type normally used in power plants and will not work at the vacuum required for a condensing turbine. With the condenser in operation, an additional 30,000 pounds of steam per hour (at 80°F ambient) may be put through the turbine when there is no steam demand for heating or chilling. Much more steam can be condensed at lower temperatures, but it is generally not needed as the steam is utilized for the higher heating loads. A more complete review of condenser operations is presented in the [illegible] section.

5. PLANT LAYOUT

The plant layout is quite flexible for the current operation and the plant is maintained in very good condition. The original plant was designed so the oil-fired standby boiler could be replaced by another coal-fired boiler of up to 120,000 pounds of steam per hour. The plant has room for another turbine opposite the oil-fired boiler. Such a turbine would have to be mounted on a pedestal as the basement appears to be too small for a condenser if a condensing turbine were installed. The oil-fired standby boiler removed to accommodate a coal-fired boiler could be installed in an addition to the plant building on the west end. There appears to be enough room outside the plant to add additional heat exchanger units for a larger steam condenser.

In conclusion, the plant appears to be as flexible and efficient as can be expected for the installed equipment. More information on present operation possibilities will be covered in the section on Economic Review of Alternatives. Please refer to Figures two through seven for graphical presentation of plant efficiencies.

C. ECONOMIC REVIEW OF ALTERNATIVES

1. INTRODUCTION

The following is an economic review of possible alternative operations for the existing power plant. They are based on present day prices with no escalations for inflation or other possible price increases or decreases. Coal is priced at $ .94 a therm; electricity at $ .03 per kwhr; oil at $ .40 a gallon. Plant energy flow rates are assumed to be similar to Figure 4 in the Appendix. This is not an in depth review and favorable alternatives should be investigated further to find the optimum plant utilization and operation.

The alternatives investigated are the following:

1. Continue present plant operation/optimize condenser use.

2. Purchase a condensing turbine.

   a. A Small Condensing Turbine capable of supplying just the University's electrical needs.

   b. A Large Condensing Turbine capable of producing power for sale.

[illegible] y Cost
Projec[illegible] existing plant operations

that the present use of coal is the most economical for the production of steam. We have not looked into steam or heat production with any other fuel. We have also assumed that at some point an additional coal-fired boiler will be installed to supply steam for heating when the University expands further.

2. CONTINUE PRESENT PLANT OPERATION - OPTIMIZE CONDENSER USE

The present plant operates efficiently for its equipment. The economics of the present plant are shown on Figure 5. Energy Dollar Flow. This figure indicates that steam can be produced for approximately $1.34 a therm, electricity can be produced for $ .0078 per kwhr from the turbine. This operation assumes that the condenser is not being used and that all steam going through the turbine eventually goes on for campus heating purposes. Figure 3 shows the electrical cost when the condenser is operated without the use of steam for campus heating. At the rated capacity of the condenser (30,000 pounds per hour), a steam rate of approximately 21.5 pounds per kwhr is realized which provides electrical power at about $ .031 per kwhr. When the condenser is operating in conjunction with the campus heating, the cost of its operation are much harder to determine. In this mode, it is possible to produce extra electricity above the heating load. Cost of this extra electricity is the cost of the coal plus electrical usage by the condenser for fan motors, etc. An additional estimating problem appears because the steam turbine now operates more efficiently due to higher steam flows. This boosts the total efficiency more than the straight increment of pure condenser operation.

We have prepared rough estimates of various operating costs with and without the condenser on line and with pure condenser operation to correspond with the three operating modes. This information is presented in the Appendix in Charts 1, 2 and 3. We used a capital cost of the condenser at $90,000 with a ten-year life at nine percent interest. If the condenser is run fifty percent of the time at an average production of 1,000 kw, the capital cost would be $ .003 per kwhr.

3. ADDITION OF CONDENSING STEAM TURBINE

When one looks at Figure 1 showing the predictions of fuel rates in the near future, it can be seen that coal is a stable fuel with a potential of it being more of a bargain then it presently is. The University is in a prime position with its existing coal handling equipment and [illegible] the [illegible] of coal [illegible] condensing steam [illegible] as the existing turbines at the University, since they utilize the steam energy down to the vacuum range. (See Figure 7.)

We have done preliminary investigations into the possibility of purchasing condensing steam turbines in the 3.5 to 15 mw range. The low end of this range would be a turbine generator that could produce all of the University's needs in the foreseeable future when used in conjunction with the existing turbines. The high end of this range would be a turbine that could utilize all of the University's steam production capabilities, produce all electricity needed by the University and be used to help produce electricity for the general Fairbanks area through some agreement with Golden Valley Electric Association.

a. SMALL CONDENSING TURBINE

Small condensing turbines of approximately 3.5 to 5 mw vary in price from between $500,000 to $1,200,000. A condenser would cost $500,000 to $600,000. A rough estimate of total cost including piping, design, controls, purchase and installation of related equipment should be around $2,000,000. If this is amortized over 20 years at eight percent, annual cost equals $210,000. This is a kwhr cost of $ .0096. The fuel cost of such a turbine can be assumed as manufacturer's data plus twenty percent or approximately twelve pounds of steam per kwhr, which is $ .0179 per kwhr. Maintenance can probably be accounted for at approximately $ .001 per kwhr for a total electrical production cost of $ .028 per kwhr. This is a very attractive figure at today's costs and can only become more attractive in the future.

b. LARGE CONDENSING TURBINE

A large condensing turbine in the 7 to 15 mw range would cost approximately $1,400,000 to $2,000,000. The condenser package would be approximately $1,000,000. Piping, controls, installation, purchase of related equipment, etc. would bring the total installed cost to about $4,500,000. If this is amortized for 20 years at nine percent, we arrive at $493,000 a year, or $ .0049 per kwhr.

A condensing turbine of this size can be expected to operate at eleven pounds per kwhr with minimal extraction (summer operation) and around sixteen pounds per kwhr when a large proportion of steam is extracted for campus heating. This means that approximately 60 MM kwhr would be produced in the summer and 40 MM kwhr produced in the winter. Taking into account steam demand, we estimate this fuel cost to be $ .0194 per kwhr. Maintenance is assumed to be approximately $ .001 per kwhr so that a total cost on a yearly average is expected to be $ .026 per kwhr.

This large condensing steam turbine would not be economical if the University is unable to sell the excess power generated. In our predictions on future fuel costs, we found that Golden Valley was paying approximately nine times as much for electricity generated by fuel oil as opposed to that generated by coal. If the University's installation of a large condensing steam turbine is only one quarter as efficient as Golden Valley's Healy power plant, it is still twice as economical as diesel-fired gas turbine generators. It appears as if negotiations with Golden Valley could be undertaken for the sale of the University's excess power to Golden Valley.

A study of the possible rates based on power, supplies, demand, charges, etc. is beyond the scope of this study. But the University should begin to discuss this with Golden Valley to see if there is an economic basis for installing a large turbine. The Fairbanks area cannot continue to use high-priced petroleum fuels for electrical power when it has such vast reserves of coal readily available. The University is in a prime position to assist the Fairbanks area in reducing its dependence on petroleum fuels and becoming more flexible in electrical power generation.

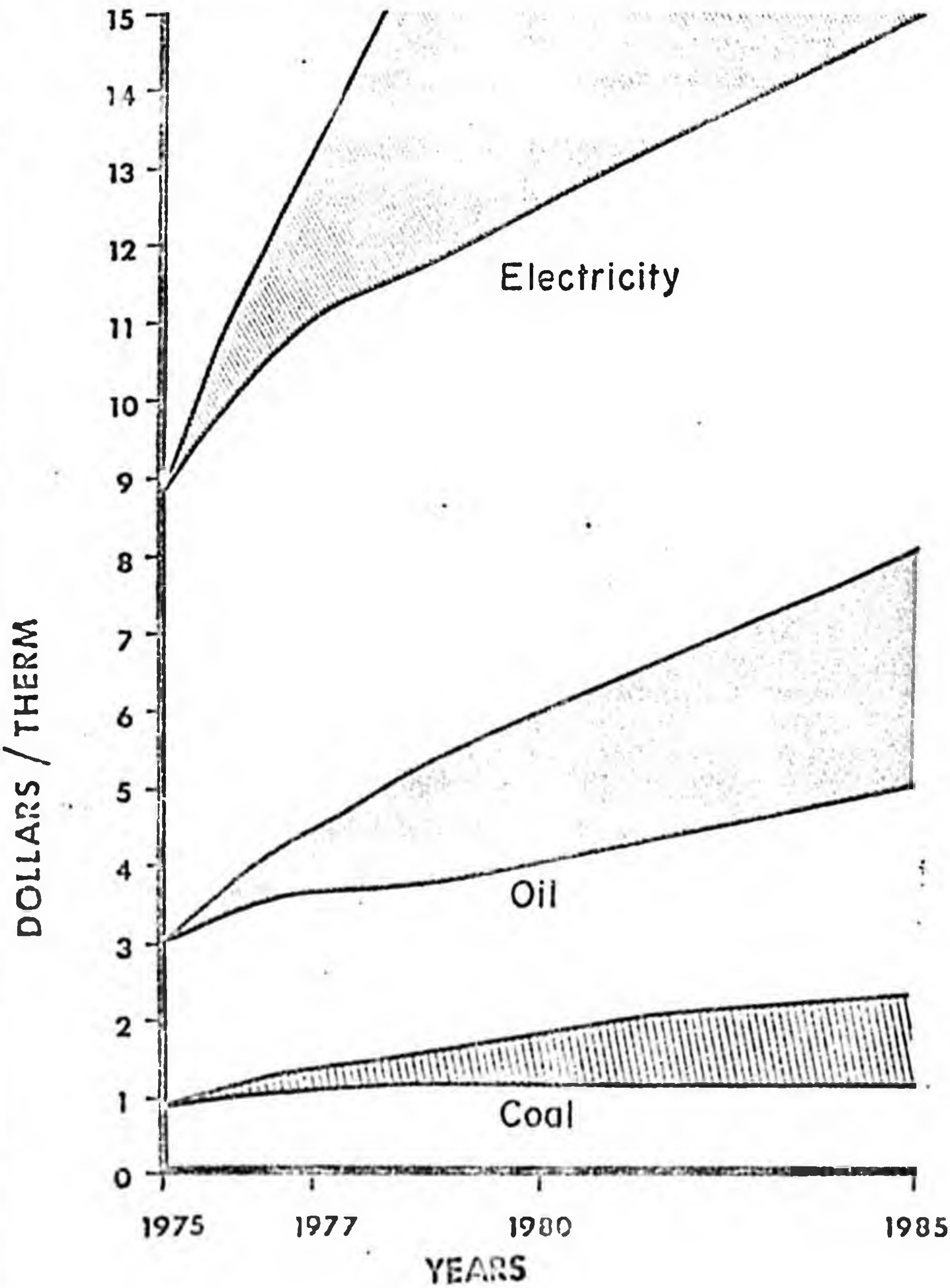
4. CONCLUSIONS ON ECONOMIC ALTERNATIVES

The preceding review on economic alternatives has demonstrated that more work must be undertaken to determine which direction the University should go in the near future. The recently installed condenser appears to have been put in operation at the ideal time to start to take advantage of increased electrical charges. A study should be undertaken to determine on a month to month basis the optimum operational modes for the condenser. This study would include projections or estimates of Golden Valley's fuel surcharges and the University's total demand, and the results of the study would indicate a point when the condenser should be put on line for minimizing Golden Valley Electic Association electrical charges to the University.

A further study must be undertaken to determine the size of a condensing steam turbine which should be installed. The study should look further into estimating the cost of such equipment and determining the optimum size of the turbine and its related equipment. This study should also undertake to determine whether Golden Valley would be interested in purchasing power and at what cost. A possibility not discussed in the preceding alternatives is that of purchasing surplus generation equipment at approximately ten percent of the cost of the new equipment. Such surplus equipment should of course be inspected in detail and [illegible] [illegible]llation [illegible] [illegible]rmanent place.

A related item that should be included in any further study is the use of a central computerized control network to shave the existing demand peaks. This in addition to energy conservation measures could appreciably reduce the University's demand for both electricity and heat; thus, reducing fuel charges and electrical charges. Computerized control could be utilized to optimize the existing plant operation so that electrical production costs are kept at a minimum.

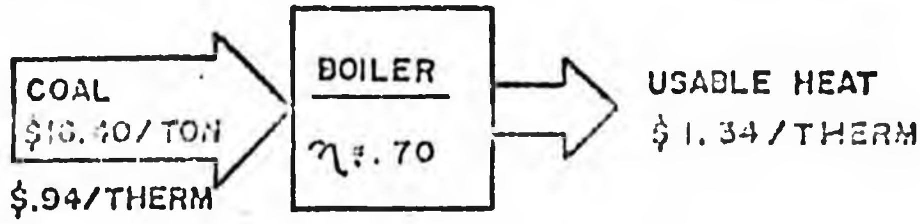
FUEL COST PROJECTION Figure 1



MOWER & ASSOCIATES

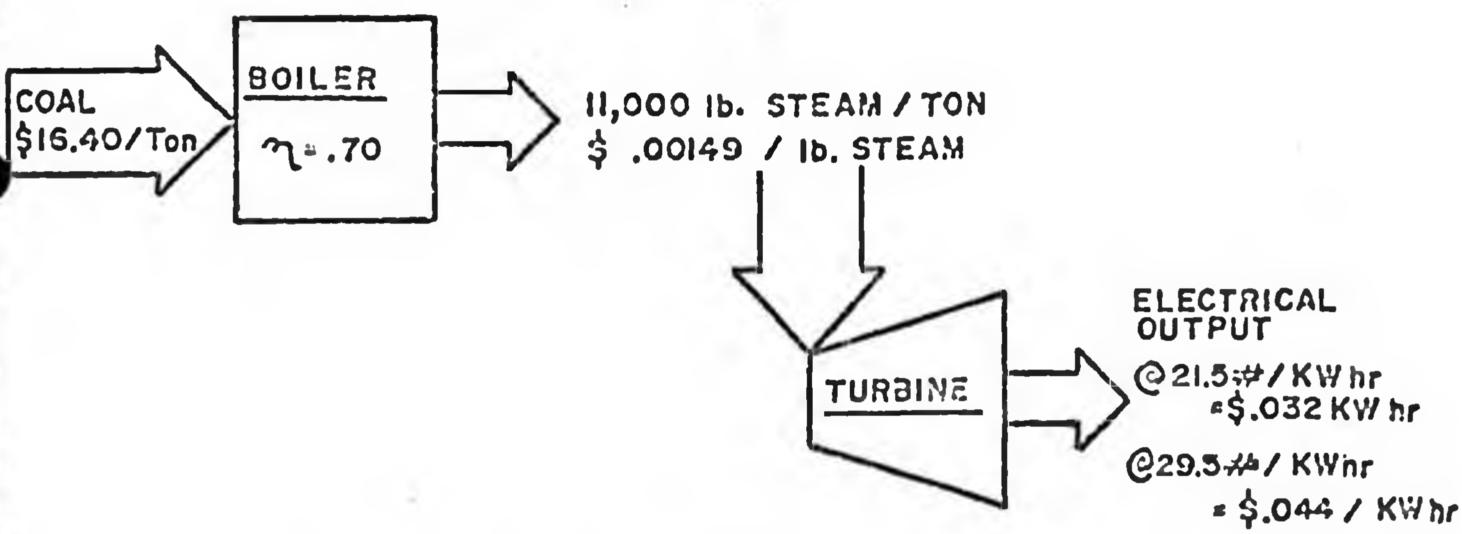
UNIVERSITY OF ALASKA, FAIRBANKS

CAMPUS ENERGY UTILIZATION STUDY



DOLLAR CHARGES IF ALL ENERGY CHARGED TO HEAT

Figure 2

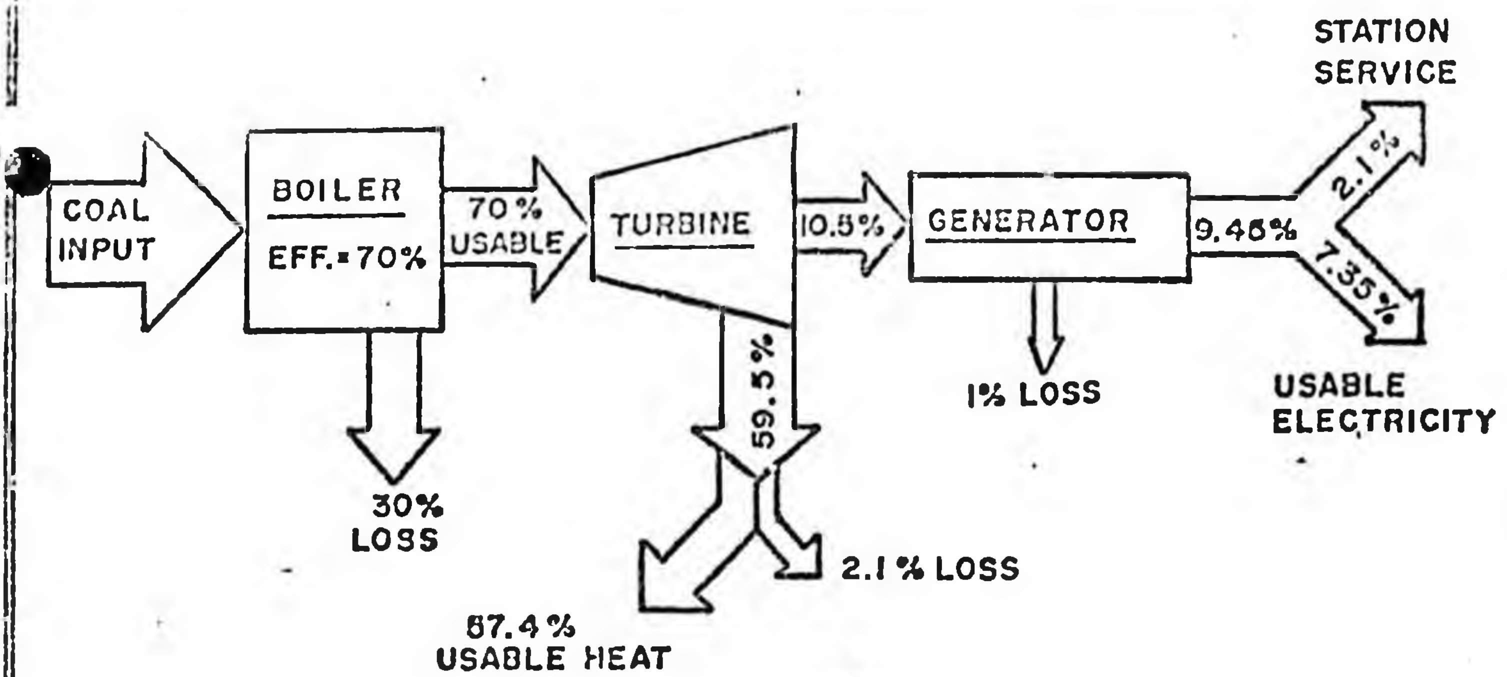


DOLLAR CHARGES IF ALL ENERGY CHARGED TO ELECTRICITY: CONDENSER OPERATION

Figure 3

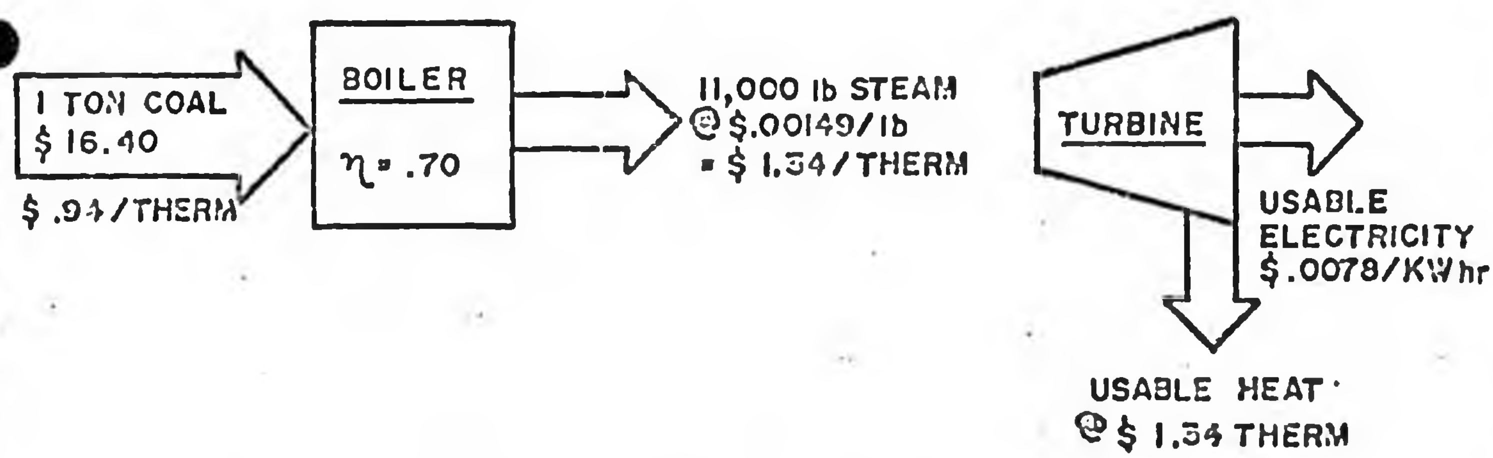
MOWER & ASSOCIATES
PO [illegible] ANCHORAGE, ALASKA

UNIVERSITY OF ALASKA FAIRBANKS
CAMPUS ENERGY UTILIZATION STUDY



PLANT ENERGY FLOW

Figure 4



ENERGY DOLLAR FLOW

Figure 5

MOWER & ASSOCIATES
PO [illegible] ANCHORAGE, ALASKA

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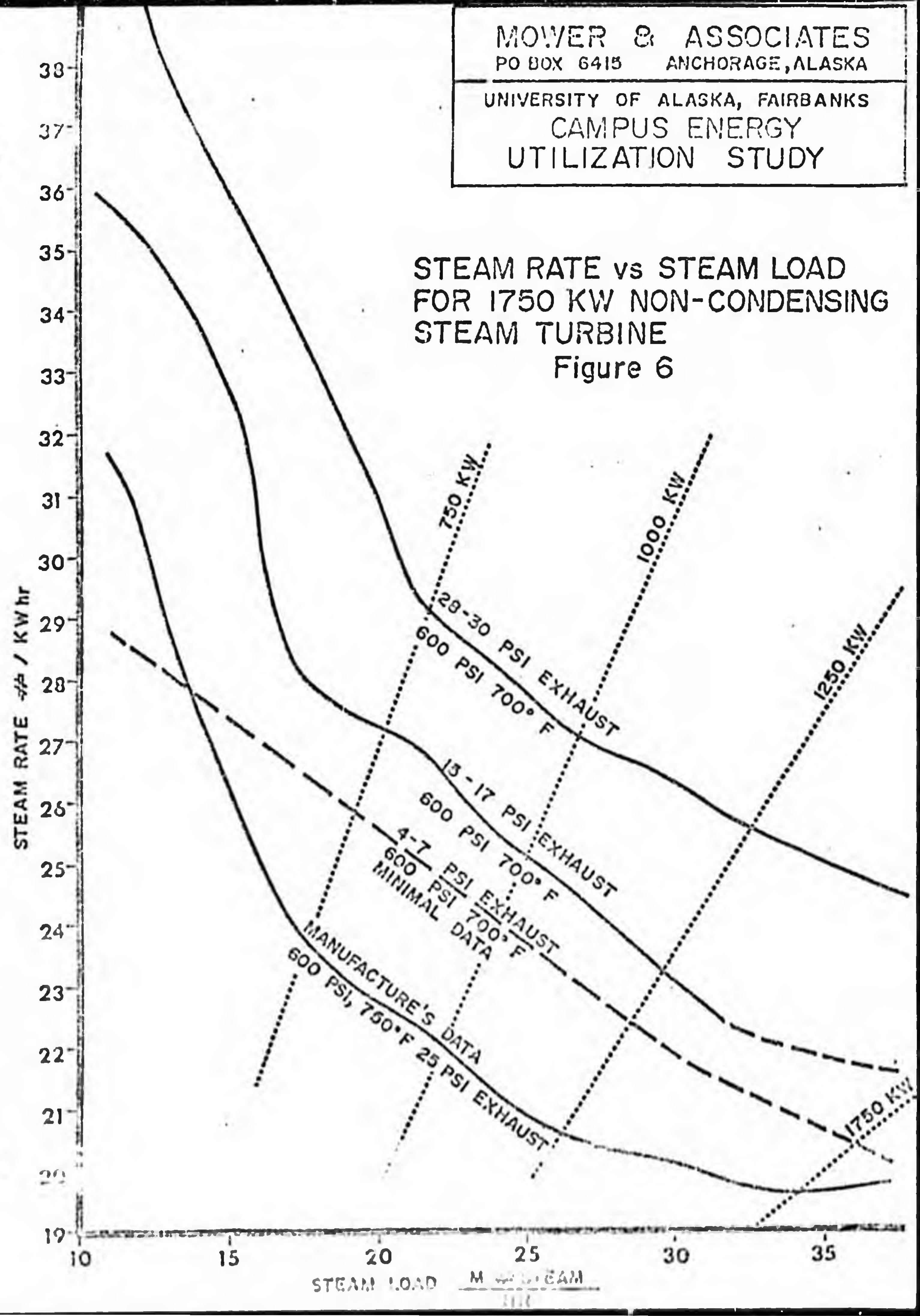
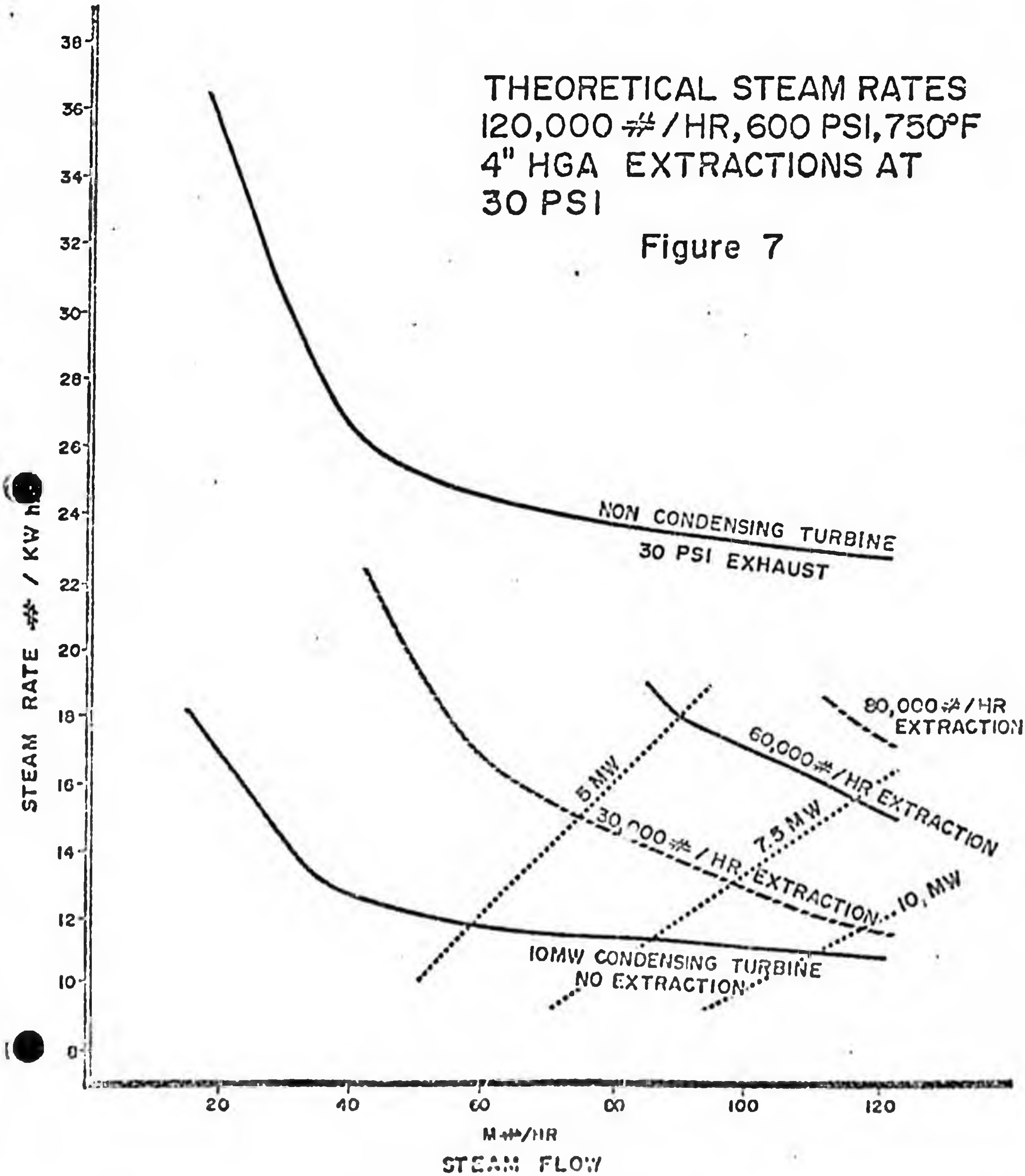
CAMPUS ENERGY UTILIZATION STUDY



STEAM RATE vs STEAM LOAD FOR 1750 KW NON-CONDENSING STEAM TURBINE
Figure 6

MOWER & ASSOCIATES
PO BOX 6415 ANCHORAGE, ALASKA

UNIVERSITY OF ALASKA, FAIRBANKS
CAMPUS ENERGY UTILIZATION STUDY



THEORETICAL STEAM RATES
120,000 #/HR, 600 PSI, 750°F
4" HGA EXTRACTIONS AT
30 PSI

Figure 7

EXISTING PLANT CONDENSER OPERATION
ESTIMATES OF FUEL COST

CHART 1
WINTER OPERATION (28 - 30 PSI EXHAUST)

STEAM LOAD M#/HR	CONDENSER STEAM M#/HR	STEAM RATES LOAD #/KWHR	STEAM RATES CONDENSER #/KWHR	EXTRA POWER STEAM LOAD KW	COND. POWER KW	MAXIMUMS TOTAL POWER KW	MAXIMUMS INCREMENT COST $	FUEL COST DOLLARS/KW-HR
10	10	57	30.8	149	324	474	14.5	$ .0306
10	20	57	26.1	208	766	974	29	.029[illegible]
10	30	57	24.1	240	1245	1485	43.5	.0295
20	10	30.8	26.1	126	383	509	14.5	.0285
20	20	30.8	24.1	190	829	1020	29	.0284
30	10	26.1	24.1	96	414	510	14.5	.028[illegible]

CHART 2
SUMMER OPERATION (15 - 17 PSI EXH[illegible])

STEAM LOAD M#/HR	CONDENSER STEAM M#/HR	STEAM RATES LOAD #/KWHR	STEAM RATES CONDENSER #/KWHR	EXTRA POWER STEAM LOAD KW	COND. POWER KW	MAXIMUMS TOTAL POWER KW	MAXIMUMS INCREMENT COST $	FUEL C[illegible] DOLLARS/[illegible]R
10	10	36	27	92	370	462	14.50	$ .0314
10	20	36	23.5	147	851	998	29	.029
10	30	36	21	198	1428	1626	43.5	.0267
20	10	27	23.5	111	425	536	14.5	.0270
20	20	27	21	212	952	1164	29	.0249
30	10	23.5	21	152	475	628	14.5	.0231

CHART 3

CONDENSER FLOW ONLY

STEAM #/HR	POUNDS/KWHR STEAM RATE	KW OUTPUT	FUEL COST DOLLARS/KWHR
10,000	29.5	339	$ .0440
15,000	27.4	547	.0408
20,000	25.5	784	.0380
25,000	22.5	1111	.0335
30,000	21.5	1395	.0320
35,000	20	1750	.0298
40,000	19		.0283

NOTE: above is conservative. No factor included for higher condensate temperature, thus less coal needed to make steam. No factor for fan power required. Also, figures were extrapolated past 22,000 pounds per hour. No data available.

UNIVERSITY OF ALASKA, FAIRBANKS

CAMPUS ENERGY UTILIZATION STUDY

PHASE II

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I. INTRODUCTION

The University of Alaska, Fairbanks has a variety of means of meeting its energy requirements during the next ten years. The University is faced with a continuing upward spiral of fuel and utilities costs. These fuel and utilities costs were projected in Phase I (See attached fuel/utilities costs projections in Appendix) of this report. In Phase II presented here, we have examined the future growth of the University in Alaska, Fairbanks campus and the future demand placed on the present University power plant.

The objective of Phase II of this study is to determine the most economical means of meeting the energy requirements of the University of Alaska, Fairbanks during the next ten years. In order to accomplish that, we utilized the fuel costs projection obtained in Phase I and projections of the University planning department on campus growth to estimate the annual cost of the present University power plant and a self-sufficient plant. The self-sufficient plant consists of a steam-turbine generator capable of providing all of the electrical power needs of the University campus. It would be installed in the existing power plant which is already capable of providing all the steam heating required by the University. With the annual cost information compiled in this report, the University should be able to effectively plan for its future energy requirements.

II. SUMMARY AND CONCLUSIONS

A. SUMMARY

This study has examined the future campus growth of the University of Alaska, Fairbanks. The campus steam heating and electrical usages for the next ten years were projected based on historical data and predicted University growth. From these projections, a determination was made on the heating plant required to meet the projected steam heating loads. A self-sufficiant power plant was recommended to meet projected electrical loads. Typical operation modes and expected efficiencies were predicted based on a self-sufficient electrical power plant. From this information and the campus growth, annual costs were determined to compare continued operation of the present plant with the proposed self-sufficient plant. From the projected annual costs, a pay-off period for the construction of the self-sufficient plant was determined.

B. CONCLUSIONS

1. There is not going to be as much growth on the University of Alaska, Fairbanks campus as there has been in the recent past. The next ten years should have maximum growth of approximately eighteen percent over present size and minimum growth of approximately ten percent.

2. The present University power plant is adequate to meet the projected steam heating demands for the next ten years. A longer time period of higher steam demand is required before a new coal-fired boiler can be justified. Steam usages in the next ten years can be met by the existing coal-fired boilers and utilization of the existing oil-fired boiler to meet peaks.

3. The present University power plant produces approximately half of the electricity used on campus. In order to be self sufficient, the University would need additional generation capabilities. The most economical form would be a condensing-type steam-turbine generator. A steam-turbine generator capable of meeting the University's anticipated electrical demands for the next ten years could be purchased and installed for approximately $3,400,000. Such a steam-turbine generator, even utilizing oil to produce the peak steam required, would be substantially less expensive over the next ten years than purchasing power from Golden Valley Electric Assoc.

3. Continued

The investment in a steam-turbine generator should be paid off in four to six years after construction through elimination of electrical purchases.

The University should plan immediately for the addition of a steam-turbine generator to the existing power plant so they can eliminate paying for the high cost of electricity. Projected growth over the next thirty or forty years should be investigated to determine the economics of adding a coal-fired steam boiler or converting the oil-fired boiler to natural gas when it becomes available.

III. DISCUSSION

A. HISTORICAL AND PROJECTED CAMPUS GROWTH

The University of Alaska, Fairbanks has undergone considerable growth in the last few years; and while this growth appears to be tapering off, many decisions must be made now and in the future to satisfy the heating and electrical demands that this growth imposes on the existing twelve-year old University power plant. In this section we propose to outline the past five years' growth in terms of square feet of building area and project this growth for the next ten years. We also will investigate the historical steam and electrical usage and project that usage for the next ten years.

1. CAMPUS GROWTH

The Fairbanks campus grew at five to ten percent per year until 1970. At that time there was a total of approximately one million square feet of building area on the campus. From 1970 to 1975 the campus grew rapidly, doubling in size, to around two million square feet. Construction included married-student housing, dormitories, recreation halls, offices, laboratories, classrooms, a student-union building, and a community center. The Hutchinson Career Center and the University Park School began to receive steam from the University power plant in 1972.

At the present time, the University supplies electricity and heat to two million square feet of its own buildings and an additional 140,000 square feet outside the University campus are provided with heat.

We have met with the University's planning department and jointly have arrived at figures for projecting additional University square footage which must be served by the power plant over the next ten years. The following is a summation of the maximum probable construction to the year 1986.

Fall of 1976 - An ice rink of 42,600 square feet will be completed.

Fall of 1976 - West Valley High School of approximately 100,000 square feet will be provided with steam heat only.

1977 - The Museum of the North is planned with approximately 50,000 square feet.

1978 - [illegible] ...ity College V[illegible]tion Educatio[illegible] square fe[illegible] planned.

1980 - A library addition of 60,000 square feet is planned.

1982 - An Arctic research building of approximately 50,000 square feet is planned.

1984 - Student housing of approximately 30,000 square feet is planned.

This indicates construction of approximately 50,000 square feet every two years or approximately 250,000 square feet over the next ten years. This information was obtained from the "Capital Budget Proposed Six Year Capital Program" and other information available to us from the planning department.

In any projection the minimum should also be looked at. At the very least, the University planning department expects to provide for the ice rink and the West Valley High School in the fall of 1976. The Museum of the North and the Tanana Community College Vocational Education Shop would probably be constructed over the next ten years. The minimum total would probably be approximately 100,000 square feet or forty percent of the maximum construction figure not including projects already under way.

We have prepared a graph showing the historical growth and projections for the period 1970 to 1986. The graph is in the appendix as Figure 1 and indicates the square footage served by heat and the square footage served by electricity and steam heat. It also indicates maximum and minimum planned construction based on the above information. From this graph we can see that the maximum projection for buildings served by steam heat is approximately two and one-half million square feet and that those buildings served by both electricity and steam heat are 2,300,000 square feet. The minimum figures are 150,000 square feet less than each of the above.

From this graph we can determine that the maximum growth in terms of percentage of existing square footage for buildings served by electricity and steam heat is approximately 11.8 percent and maximum growth for steam-heated square footage is approximately 17.7 percent. The minimum growth for buildings served by electricity and steam heat is approximately 7.1 percent and for buildings served by steam heat, approximately 11.2 percent.

The physical plant growth over the next ten years at the University of Alaska, Fairbanks appears to be considerably less than over the last five years. The growth seems to be dropping back to pre-1970 figures. While this growth may be small in terms of percentage of existing physical plant, it is nonetheless large in terms of square footage per year as compared to pre-1970 figures. The growth also appears to be quite steady over the next ten years. Most planned buildings are approximately the same size and spaced at even time intervals.

2. STEAM USAGE - HISTORICAL AND PROJECTED

The University has experienced considerable growth in steam demand for heating and cooling purposes over the past ten years. The steam usage has grown from under two hundred million pounds per year in 1967 to a peak of almost three hundred eighty million pounds per year in 1973-4. We have prepared a graph of steam usage. (See Figure 2 of the Appendix.) The steam usage has not grown as rapidly as the square footage constructed due to more energy-efficient construction and more diversity in the steam load.

The steam usage has been projected from the present to 1985 using past data on steam usage per square feet and projected data on construction. In the discussion of campus growth, we found that the maximum projection for steam-heated buildings was 17.7 percent and the minimum growth was expected to be 11.2 percent. Figure 2 indicates a maximum projection of 18 percent over the next ten years to a total of four hundred fifty million pounds of steam used per year. The minimum growth would be approximately ten percent so that present demands could rise to approximately four hundred twenty million pounds of steam per year. Note that these figures are for heating only. Steam used in the new "condenser" will probably average one hundred twenty million pounds per year.

3. ELECTRICAL USAGE - HISTORICAL AND PROJECTED

The total electrical usage on the Fairbanks campus has increased rapidly over the past few years, although energy conservation measures initiated several years ago have been able to reduce present electrical usage to that of four or five years ago. The present electrical usage is approximately thirty million kw hours per year plus another four million kw hours per year station service. We have projected the electrical usage over the next ten years and have arrived at growth rates in line with those for the building square footage growth. These indicate maximum growth of 11.8 percent over the next ten years and a minimum growth of 7.1 percent over the next ten years. These projections are shown on Figure 3. From this we would expect by 1985 the total electrical usage to increase to approximately thirty-eight million kw hours per year as a maximum or a minimum of thirty-three million kw hours per year.

B. PLANT REQUIREMENTS TO MEET PROJECTED HEATING USAGE

In the previous section, we determined that the maximum growth over the next ten years will be approximately eighteen percent and the minimum growth would be approximately eleven percent; thus, the present yearly steam demand of three hundred eighty million pounds would increase to a maximum of four hundred fifty million pounds per year or a minimum of four hundred twenty million pounds per year in the next ten years. In this section we will determine if the existing power plant can accommodate that demand; and if not, what steps should be taken to meet it.

The present University power plant has two coal-fired boilers with name plate capacities of 50,000 pounds per hour of 600 psi, 750°F. steam. There is one oil-fired boiler which has a name plate rating of 100,000 pounds per hour of 600 psi, 750°F. steam. The two coal-fired boilers are used for the basic steam load with the oil-fired boiler used as a standby.

In the last few years the power plant has been able to meet the steam demand peaks using only the coal-fired boilers. Last year the maximum hourly peak was 92,400 pounds per hour. During that time the average output for the entire week was 81,000 pounds per hour. The existing coal-fired boilers apparently cannot achieve their rated 100,000 pounds per hour output due to the low heating value of the coal used. The maximum combined output from the two coal-fired boilers appears to be approximately 94,000 pounds per hour.

Typical average steam demands are shown on Figure 4 of the Appendix. The University's demand on steam production usually averages about 70,000 pounds per hour during the winter months and the peak demand of 81,600 pounds per hour for a one-week period normally occurs for only a week or two per year. We have determined that if the present maximum output is increased by eighteen percent to 96,300 pounds per hour, it would exceed the output of the present coal-fired boilers approximately three weeks out of the year.

At the present time in Fairbanks coal costs approximately one third as much as oil for the same amount of heat, so it is obviously economical to operate coal-fired equipment as much as possible. (See Appendix Figure 5.) The existing coal-fired boilers should be able to handle the projected steam demand approximately 95 percent of the time ten years from now at the maximum projected University growth. If higher heat-value coal could be obtained during the winter months, the existing coal-fired boilers could possibly handle 100 percent of the projected weekly heating demand.

It was originally thought that an additional coal-fired boiler would have to be installed in order to economize on steam production. This assumption was made before a precise projection of future steam demands was made. It now appears that the investment of three to five million dollars for an additional coal-fired boiler and its related fans, pumps, motor control centers, additional building area, etc. is not economical and that the existing oil-fired boiler should be used to meet steam-demand peaks in the future. In Section D of this report we discussed the cost of producing steam for the next ten years and in that section we arrived at oil cost to meet heating peaks ranging from $2,000 a year in the next year to approximately $50,000 a year ten years from now. This is considerably cheaper than purchasing and installing a coal-fired boiler and its related equipment. Natural gas is a possible fuel in ten to fifteen years and the oil boiler could be converted to take advantage of the probable lower fuel cost.

The existing University power plant can easily accommodate the projected steam demands for the next ten years. In order to justify purchasing an additional coal-fired boiler, a twenty or thirty year demonstrated need must be shown. At the present time this need does not appear to exist; therefore, the University should not anticipate expanding its steam production capabilities.

C. PLANT REQUIREMENTS TO MEET PROJECTED ELECTRICAL USAGE

1. PRESENT PLANT CAPABILITIES

At the present time the University produces its own power and purchases power from Golden Valley Electric Association. The present electrical demand and projected maximum and minimum electrical demands for the next ten years have been discussed in Section A. At the present time the University power plant has been able to produce approximately one third of the yearly electrical usage. The electrical generation equipment consists of two 1.7 megawatt, non-condensing steam turbine generators. Recently, a direct steam-to-air condenser has been added to utilize the turbines a higher percentage of the time.

In the past the existing steam turbine generators were totally dependent on the steam heating load requirement for their operation. Steam goes into the turbine at 600 psi, 750°F. and exits from the turbine at pressures of fifteen to thirty psi and temperatures of 300 to 350°F. This exhaust pressure is determined by steam distribution requirements on campus. During high heating demands in the winter, thirty psi must be maintained at the plant [illegible] psi steam to the West Ridge.

In the past the turbines did not operate fully when there was light steam demand due to the lack of condensing capabilities in the plant. The addition of the air-cooled condenser in the summer of 1975 allowed operation of the existing steam turbines during times when steam demand was light. The condenser is capable of handling 30,000 pounds of steam per hour at 80°F. outside air temperature and it normally operates at five to seven psi. Steam exhausting from the turbines goes through the condenser and then goes back to the boilers as condensate rather than circuiting the campus as steam for heating purposes.

Optimizing the operation of the new steam condenser should allow the University to produce an additional four to five million kw hours per year above their average of ten million kw hours per year. The means that the University is now capable of producing one half of its present electrical demand. The other half of this electrical demand is provided by Golden Valley Electric Association.

The Fairbanks area currently is having considerable problems with electrical generation. The electrical production plants in the area have had to operate at peak capacity to meet winter loads and this has forced the utilities to install gas turbine generators running on oil to meet the demand peaks. These gas turbine generators are quite inefficient; and in the Fairbanks area, electricity produced by oil-consuming equipment costs approximately eight times as much as electricity produced by coal-fired equipment. The Public Utilities Commission has allowed Golden Valley Electric Association to institute a fuel surcharge so that they can pass on their additional generation costs to their customers. Golden Valley Electric Association has also increased its demand charges to discourage high electrical consumption during demand peaks.

Figure 5 in the Appendix shows the projected fuel and utilities rates over the next ten years. The graph was prepared for Phase I of this energy study and demonstrates the probable rapid increase in the cost of utility-produced electricity. Golden Valley Electric Association will utilize more oil consuming electrical generation equipment so that the cost of electricity will rise rapidly. It, therefore, behooves the University to investigate the possibilities of becoming totally self-sufficient in the production of electrical power.

The present steam turbine generators in the University power plant serve their purpose with reasonable total efficiencies, but the prime purpose of the power plant has been to produce steam for heating with a secondary [illegible] ...icity. [illegible] University is [illegible] ...ical de[illegible] ...dditional [illegible] be installed

2. PROPOSED ELECTRICAL GENERATION EQUIPMENT

The present peak electrical demand for a short time period is 5.8 megawatts (mw). If we multiply this by the projected increase in total electrical demand of approximately twelve percent, we arrive at 6.5 mw. In order to be self sufficient, generation capabilities meeting this figure should be installed. The modern automatic extraction condensing steam turbine generator can produce electrical power and provide extraction steam for heating purposes with much more efficiency than is demonstrated by the University's present non-condensing steam turbines.

We have determined that an automatic extraction condensing steam turbine generator with a shaft output of 6.5 to 7.5 mw would be ideal in serving the University's electrical and steam demands for the foreseeable future. This turbine would have approximately 120,000 pounds per hour steam inlet capacity at 600 psi, 700°, exhausting at four inches of mercury vacuum into a condenser, with extraction capabilities of between 20,000 and 100,000 pounds of steam per hour at 50 psi.

The turbine could easily meet the University's peak electrical demands. It could pass enough steam through its extraction nozzle to serve most of the University's heating demands and by using a vacuum steam condenser, it could produce electrical power when there was little steam demand. Its operation modes will be covered more completely in Section D.

In addition to the turbine generator, the University would need a dry-type steam-to-air condenser. Boiler feed pumps would be required to pump the condensed steam back to the boiler. Various electrical switch gear would be required to control misc. pumps and motors. A generator control center, breakers, and misc. wiring would also be required. Various piping, valves, controls, etc. would be required to install this in the power plant. Little work is required on the existing power plant building to install such a generator. It could fit on the turbine generator floor to the west of the existing steam turbine generators. There is already an allowance for a smaller steam turbine generator and some modification of the turbine floor for foundations, equipment supports, etc. would be required. The dry-type condenser could be installed to the west of the power plant between the power plant and the water treatment plant.

The dry-type steam-to-air condenser would be similar to the condenser now in operation at the power plant with the major [illegible] a steam ejector would be utilized [illegible] in the con[illegible]er; thus, allowing more [illegible] operation. [illegible] condenser would also have an air re-circulating system to prevent freeze ups in winter weather. The dry-type condenser has many advantages in the Fairbanks climate. It does not use any cooling water, thus, eliminating large cooling water pumps and water treatment to avoid scaling problems. It also does not contribute to the generation of ice fog. Such a condenser would only have to handle approximately 40,000 pounds per hour of steam due to the fact that most of the steam would be extracted for campus heating use.

We have used a 50 psi extraction pressure rather than the currently utilized 20 to 30 psi due to the proposed increase in steam distribution pressure to allow for various steam equipment to be used in laboratories, classrooms, and other buildings. This increase in distribution pressure would be tied into the possible construction of a loop on the West Ridge steam line. The present steam-turbine generators can operate at 50 psi exhaust pressure but they would become less efficient.

We have prepared an approximate cost estimate for such a turbine-generator installation. The earliest such an installation could take place would be in 1978 due to the approximate eighteen-month construction and delivery time for the steam-turbine generator. Our cost estimate is based on 1978 prices and includes contingencies and contractor's overhead and profit, and engineering costs. See Chart 5 of the Appendix. The total construction cost in 1978 should be approximately $3,400,000.

With such a turbine installation, the University would be totally independent of the local electrical utilities. It could, however, provide up to seven megawatts of power to the Fairbanks community in times of emergency by utilizing the existing turbine generators (which would normally be used only for standby purposes), utilizing all available steam output from both its coal-fired and oil-fired boilers and lowering electrical consumption on campus to approximately three megawatts.

The operating economies of such a turbine installation are discussed in Section D of this report where the installation of additional generation capability is economically compared with continued operation of the present plant and purchase of power from Golden Valley Electric Association.

D. PROJECTED POWER PURCHASING AND PRODUCTION COSTS

In previous sections of this report, we have discussed campus growth, the required production to meet the projected heating demands and the required production to [illegible] we will [illegible] of meeting these requirements.

One alternate involves no new construction; merely, continuing to operate the existing power plant. Providing steam with existing equipment and power with both existing equipment and purchased power from Golden Valley Electric Association. The annual cost will include coal and oil costs, electric purchasing costs, operation and maintenance costs and amortization of the construction cost of the existing plant.

A second alternative for meeting electrical and steam demands for the next ten years will be one in which the University will be totally self sufficient. In this alternate we will assume that the steam-turbine generator proposed in Section C will be installed by 1978 and from then on the University will be totally independent from Golden Valley Electric Association. Total independence may not be the most economical mode; but with the equipment installed, the most flexible operation points can be determined. The annual cost of a totally self-sufficient plant will include coal costs and oil costs, amortized capital costs of additional equipment installed as discussed in Section C, normal plant operation and maintenance, additional plant operation and maintenance as required for the additional equipment, and amortization of the existing power plant.

In both of the above alternatives, we have used the maximum growth projected for the next ten years as a basis for our estimates. This insures that the equipment will meet the demands; and if there is less than maximum growth, the annual cost should be less.

In both alternatives a minimum and a maximum yearly cost was computed. The demands were scaled up at the projected growth rate from existing demands. The fuel and utilities rates utilized were based on the fuel/utilities costs projection shown in Figure 5 in the Appendix. At the minimum, coal costs were expected to increase at one percent a year. At maximum, coal costs were expected to increase ten percent per year. Electrical costs for Alternate One were assumed to increase at the minimum of seven percent per year and a maximum of twenty percent per year. Due to the small amount of oil required, an average of ten percent per year increase in cost was utilized with no maximum or minimum calculated.

1. <u>MEET PROJECTED POWER REQUIREMENTS WITH EXISTING POWER PLANT. PURCHASE ELECTRICITY AS REQUIRED.</u>

In this alternate the present power plant was expected to continue with approximately the same efficiencies it now has. The newly installed steam condenser was expected [illegible] possible [illegible] produce the required [illegible] rates it can be [illegible] that the [illegible] condenser operation can be optimized to produce power at less than purchased rates.

The present plant operation and maintenance budget is approximately $650,000 per year. This was assumed to increase at ten percent per year for the purposes of this calculation. The amortization cost of approximately $500,000 per year to 1985, then $200,000 per year to 1994 was obtained from the planning department and used as is for the purpose of this calculation.

The results of our calculations are shown on Figure 7 where a graph of annual costs versus years can be found. Also, in the Appendix are the figures we utilized to determine the fuel costs.

2. <u>MEET PROJECTED POWER REQUIREMENTS WITH A SELF-SUFFICIENT PLANT</u>

If additions to the present power plant as outlined in Section C are utilized, the production costs of steam and electricity for the next ten years can be determined. Until such alterations can be made to the plant, we must utilize figures obtained in Alternate One. The same fuel costs were used as were used in Alternate One. A graph of the automatic extraction condensing steam turbine performance was prepared so that steam requirements could be determined for various electrical outputs. It was assumed that the existing steam-turbine generators would only be used for standby purposes and that the oil-fired boiler would only be utilized as required to meet peaks.

The capital cost of installing steam-turbine generation capabilities were amortized at eight percent interest for twenty years. Operation and maintenance costs were assumed to be fifteen percent over existing and projected operation and maintenance costs for the present plant.

There was assumed to be no exchange of power between the University and Golden Valley Electric Association. It is possible that an agreement could be made that would be advantageous to both Golden Valley Electric Association and the University; but since this is described as a self-sufficient plant, it was assumed to operate as such for the purposes of this study. This eliminates utility standby charges but also requires producing electricity with the oil-fired boiler when it may be more economical to purchase power. It should be noted that the additions proposed would result in a much more flexible plant and perhaps more optimal operation could be accomplished.

The results of our calculations are shown on Figure 8 which graphs the annual costs of a self-sufficient plant for the next ten years. Also in the Appendix are charts outlining operational modes for winter and summer operation periods [illegible] each and [illegible]-six week period cover[illegible] these op[illegible] modes.

3. COMPARISON OF THE TWO ALTERNATIVES

It can easily be seen from Figure 9, projected total savings, that the self-sufficient plant is much more economical with a total savings of over twelve million dollars by 1985; or a pay off on installation costs in four to six years from construction. The self-sufficient plant becomes more economical beyond the next ten years due to its larger capacity and more flexible operation.

Even if there were no difference between the two alternatives, the University would be in a better position with a self-sufficient plant due to its more flexible operation and its independence from outside influences. With a self-sufficient plant operating costs are easier to predict and planning is much more stable. The Fairbanks area is having an electrical shortage at the present time. If the University were to become self sufficient, it would not have to worry about what the future may hold.

We recommend that the University begin the design phase for the addition of an automatic extraction condensing steam turbine with related equipment to its existing power plant. The approximate two-year lead time on equipment and installation dictates that the University move with all possible speed to realize savings as soon as possible. It is unfortunate that such a plant is not available at the present time so that electrical charges of 4.4¢ per kw hour for the month of February 1976, could be avoided. It is unusual to find such a bargain in today's age and equally rare to have a bargain to be advantageous to both the University and the Fairbanks community.

IV. APPENDIX

Fuel/Utility Costs and Projections (From Phase I Report)

1. Building Square Footage - Historical and Projected
2. Steam Usage - Historical and Projected
3. Electrical Usage - Historical and Projected
4. Typical Steam and Electric Range of Demands
5. Fuel Cost Projection
6. Typical Steam-Turbine Generator Performance
7. Projected Annual Costs For Operation of Present Plant
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CHARTS

1. Present Plant - Future Electric and Steam Usages
2. Present Plant - Purchased Electric Power Costs
3. Present Plant - Future Coal Costs
4. Present Plant - Future Oil Costs
5. Self-Sufficient Plant - Construction Cost Estimate
6. Self-Sufficient Plant - Summer Coal Costs
7. Self-Sufficient Plant - Middle Season (Fall/Spring) Coal Costs
8. Self-Sufficient Plant - Winter Coal Costs
9. Self-Sufficient Plant - Future Oil Costs
10. Self-Sufficient Plant - Summary of Future Fuel Co [illegible]
11. Self-Sufficient Plant - Savings and Payoff Rate [illegible]
12. Alternate 3 Sell Power to Golden Valley Elec [illegible] Per Kw-hr Costs
13. [illegible] to Gol[illegible] [illegible] F[illegible] [illegible] ectric Associat[illegible] Power
14. Alternate 3 Sell Power to Golden Valley [illegible] Possible Profit From Power Sale

III. DISCUSSION

A. FUEL/UTILITY COSTS AND PROJECTIONS

The University of Alaska utilizes either coal or oil as a source of thermal energy. Electrical energy is either produced in their own power plant or purchased from Golden Valley Electric Association. At the moment there is no natural gas available in Fairbanks. Of primary importance to the University is predicting the future cost of fuels and utilities.

1. COAL

We will discuss the current and the future cost of coal first as this is the simplest to determine. Coal is the least-controlled fuel and has the largest reserves available. The current reserves in the Nenana area consist of approximately 95 million tons with less than 200 foot overburden. There are demonstrated reserves of two billion tons and hypothetical reserves of eight to nine billion tons in the area. The present output of the Usebelli mine in Healy is approximately 730,000 tons a year. The mine estimates that there are 200 years worth of reserves in the immediate area accessible with their present equipment. They also indicated that they see an undiminished supply for any foreseeable increase in demand.

At the present time, the University has a short-term contract with the Usebelli mine to provide coal at a cost of approximately $11.40 a ton. This coal is purchased on a BTU per ton basis with one ton equal to 17,400,000 BTU. The railroad freight rates are established at $4.93 a ton. Thus, the total cost for coal in Fairbanks at the University storage area is approximately $16.33 a ton or $ .94 per therm.

The shipping rates are expected to increase with inflation. Mr. Hoefler of the Alaska Railroad indicated the railroad had not had a freight rate increase for 20 years as of October 1968, and since then their rates have increased steadily at approximately the rate of inflation. These increases were nine percent in 1968; fifteen percent in 1972; three percent in 1973; two percent in 1974; and ten percent in July 1975. Mr. Hoefler indicates that for the next two to four years the Alaska Railroad is using a seven percent inflationary figure for their budget. He also indicated that since at the present time both coal and petroleum products are shipped to Fairbanks by rail, the increase in the freight rate for one product would be similar to that of any other product. The railroad does not [illegible] major changes in operation or outlays fo[illegible] their cars, [illegible] or engines in the near future. Our opinion is that with the increased use of the Alaska Railroad in the past few years that some input for additional maintenance on the line and rehabilitation of engines and cars should be included in estimating any increase in rates.

The Usebelli mine does not anticipate any increase in the cost of coal other than to follow the general inflationary trend across the country. Joe Usebelli indicated that he would prefer a longer term contract (approximately ten years) with the University, so that he could more easily plan plant expansion, hiring, budget, etc. The Golden Valley Electric Association is on a long-term contract for the coal that they use in their Healy power plant. Mr. Usebelli also indicated that he is in negotiations with the Amax Corp. for the purchase of his mine. Amax Corp. indicates that there is a possibility of exportation of coal to the West Coast. Any increased demand at the mine would level off or possibly reduce the coal prices. Joe Usebelli indicated that with fifty percent more demand he could reduce the price of coal approximately twenty percent due to more efficient utilization of the present physical plant. The prime users of coal are Ft. Wainwright, Golden Valley Electric Association, City Power Plant, Eilson Air Force Base, Clear and the University of Alaska. None of these plants expect to increase their usage by fifty percent so a price reduction cannot be contemplated unless there is exportation to the West Coast.

In conclusion, we can expect that in the future coal prices in Fairbanks will rise at approximately the general inflationary rate so that the cost would be approximately $1.10 to $1.20 per therm by the end of 1977. (See Figure 1).

2. <u>OIL</u>

Oil is the most heavily used fuel for heating and is becoming the major electrical-producing fuel in the Fairbanks area. At the present time all oil for the Fairbanks area is brought up from Anchorage on the Alaska Railroad, with Tesoro being the prime supplier in Fairbanks. The posted price of Arctic diesel fuel in Fairbanks now is $ .5195 per gallon and number two fuel oil is $ .4459 per gallon. Any price less than posted must be negotiated. Golden Valley Electric Association pays between $ .37 and $ .40 per gallon for diesel fuel used in their generation facilities.

At the present time crude oil is controlled by the crude oil entitlement which subsidizes those refineries which must purchase crude oil from foreign producers. The Tesoro p[illegible] itlement for "old crude" is now $6.6[illegible] entitlement [illegible] goes up to $11.00 a barrel. The price before entitlement is for "old crude" from areas that were producing crude oil before the controls went into effect. "New crude" is from areas developed after controls and is approximately \$2.00 above the "old crude" price.

There is the possibility that the various controls on oil may be eliminated. Then the price is expected to stabilize at approximately \$11.00 to \$12.00 a barrel, or approximately the same as the present price with entitlements. Current controls produce price flucuations and shortages.

Another variable in the Fairbanks area is the proposed Energy Company of Alaska-North Pole Topping Plant. This plant will come on line sometime in mid-1977 with a 15,000 barrel a day capacity. At that time, it is expected to provide heating oil, diesel fuel, turbine fuel, military jet fuel and asphalt. The Golden Valley Electric Association is going to use the turbine fuel for 2 - 60 mw gas turbine generators. A portion of the waste heat from these turbines will go to the Topping Plant for their production facilities. The Topping Plant will also provide fuel for the Alyeska Pipeline Pumping Station No. 8; and in the future, would be expected to produce gasoline and commercial jet fuel.

The Topping Plant would remove approximately 25,000 barrels a day of crude oil and return 10,000 barrels a day of residuals to the pipeline. All their planned production will be sold only on a contract basis. At the moment it is very difficult to predict what prices may be; however, they can be expected to be still competitive with imported liquid fuels.

In conclusion it can be expected that petroleum prices will go up in the next two years at probably the inflationary rate with perhaps a leveling off when the North-Pole Topping Plant comes on line. The other possibility is that removal of controls may cause the price to escalate further. Our best estimate is that the price of diesel fuel which is now approximately \$3.00 per therm to contract users will go up to approximately \$3.60 a therm in the next two years. Predicting future cost of oil is considerably harder than predicting the future cost of coal because of the large number of variables effecting crude oil cost.

3. OTHER FUELS

Natural gas is not available now in the Fairbanks area. There are several possibilities in the future. One is that the natural gas reserves on the North Slope will be piped through Fairbanks along the oil pipeline route. If the gas pi[illegible] through Canada, a [illegible] line to Fairbanks may [illegible] Neither of these possibilities are expected to [illegible] occur within the next ten years; therefore, we are discounting Natural Gas as a potential fuel in the Fairbanks area.

4. ELECTRICITY

Electricity in Fairbanks is generated by either coal or oil. At the present time, there is no hydro power available and there is no natural gas for turbine generation. Golden Valley Electric Association provides electrical power to the University and is tied in with the military sites in the area and the City Power Company. There are coal-fired steam generation plants in the Fairbanks area with prime electrical generation at the Golden Valley plant in Healy. Other major coal users were listed in the coal section of this report. The large demand for electricity in the Fairbanks area has caused Golden Valley Electric Association to install gas turbine generators running on diesel fuel to meet the demand peaks.

The University is on Golden Valley's rate number seven which consists of energy charges starting at $ .0375 per kilowatt hour for the first 10,000 kwhr per month and going to $ .013 kwhr for use over 500,000 kwhr per month. In addition, there are demand charges from $3.00 a kilowatt hour for the first 100 kw of demand to $2.75 a kwhr for anything over 500 kw demand per month. There is also a fuel cost rate adjustment which varies according to Golden Valley's fuel costs for power generation. This has been around $ .008 to $ .015 per kilowatt hour. With their present usage, the University is paying Golden Valley Electric Association between $ .027 and $ .0375 per kwhr for purchased power.

Golden Valley is expected to submit a rate increase on the order of fifty percent. This should absorb the present fuel cost rate adjustment, but leave the option to use this adjustment if fuel costs continue to climb. One of the reasons that the fuel cost adjustment is so severe is that in Fairbanks, the fuel cost of generating electricity with oil is approximately eight to nine times the cost of generating electricity with coal. This does not take into account the cost of purchasing and maintaining additional equipment running on diesel fuel to meet peaks.

The cost of electricity will go up with the increased fuel prices. The only leveling off would come about if demand were reduced sufficiently so that fuel would not have to be used so much. Unfortunately, the present trend is towards increased use of diesel fuel for power generation, especially with the 2 - 60 mw combustion turbine generators planned for North Pole.

The proposed Susitna Hydro-Electric power plant could effect the electricity rates in Fairbanks, but expectations are that [illegible] to expect power would involve one year to ge[illegible] record; two t[illegible] years to get a supplemen[illegible]; two to five years to investigate sites and design; and three to six years for construction. Therefore, no hydro-electric power is expected, even if authorized, within the next ten years. It is expected that such a project would produce power for about \$ .02 per kwhr before distribution. Due to these factors, we are discounting possible hydro-electric power.

In conclusion, we can expect electrical rates to rise over the next few years. They will rise faster than fuel costs due to the larger proportion of more expensive fuel needed to meet the demand. We estimate that in two years, the cost to the University of Alaska for electricity, including demand and fuel charges, would be somewhere between \$ .038 and \$ .045 per kwhr.

5. SUMMARY

The foregoing predictions (summarized in Figure 1, Appendix) are based on current data and cannot take into account the possibilities of increased or lessened governmental control, shortages in other parts of the country or general increases or decreases in demand. Of the above figures, the coal price appears to be the most stable due to steady demand and minimal controls, with oil prices flucuating greatly due to governmental controls and demands or heavy inputs from projects that are expected to be completed within the next few years. Since electrical rates are based on both coal and oil prices in addition to amortization of new equipment, they are the least predictable.

B. EXISTING PLANT OPERATIONS AND EFFICIENCES

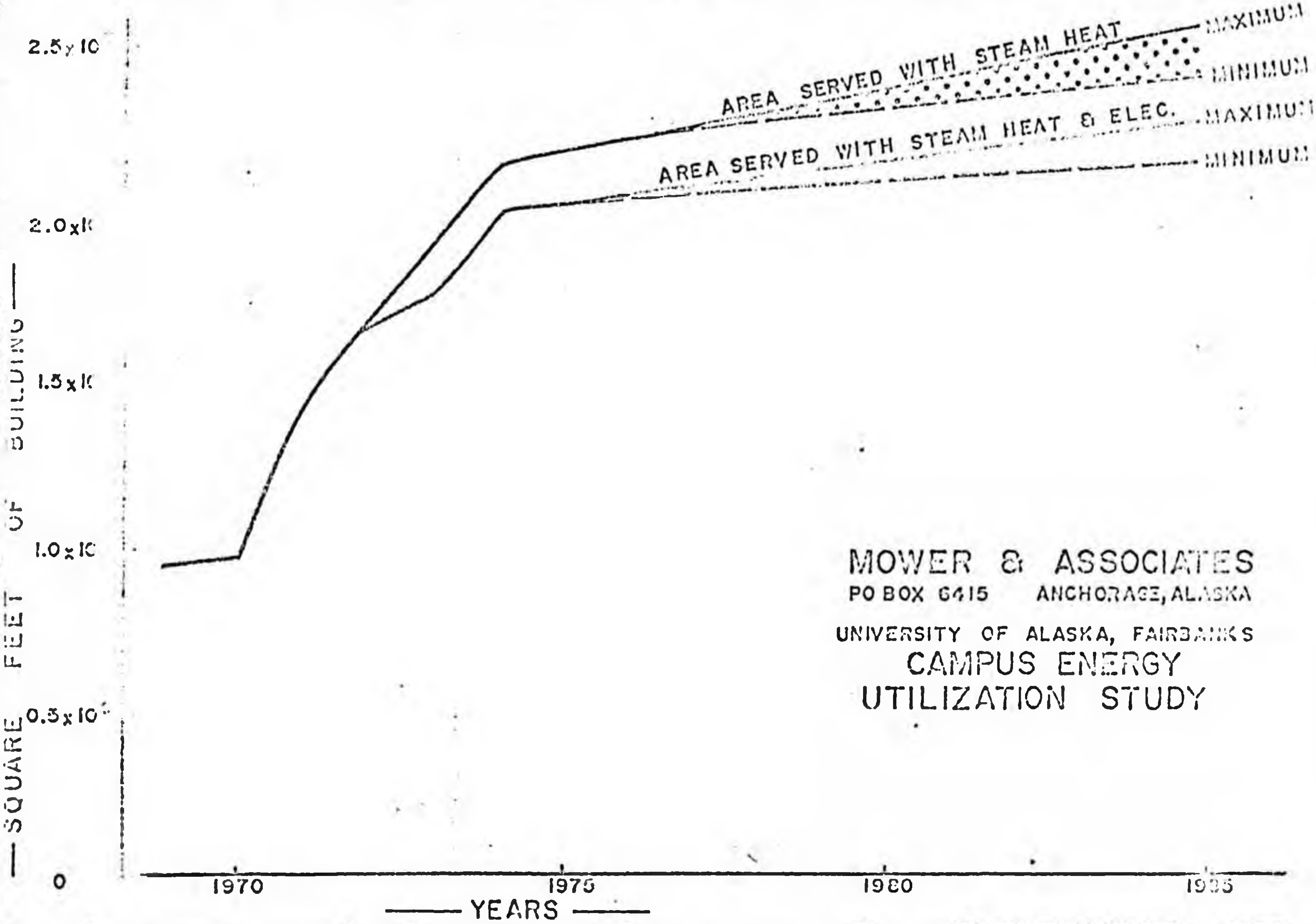
The power plant at the University of Alaska, Fairbanks produces steam for heating and electricity for the University. The plant uses coal or oil to produce steam and generates electricity with non-condensing steam turbine generators. The boilers produce steam at 600 psi, 700°F which goes through the turbines and is reduced to approximately 30 psi for winter steam heating production and 17 psi for summer steam production for absorption chillers and heating or to approximately five to seven psi when the new condenser is operating for the pure production of electricity.

1. PLANT CAPACITIES AND LOADS

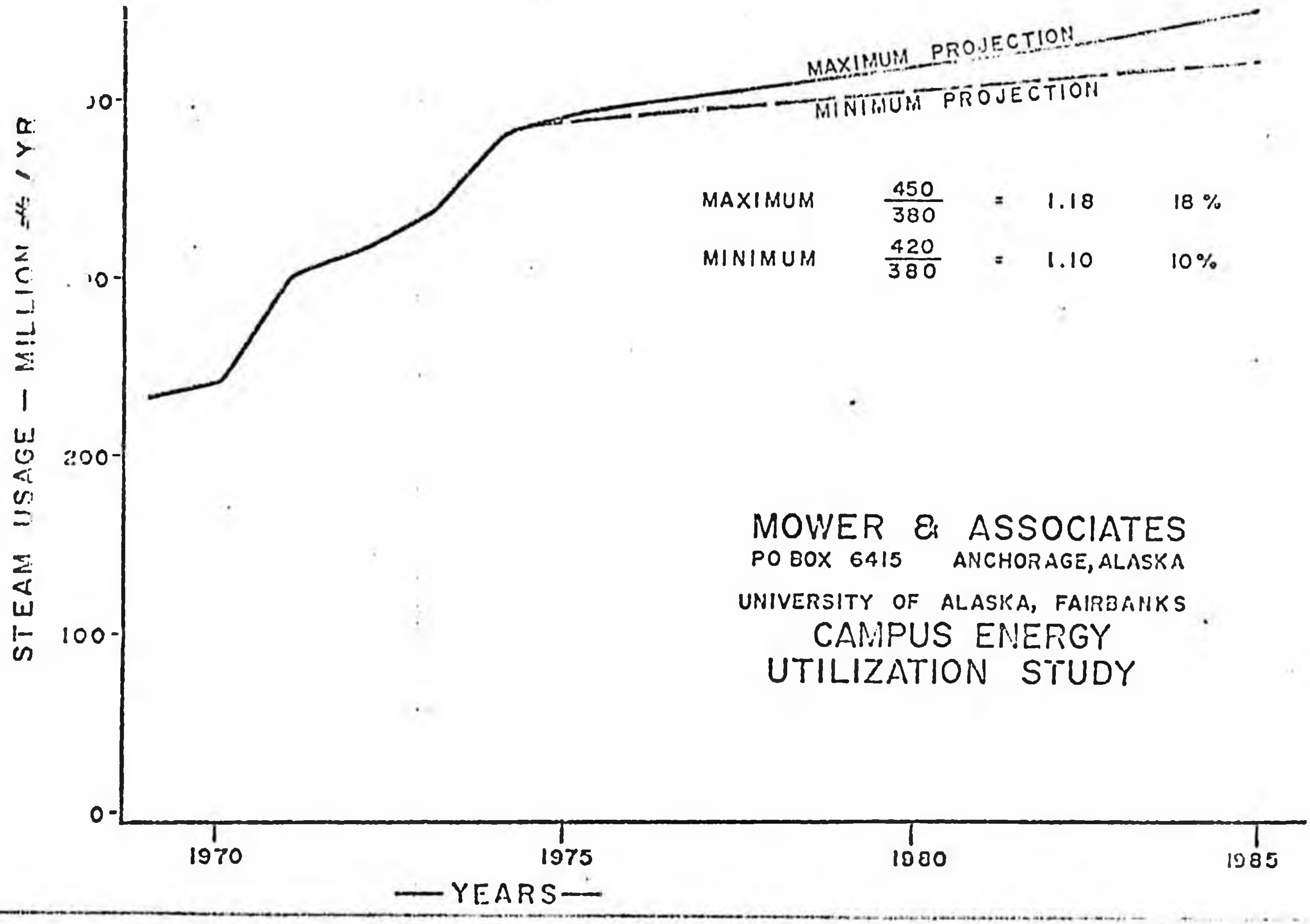
a. STEAM

The steam plant can generate approximately 95,000 pounds per hour of steam with its coal-fired boilers, except for a six-week period each year when the boilers are out of commission for maintenance. During that time, [illegible] used. [illegible] per year, [illegible] pounds per [illegible], or [illegible] MM pounds per day.

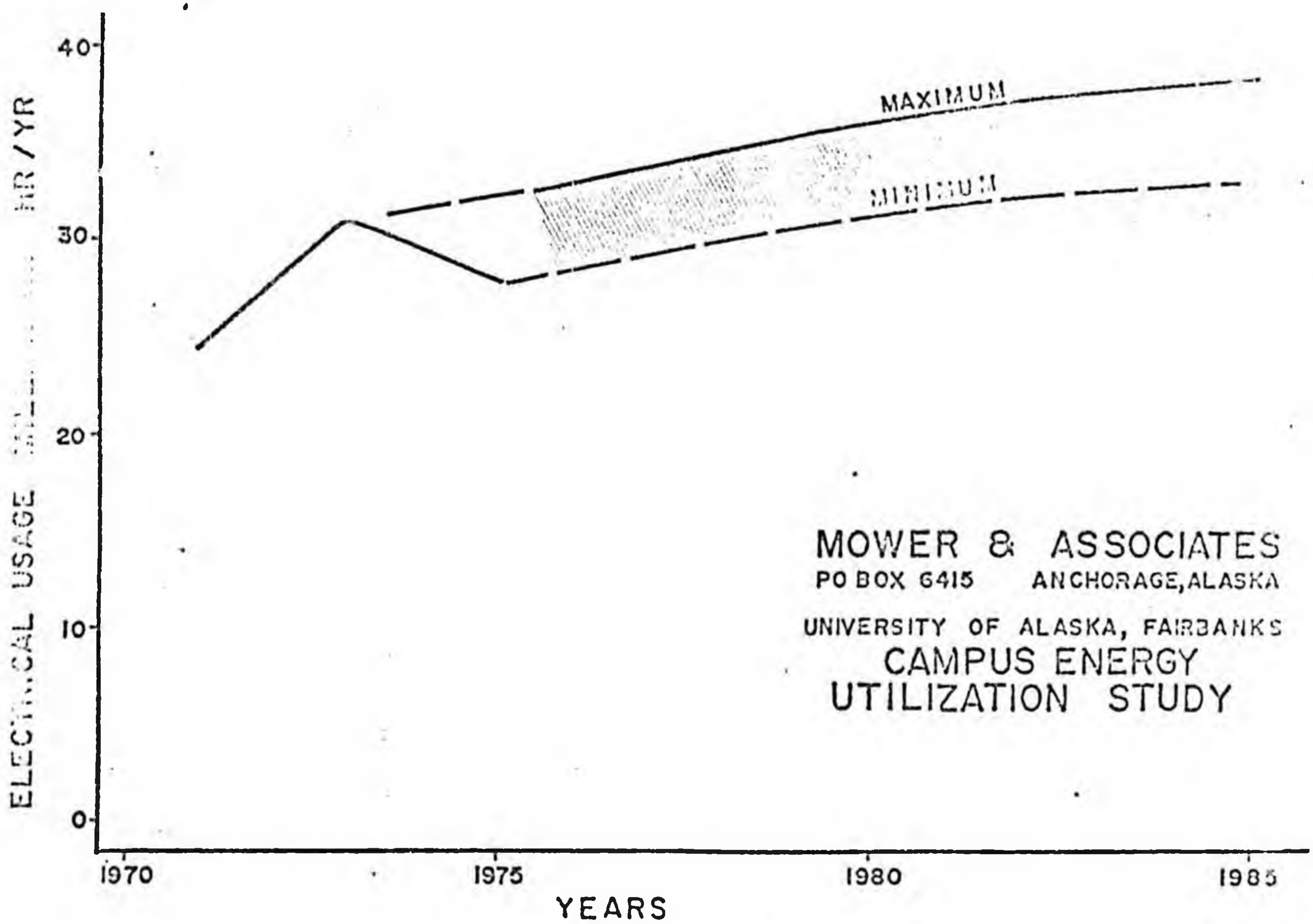
ILDING SQUARE FOOTAGE — HISTORICAL & PROJECTED



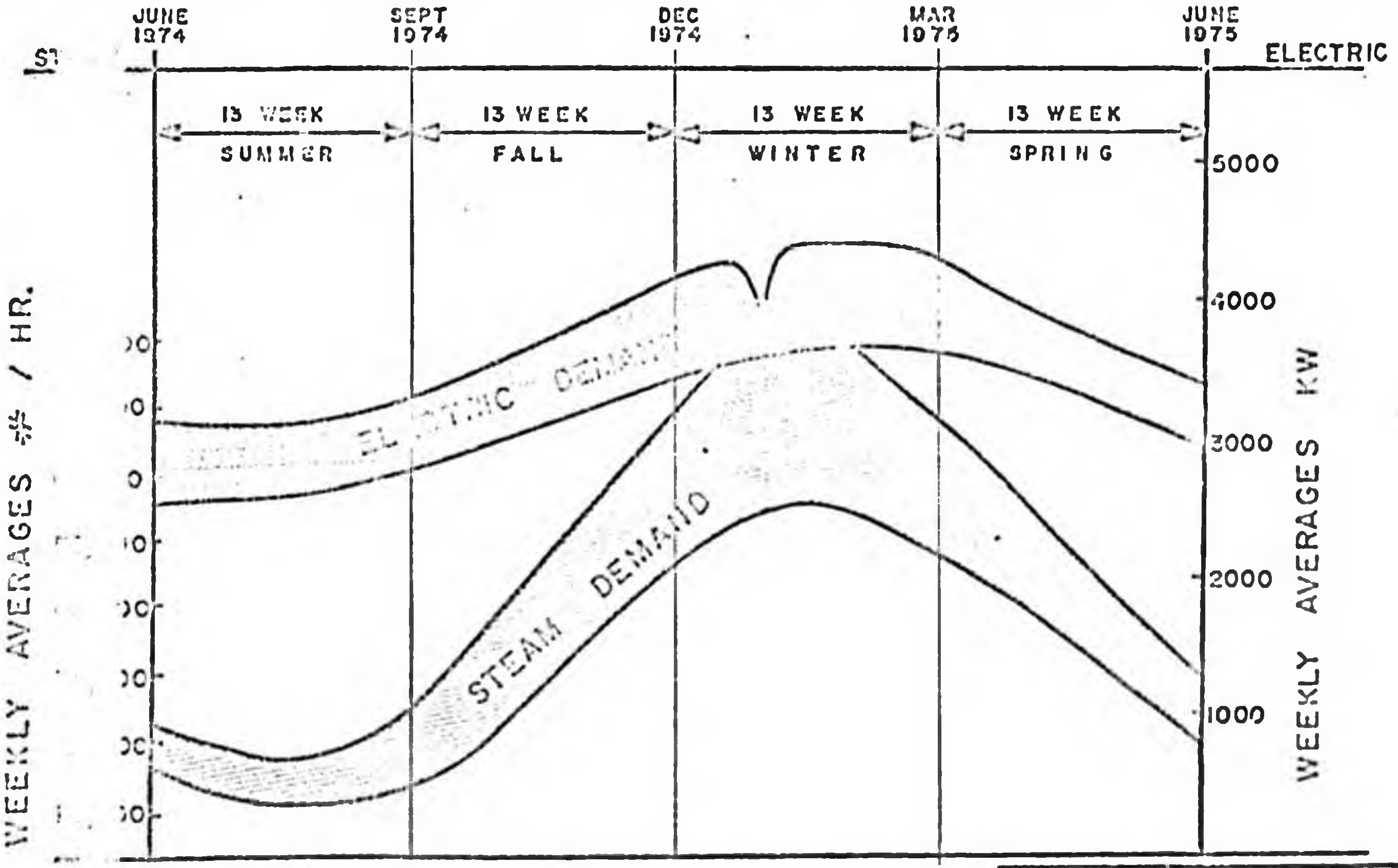
STEAM USAGE — HISTORICAL AND PROJECTED



ELECTRICAL USAGE — HISTORICAL & PROJECTED



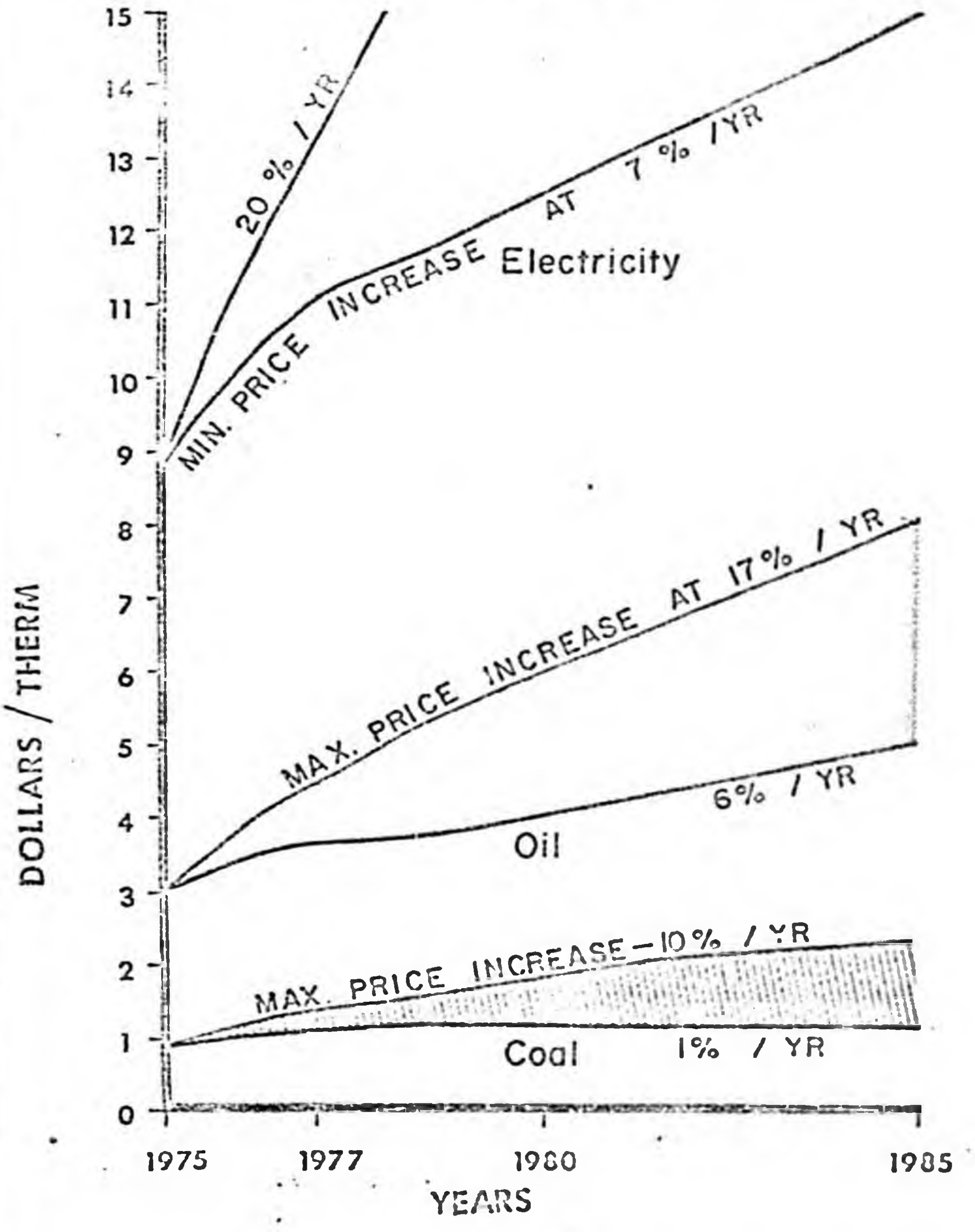
T...CAL STEAM AND ELECTRIC RANGE OF DEMANDS (BEFORE CONDENSER)



MOWER & ASSOCIATES
PO BOX 6415 ANCHORAGE, ALASKA

UNIVERSITY OF ALASKA, F...BANKS
CAMPUS ENERGY
UTILIZATION STUDY

FUEL COST PROJECTION Figure 5



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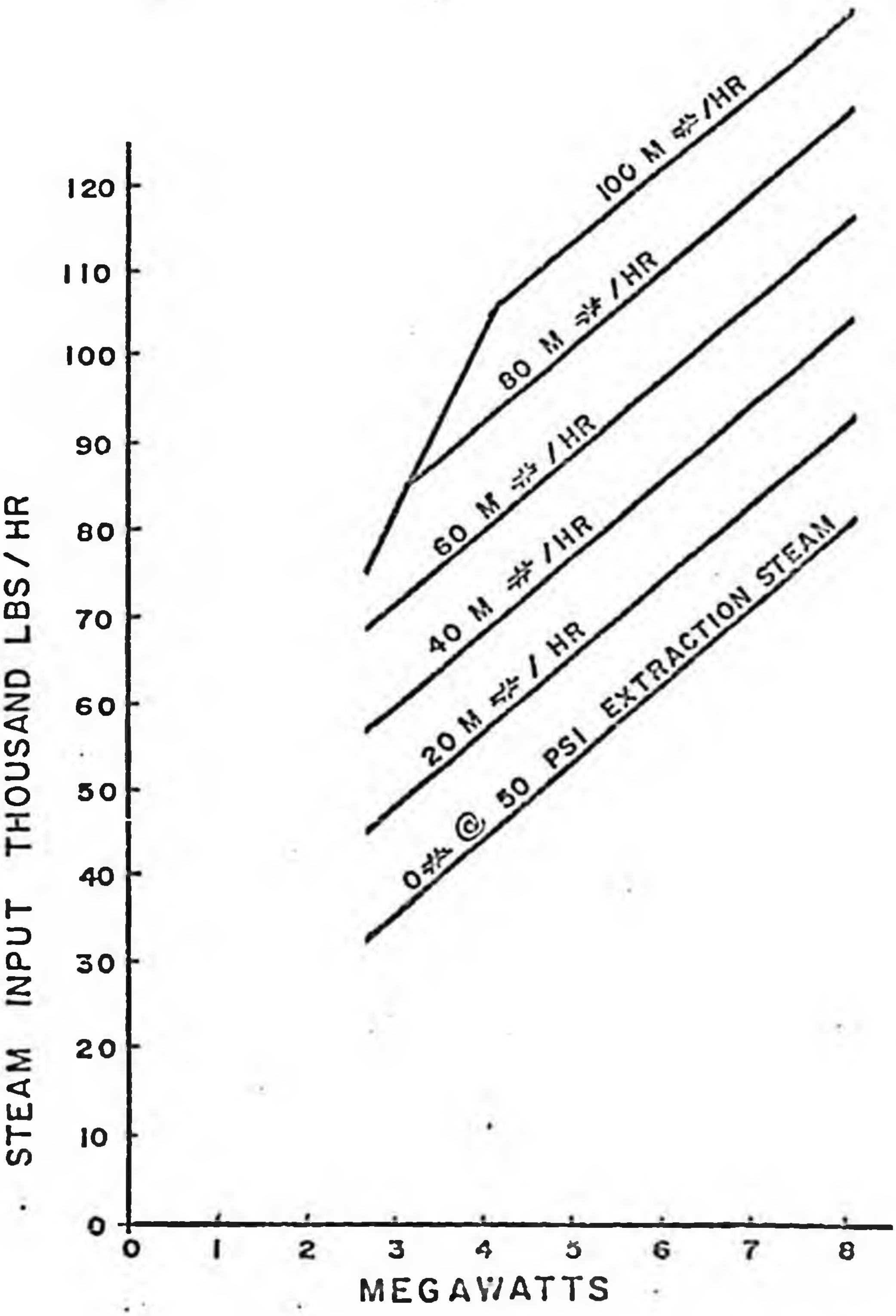

TYPICAL AUTOMATIC EXTRACTION
CONDENSING STEAM TURBINE
GENERATOR PERF
600 PSIG 700° F
INLET STEAM
4" HG OUTLET

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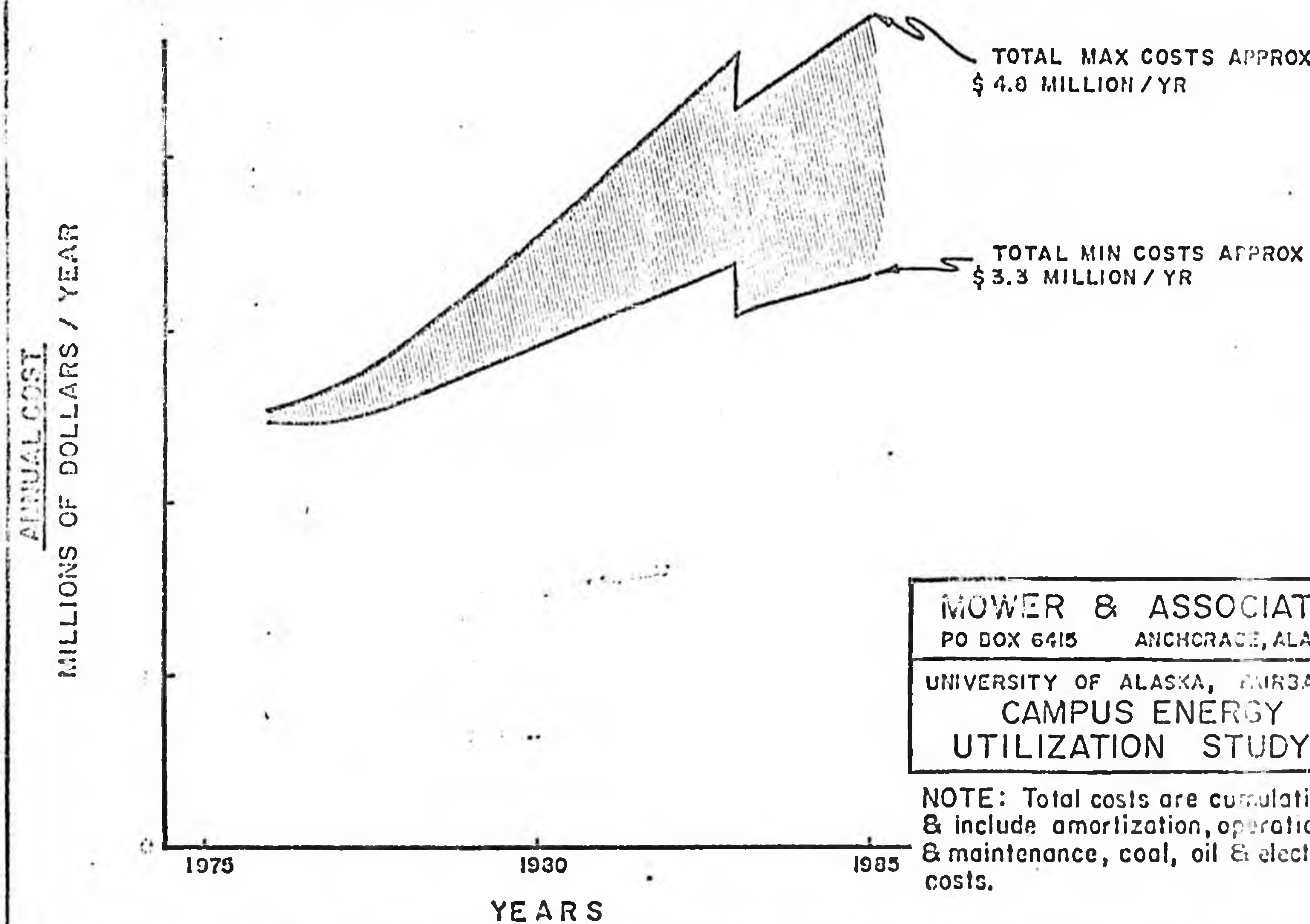
UNIVERSITY OF ALASKA, FAIRBANKS

CAMPUS ENERGY
UTILIZATION STUDY

OJECTED ANNUAL COSTS · FOR OPERATION OF PRESENT PLANT



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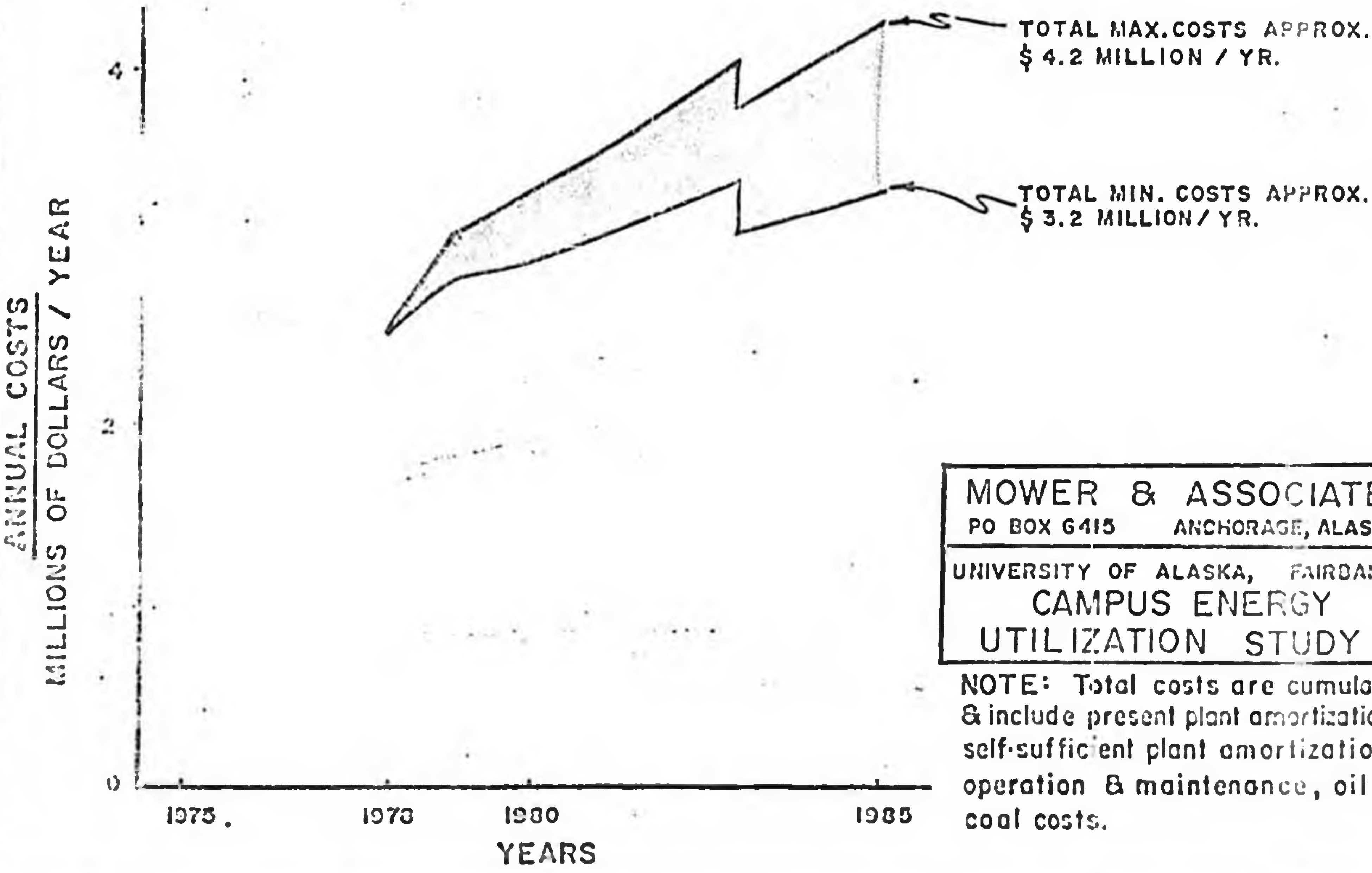
NOTE: Total costs are cumulative & include amortization, operation & maintenance, coal, oil & electrical costs.

PROJECTED ANNUAL COSTS - FOR OPERATION OF SELF-SUFFICIENT PLANT



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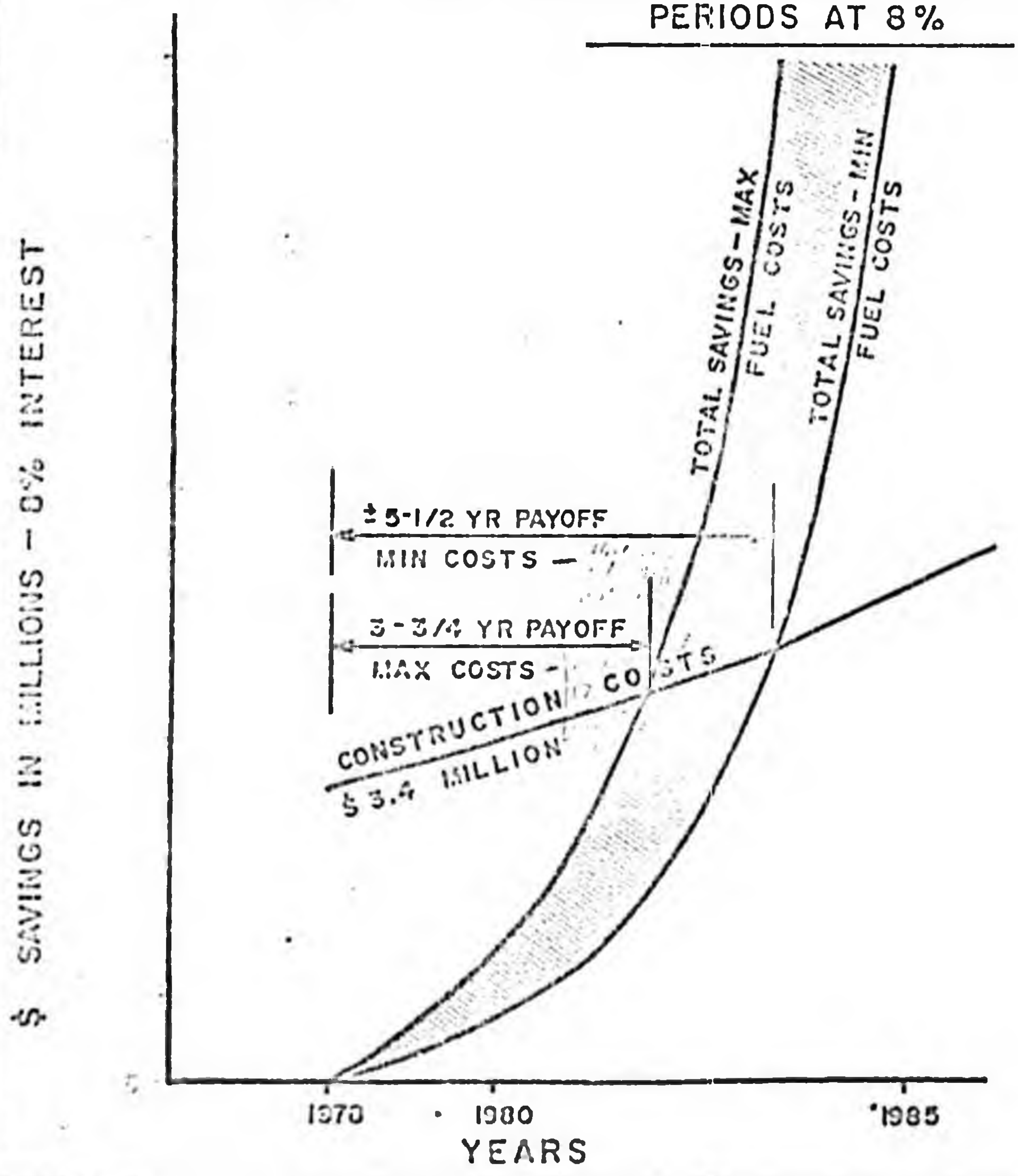
NOTE: Total costs are cumulative & include present plant amortization, self-sufficient plant amortization, operation & maintenance, oil & coal costs.

:OJECTED TOTAL SAVINGS FOR SELF-SUFFICIENT PLANT WITH PAYOFF PERIODS AT 8%



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UNIVERSITY OF ALASKA, FAIRBANKS
CAMPUS ENERGY UTILIZATION STUDY

CHART I
PRESENT PLANT
FUTURE ELECTIC AND STEAM USAGES

YEAR	M[illegible] F[illegible] C[illegible]	[illegible]ON SQ. FT. ELECTRIC & HEAT	STEAM TOTAL* MILLION LB/YR	TOTAL ELECTRICAL DEMAND MILLION KW-HRS.	MILLION KW-HRS/YR. ELECTRIC GENERATION @ 26 LB/KW-HR	ELECTRIC POWER PURCHASED
1976	2.[illegible]	2.063	448	34	17	17
1977	2.[illegible]	2.063	533	34	20.5	13.5
1978	2.[illegible]	2.113	542	34.9	20.8	14.1
1979	2.[illegible]	2.163	552	35.8	21.2	14.6
1980	2.460	2.163	552	35.8	21.2	14.6
1981	2.460	2.223	563	36.9	21.6	15.3
1982	2.[illegible]	2.223	563	36.9	21.6	15.3
1983	2.[illegible]	2.273	572	37.8	22	15.8
1984	2.[illegible]	2.273	572	37.8	22	15.8
1985	2.540	2.303	577	38.4	22.1	16.3

* 120 x 10^6 # steam/year flow through condenser added to protect steam demand; only 60 x 10^6 pounds steam were added to 1976 because of condenser breakdown.

CHART 2
PRESENT PLANT
PURCHASED ELECTRIC POWER COSTS

YE	ELECTRIC POWER PURCHASED MILLION KW-HR/YEAR	MINIMUM RATE $/KW-HR	MINIMUM RATE TOTAL $	MAXIMUM RATE $/KW-HR	MAXIMUM RATE TOTAL $
19[illegible]	17	.035	595,000	.048	680,000
19[illegible]	13.5	.0375	506,000	.048	648,000
197[illegible]	14.1	.0399	562,600	.056	789,600
1979	14.6	.0424	619,040	.0[illegible]4	934,400
1980	14.6	.0443	654,030	.0[illegible]	1,051,200
19[illegible]	15.3	.0473	723,700	.0[illegible]	1,224,[illegible]00
19[illegible]	15.3	.0497	760,400	.0[illegible]	1,346,[illegible]00
1983	15.8	.0522	824,760	.[illegible]	1,516,[illegible]
1984	15.8	.0546	862,680	.104	1,653,200
1985	16.3	.057	872,100	.112	1,713,600

7%/year minimum rate of cost increase
20%/year maximum rate of cost increase

CHART 3
PRESENT PLANT
FUTURE COAL COSTS

YEAR	MILLION LBS. STEAM/YEAR	MINIMUM RATE $/LB.	MINIMUM RATE $/YEAR	MAXIMUM RATE $/LB.	MAXIMUM RATE $/YEAR
1976	448	.0015	672,000	.0015	672,000
1977	533	.00152	808,000	.00165	879,000
1978	542	.00153	829,000	.0018	976,000
1979	552	.00154	850,000	.00195	1,076,000
1980	552	.00156	861,000	.0021	1,159,000
1981	563	.001588	887,000	.00225	1,267,000
1982	563	.00159	895,000	.0024	1,351,000
1983	572	.00160	918,000	.00255	1,459,000
1984	572	.00162	927,000	.0027	1,544,000
1985	577	.0016	943,000	.00285	1,644,000

Assu[illegible]ons: Coal cost minimum rate of increase of 1% per year.
Maximum rate of 10 percent per year.
Use steam usages from Chart #1.

CHART 4
PRESENT PLANT
FUTURE OIL COSTS

	STEAM PEAK THOUSAND LB/HR	OIL-FIRED STEAM MILLION LB/YR.	$/LB OIL FIRED FUEL COSTS	$/YR.
	92.5			
	92.5		.0051	
	98.6	.246	.0056	1,500
[illegible]	100.7	.694	.0061	4,200
[illegible]	102.7	1.114	.0066	7,400
[illegible]	102.7	1.114	.0071	7,900
[illegible]	105.5	2.665	.0076	20,300
[illegible]	105.5	2.665	.0082	21,900
[illegible]	107.3	3.866	.0087	33,600
[illegible]	107.3	3.866	.0092	35,600
1985	108.9	5.518	.0097	53,500

Assumptions: Coal-fired boilers can produce 93,000 pounds per hour.
Hours of operation at or near peak are:
20 hours @ peak 200 hours @ (.95) (Peak)
500 hours @ (.90) (Peak) 800 hours @ (.85) (Peak)

CHART 5
SELF-SUFFICIENT PLANT
CONSTRUCTION COST ESTIMATE

TURBINE GENERATOR-condensing automatic extraction 7.5 mw, 120,000 pounds per hour input @ 600 psig 700°F., Extract 20,000 to 100,000 pounds per hour @ 50 psig. Exhaust at 4" Hg, 4160 v, 60 Hz, 3Ø with gearbox, baseplate, etc.	$1,000,000.00
CONDENSER - dry type, steam to air, 40,000 pounds per hour, 4" Hg, 70°F. design temperature. 45° MTD, 8,000 sq. ft. bare surface with 8-30 HP fans (2 spd, or auto pitch), recirculating system, steam ejector, etc.	300,000.00
FEED PUMPS - 2 @ 50 HP, 80 GPM, 2000' Head	20,000.00
ELECTRIC SWITCHGEAR - Motor control center, generator control center, breakers, wiring and labor.	150,000.00
MECHANICAL - piping, valves, equipment installation, controls, start up, freight, etc.	500,000.00
BUILDING MODIFICATIONS - foundations, equipment supports, etc.	30,000.00
1976 PRICES	$2,000,000.00
Engineering, contractor's overhead and profit, contingencies, etc. (x1.4)	$2,800,000.00
Inflation for 1978 construction (x1.2)	$3,400,000.00
TOTAL COST IN 1978	$3,400,000.00

CHART 6
SELF-SUFFICIENT PLANT
SUMMER COAL COSTS

YEAR	RAGE STEAM AND #/HOUR	AVERAGE ELECTRIC DEMAND: KW	AVERAGE THROTTLE STEAM TO MEET ELECTRIC DEMAND #/HR	TOTAL SUMMER STEAM MILLION PO[illegible] $	MIN. $	MAX. $
1977	23,500	2,650	47,000	103.4	157,000	171,00
1978	24,000	2,700	48,000	105.6	162,000	190,00
1979	24,500	2,800	49,000	107.8	167,000	210,00
1980	24,500	2,800	49,000	107.8	168,000	226,00
1981	25,000	2,850	50,000	110	173,000	248,00
1982	25,000	2,850	50,000	110	175,000	264,00
1983	25,500	2,900	51,000	112.2	180,000	286,00
1984	25,500	2,900	51,000	112.2	182,000	303,00
1985	26,000	2,970	52,000	114.4	187,000	326,00

Assump[illegible]s: Steam turbine performance [illegible] per Figure #6.
Minimum/maximum coal costs same as Chart #3.
Peaks and valleys roughly average.
Present averages are 22,000 #/hr. steam and 2650 kw. Projections made per Figure #4.

CHART 7
SELF-SUFFICIENT PLANT
MIDDLE SEASON (FALL/SPRING) COAL COSTS

[illegible]	AVERAGE STEAM DEMAND LB/HR.	AVERAGE ELECTRIC KW	AVG THROTTLE STEAM	TOTAL SYSTEM STEAM	MINIMUM DOLLARS PER YEAR	MAXIMUM $ PER YEAR.
[illegible]	46,000	3,250	66000	[illegible]	443,290	471,900
[illegible]	46,650	3,350	67000	295	451,044	530,640
[illegible]	47,700	3,400	68000	299	462,264	583,440
[illegible]	47,700	3,400	68000	299	466,752	628,320
1981	49,000	3,500	70000	308	485,100	693,000
1982	49,000	3,500	70000	308	489,720	739,200
[illegible]	49,900	3,600	72000	317	508,464	807,840
[illegible]	49,950	3,600	72000	317	513,216	855,360
1985	50,600	3,650	73000	321	525,162	915,420

Present average steam demand - 43,000 pounds per hour, electric 3,250.

CHART 8
SELF-SUFFICIENT PLANT
WINTER COAL COSTS

YEAR	AVERAGE STEAM DEMAND LB/HR.	AVERAGE ELECTRIC KW	AVERAGE STEAM TO MEET ELECTRIC LB/HOUR	TOTAL STEAM MILLION LBS	COAL COSTS MINIMUM $	COAL COSTS MAXIMUM $
1[illegible]	69,300	3,600	83,000	182.6	276,639	301,290
19[illegible]	70,700	3,700	84,000	184.8	282,744	332,640
19[illegible]	72,000	3,800	86,000	189.2	292,314	368,940
19[illegible]	72,000	3,800	86,000	189.2	295,152	397,320
19[illegible]	74,000	3,900	88,000	193.6	304,920	435,600
1982	74,000	3,900	88,000	193.6	307,824	464,640
1983	75,400	3,960	89,000	195.8	314,259	499,290
1984	75,400	3,960	89,000	195.8	317,196	528,660
1[illegible]	76,500	4,050	90,000	198.0	323,730	564,300

CHART 9
SELF-SUFFICIENT PLANT
FUTURE OIL COSTS

[illegible]R	OIL-FIRED STEAM REQUIRED MILLION/LBS.	MINIMUM $/LB.	MINIMUM $/YEAR	MAXIMUM $/LB	MAXIMUM $/YEAR
[illegible]0	17,794	.0059	105,000	.0075	133,500
[illegible]0	17,794	.0062	110,300	.0084	149,500
[illegible]1	24,200	.0065	157,300	.0092	222,[illegible]
[illegible]2	24,200	.0068	164,600	.0100	242,[illegible]
[illegible]3	28,383	.0071	201,500	.0109	309,400
[illegible]4	28,383	.0074	210,000	.0118	334,[illegible]0
[illegible]5	31,968	.0077	246,200	.0126	402,800

[illegible]mptions: Minimum price increase - 7% per year.
Maximum price increase - 17% per year.
Same peak steam usages as with present plant with addition of 15,000 pounds per hour condensed steam.

CHART 10
SELF-SUFFICIENT PLANT
SUMMARY OF FUTURE FUEL COSTS

	MINIMUM			MAXIMUM		
	COAL	OIL	TOTAL	COAL	OIL	TOTAL
[illegible]	921.0	105.0	1,206.	1,162.6	133.5	1,296.1
[illegible]	930.0	110.3	1,040.3	1,252.0	149.5	1,401.5
[illegible]	963.0	157.3	1,120.3	1,376.0	222.6	1,598.6
1982	972.5	164.6	1,137.1	1,468.0	242.0	1,710.0
1983	1,003.0	201.5	1,204.5	1,593.0	309.4	1,902.4
[illegible]	1,012.2	210.0	1,222.2	1,687.0	334.9	2,021.9
[illegible]	1,036.0	246.2	1,282.2	1,806.0	402.8	2,208.8

13 weeks summer, 26 weeks fall and spring, 13 weeks winter.

CHART 11
SELF-SUFFICIENT PLANT
SAVINGS AND PAYOFF RATE

(Costs & Savings in Millions of Dollars)

YEAR	ADD. OPERATION & MAINTENANCE	MINIMUM FUEL INCREASE: ENERGY COSTS PRESENT	MINIMUM FUEL INCREASE: ENERGY COSTS S.S.*	MINIMUM FUEL INCREASE: SAVINGS	MINIMUM FUEL INCREASE: TOT. SAVINGS @ 8 PERCENT	MAXIMUM FUEL INCREASE: ENERGY COSTS PRESENT	MAXIMUM FUEL INCREASE: ENERGY COSTS S.S.*	MAXIMUM FUEL INCREASE: SAVINGS	MAXIMUM FUEL INCREASE: TOT. SAV. @ 8%	S.S.PLANT AT 8%
1978	-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	3.4
1979	.130	1.47	1.03	.31	.33	2.00	1.30	.57	.62	3.67
1980	.140	1.52	1.04	.34	.79	2.22	1.40	.68	1.51	3.96
1981	.150	1.61	1.12	.34	1.42	2.51	1.60	.76	2.86	4.23
1982	.160	1.66	1.14	.36	2.42	2.72	1.71	.85	5.05	4.62
1983	.175	1.74	1.20	.36	4.08	3.01	1.90	.94	8.79	4.99
1984	.190	1.79	1.22	.38	7.09	3.22	2.02	1.01	15.56	5.40
1985	.200	1.82	1.28	.30	12.66	3.40	2.21	1.00	28.38	5.83

*S.S. - Self-Sufficient Plant

Note:
1. Savings are fuel cost savings (Present plant fuel costs - self-sufficient plant fuel costs. Minus additional operation and maintenance)
2. Total savings is the sum of yearly savings times compound amount factor @ 8%.
3. Self-sufficient plant cost is multiplied by compound amount factor @ 8%.
4. Payoff at maximum fuel increase is less than four years.
   Payoff at minimum fuel increase is less than six years.

CHART 12
ALTERNATE 3 SELL POWER TO GOLDEN VALLEY ELECTRIC ASSOCIATION

PER KW-HR COSTS

Assume installation of coal-fired boiler, 18 mw turbine generator, building addition and related equipment.

Capital Cost:

Boiler - 100,000 #/hr. coal	$3,000,000.
Turbine - 200,000 #/hr/18 mw	1,500,000
Condenser - 150,000 #/hr.	1,500,000
Extra equipment, piping	1,000,000
Building addition	1,000,000
System Revamp, Bus-work	1,000,000
	$9,000,000

	COST PER KW-HR
Yearly Amortization @ 8%, 20 year - $920,000. Assume average net power - 14 mw Power sold/year - 122 x 10^6 KW-HR	$ .0075
Fuel Costs @ (10#/kw-hr)($ .0016/lbs. steam)	$ .016
Operation & Maintenance: Assume double present $600,000/year / 122,000,000 kw-hr/year	$ .0049
	$ .0285
Plus Profit	?

CHART 13
GOLDEN VALLEY ELECTRIC ASSOCIATION
POWER COSTS ASSUMED

60 mw gas-turbine generators as prime power producers.

Frame 7 fuel oil @ $\frac{\$.40/gal}{.135.-BTU/gal} \cdot \frac{1}{.32\% \text{ Eff.}} \cdot \frac{3413 \text{ BTU}}{\text{KW-HR}}$

= $.0307/Kw-hr

Maintenance Average: $.002/Kw-hr

Operation ?

Capital $120/kw 6100 hr/yr
20 years @ 80% - $12.18/yr.

Am = $12.18/yr.
= $ .002

TOTAL $.0347 plus operation
kw-hr.

CHART 14
POSSIBLE PROFIT FROM POWER SALE

PRICE CHARGED $/KW-HR	PROFIT $/KW-HR	YEARLY $ PROFIT
.0305	.002	244,000
.0315	.003	366,000
.0325	.004	488,000
.0335	.005	610,000
.0345	.006	732,000

Payoff at .003 $/kw-hr profit ($366,000/yr.)
At 8% (Profit = .003 $/kw-hr plus .0075 $/kw-hr
Amortization = .0105 $/kw-hr = $1,280,000/year)

YEARS	CONSTRUCTION COST	AMORTIZED PROFIT
0	$ 9,000,000	$ -0-
1	9,720,000	1,280,000
5	13,221,000	7,510,000
10	19,430,000	18,543,000
11	20,988,000	21,806,000

Payoff in ten to eleven years.

NOTE: 1. If natural gas is available within ten years Golden Valley Electric Association will be able to produce for less.

2. Long term contracts for coal and electricity must be negotiated before design initiated.

3. Plant must be base loaded to be profitable.

Ah Mayers

MOWER & ASSOCIATES

PROFESSIONAL ENGINEERS

Area Code 907
Phone. 272-5335

P.O. Box 6415
Anchorage, Alaska 99502

April 26, 1976

Mr. Gerald V. Neubert
University of Alaska
Office of Institutional Studies
& Physical Facilities Development
Fairbanks, Alaska 99701

Subject: Proposed Golden Valley Electric Association Rate Increase

Dear Mr. Neubert:

We have reviewed the proposed Golden Valley Electric Association electric rate increase for the University. The proposed rate increase is substantially higher than the one the University is presently billed under.

At the present time the University pays approximately 3.75¢ per kwhr for the first 10,000 kwhrs of monthly use. This rate drops to 1.3¢ per kwhr for usage over one-half million kwhrs per month. In addition to this, there are demand charges for peak monthly demand over 500 kw of $2.75 a kw. The University also pays a fuel charge which is a varying percentage based on Golden Valley Electric Association's fuel bill.

The proposed Golden Valley Electric Association rate increase has base rates of 10¢ a kwhr for the first 400 kwhrs a month and these rates drop to 3.5¢ a kwhr for usage over 18,000 kwhrs a month. The demand charge is raised to $3.75 a kw for peak monthly demand over 50 kw. It is assumed that this rate increase will absorb the present fuel surcharges, but Golden Valley will continue to have that fuel surcharge option available to it if the cost of fuel oil increases.

Your power plant superintendant, Gerald England, has computed the effects of this proposed rate increase on your present electrical usage. We investigated the effect of the proposed rate increase on electrical usage costs of a year ago. Gerald England found that in December 1975, your charges under the present rate schedule were 3.86¢ per kwhr. Under the proposed increase they would be 4.55¢ per kwhr, for an eighteen percent increase. In January the present rate was 4.06¢ per kwhr, an increase of approximately eleven percent. In February 1976 you paid 4.38¢ per kwhr for an increase of six percent. In March you paid 5.36¢ per [illegible] proposed rate increase would have cost you 5.39¢ per kwhr for approximately one percent increase in cost. These figures indicate that the proposed rate increase is planned to absorb the fuel surcharge with no appreciable increase in total electrical charges. This indication is enhanced by our investigation of the electrical charges for the same period a year ago. If the proposed rate increase had been in effect at that time, the charges would vary between 111 percent and 38 percent above the actual charges. Your historical experience has been that the fuel surcharges are increasing at an extremely rapid rate.

The proposed rate increase establishes a new base rate of 3.5¢ a kwhr. This means that the University under this rate would never pay less than 3.5¢ a kwhr. When this is taken into account and the fact that the electrical rates will probably not decrease, it becomes imperative that the University produce more of its own power. At 3.5¢ a kwhr, the University can save approximately one-half cent a kilowatt hour with its existing equipment and more with the addition of an condensing steam turbine generator.

Mower & Associates projected electrical fuel costs would increase an average of 13 percent per year. The current proposed increase would place the electrical power cost substantially higher than our projection; however, we must remember that rates tend to increase in steps and then level out for a time. The fuel surcharge somewhat alters this trend, but we would expect our projections to be very conservative.

The proposed rate increase has made the addition of a condensing steam turbine generator to the existing power plant much more profitable. Golden Valley has effectively stated that power will not be available from them for less than 3.5¢ a kwhr. With our conservative projections of approximately 13 percent per year increases in electric charges, the proposed addition of a steam turbine generator has pay-off rates in three to five years. The proposed rate increase makes this pay-off rate even faster.

Sincerely yours,

MOWER & ASSOCIATES

Michael G. Mower

MGM/lo

MOWER & ASSOCIATES

PROFESSIONAL ENGINEERS

Area Code 907
Phone: 272-5335

P.O. Box 6415
Anchorage, Alaska 99502

April 8, 1976

Mr. Gerald V. Neubert
University of Alaska
Office of Institutional Studies
& Physical Facilities Development
Fairbanks, Alaska 99701

Subject: 1. Steam Condenser Economic Justification
2. Proposed Power Plant Addition Economic Details

Dear Mr. Neubert:

Attached find an economic justification for the additional proposed steam condenser. Included with this is a chart showing estimated annual savings and a second chart showing accumulated savings and a pay off of between four and five years. Also enclosed is a proposed condenser project schedule.

Also attached find a graph showing projected present plant annual costs and estimated self-sufficient plant annual costs. Also shown on this graph are cumulative savings. The information for this graph is presented in chart form.

These attachments should answer your latest questions.

Sincerely yours,

MOWER & ASSOCIATES

Michael G. Mower

MGM/lo

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ECONOMIC JUSTIFICATION OF PROPOSED STEAM CONDENSER
University of Alaska, Fairbanks

The University of Alaska, Fairbanks is proposing to purchase and install an additional steam condenser which would be capable of condensing approximately 40,000 pounds of steam an hour. This condenser would be ultimately able to be utilized with the proposed steam-turbine generator discussed in Phase II of Mower & Associates energy study. This economic justification will not take into account the possible future adaptation of this condenser and will only discuss the annual savings of utilizing the proposed condenser with the present steam plant.

Purchase of an additional condenser has two prime advantages to the University's Fairbanks power plant. The first is that additional steam above and beyond the present campus demand and present condenser capacity can be condensed so that additional electricity may be generated. The second advantage is that with two separate condensers, the turbine back pressure can be adjusted for most efficient turbine operation when the campus steam load is less than the capacity of one turbine. The turbines operate most efficiently when they are at maximum capacity. With two condensers one turbine can serve the campus heating load during summer months and during a portion of the early fall and late spring and also be connected to a condenser that will operate at the steam distribution pressure. The other turbine will then operate at its lowest feasible exhaust pressure with the other condenser. With this operation more electricity is produced with less steam than if both turbines were connected to a single condenser.

Chart I is a summation of estimated annual savings with the proposed condenser. We have divided the operation modes into three seasons. During the summer the existing condenser will operate with a turbine supplying steam to the campus while the proposed condenser will operate with the other turbine at the optimal output. Six weeks during the summer at least one boiler and one turbine are not in operation due to annual maintenance; therefore, we have shown a seven-week summer operation with those turbines rather than thirteen weeks.

A thirteen-week period of early fall and late spring will have operation modes the same as summer operation. The only difference is that additional campus steam is required so that one of the condensers is not used to its optimum.

During the late fall and early spring the campus heating requirement is high enough so that steam must be taken through both turbines; therefore, both turbines must operate at the campus distribution pressure of approximately 27 to 30 psi and [illegible] pres- [illegible] condensers would be [illegible], the proposed condenser would be more efficient and, therefore, probably used more often.

We have utilized steam rates derived from Phase I of our report and steam costs and electric rates derived from Phase I, Phase II and current information from the University. We have assumed that extra operation and maintenance for the additional condenser and additional usage of boilers and turbines would be approximately $5,000 a year.

Chart I indicates that at the present time annual savings in the order of $60,000 to $70,000 a year can be realized. This figure could be improved by shortening the time required for annual boiler and turbine maintenance. It should also be noted that estimates of electric rates are very hard to determine month by month, but that electric rates will rise faster than costs of coal to product steam. We can, therefore, expect that annual fuel and el ctric savings will probably increase as the years go by.

Chart II is a summary of the economics of the proposed condenser. This chart includes an estimate of the purchase cost of the condenser, its installation and engineering cost for a first cost of approximately $230,000. We have used an eight percent annual interest rate to determine the time required to pay off the initial investment. It can be seen that the cumulative savings will pay off the original investment in four or five years.

Annual savings will increase over the life of the equipment due to the fact that electricity costs are rising faster than coal costs.

<u>CONCLUSION</u>

We conclude that the purchase of an additional steam condenser for the University of Alaska's power plant can be justified economically. The condenser will save the University approximately $60,000 to $70,000 a year. The total annual savings including amortization of the proposed condenser would be approximately $37,000 a year. These annual savings will increase with increased electrical costs. The annual savings will be such that the first cost of the proposed condenser will be paid off in four to five years. The proposed condenser becomes even more attractive when it is realized that with the addition of recirculation equipment and a steam ejector, it could be used with the proposed steam-turbine generator detailed in Phase II of our report. The condenser will be designed at the present time to accommodate both operation modes so that in the future its entire purchase price will be saved if the University elects to become totally self-sufficient in power generation.

PROPOSED CONDENSER
PROJECT SCHEDULE

Start Project.	April 14, 1976
Preliminary Engineering Complete.	April 21
Contact with Manufacturers & Outline Specifications.	April 30
Write Performance Specifications For Manufacturers Proposals.	May 7
Bid Date.	May 28
Evaluation and Award to Manufacture Prepare Pad, Foundation, Piping, Etc. on Site.	June 2
Shipment From Factory.	September 2
Arrival on Site.	September 30
On Site Connection and Set Up.	October 15
Testing and Preliminary Acceptance Subject to Full Load Hot Weather Test.	November 1

CHART I

PROPOSED CONDENSER ESTIMATED ANNUAL SAVINGS

SEASON	HRS	AVERAGE POUNDS PER HOUR	TOTAL POUNDS (MILLIONS)	STEAM COST ($)	AVE.STEAM RATE #/KWHR	ELEC. KW	TOT.ELEC. KWHR (MILLIONS)	EST.ELEC. RATE $/KW	ELEC. COST ($)	SAVINGS ($)
		ADDITIONAL STEAM REQUIRED				ADDITIONAL ELECTRICITY REQUIRED				
Summer										
7 weeks See Note 1 & 2	1176	42,800	50	67,900	23	1860	2.19	.04	87,[illegible]	19,500
Early Fall Late Spring										
13 weeks See Note 1	2184	42,800	93	126,100	23	1860	4.06	.041	166,000	40,500
Late Fall Early Spring										
13 weeks	2184	17,000	37	50,100	27	630	1.38	.043	59,100	9,000
							7.63			$69,000
						Extra Operation & Maintenance				-5,000
						Saving				$64,000

Note 1. Summer and early fall/late spring assumes existing condenser operating at campus distribution pressure (17-20 psi) and proposed condenser on one turbine operating at 5-7 psi with manual output.

Note 2. Summer assumes 6 weeks for boiler & turbine maintenance

<u>CHART 2</u>

ECONOMIC JUSTIFICATION OF PROPOSED CONDENSER

FIRST COST

Purchase Cost of Condenser (including start up)	$190,000.
Installation by University	35,000.
Engineering	5,000.
	$230,000.

Interest for Amortization is Assumed at 8%.

YEAR	PROJECTED ANNUAL SAVINGS (THOUSANDS)	CUMULATIVE ANNUAL SAVINGS (THOUSANDS)
1976	$20.	$20
1977	70.	90
1978	77.	167
1979	84.	251
1980	91.	342

Four year amortization at 8% = $55,972/year

Five year amortization at 8% = $66,847/year

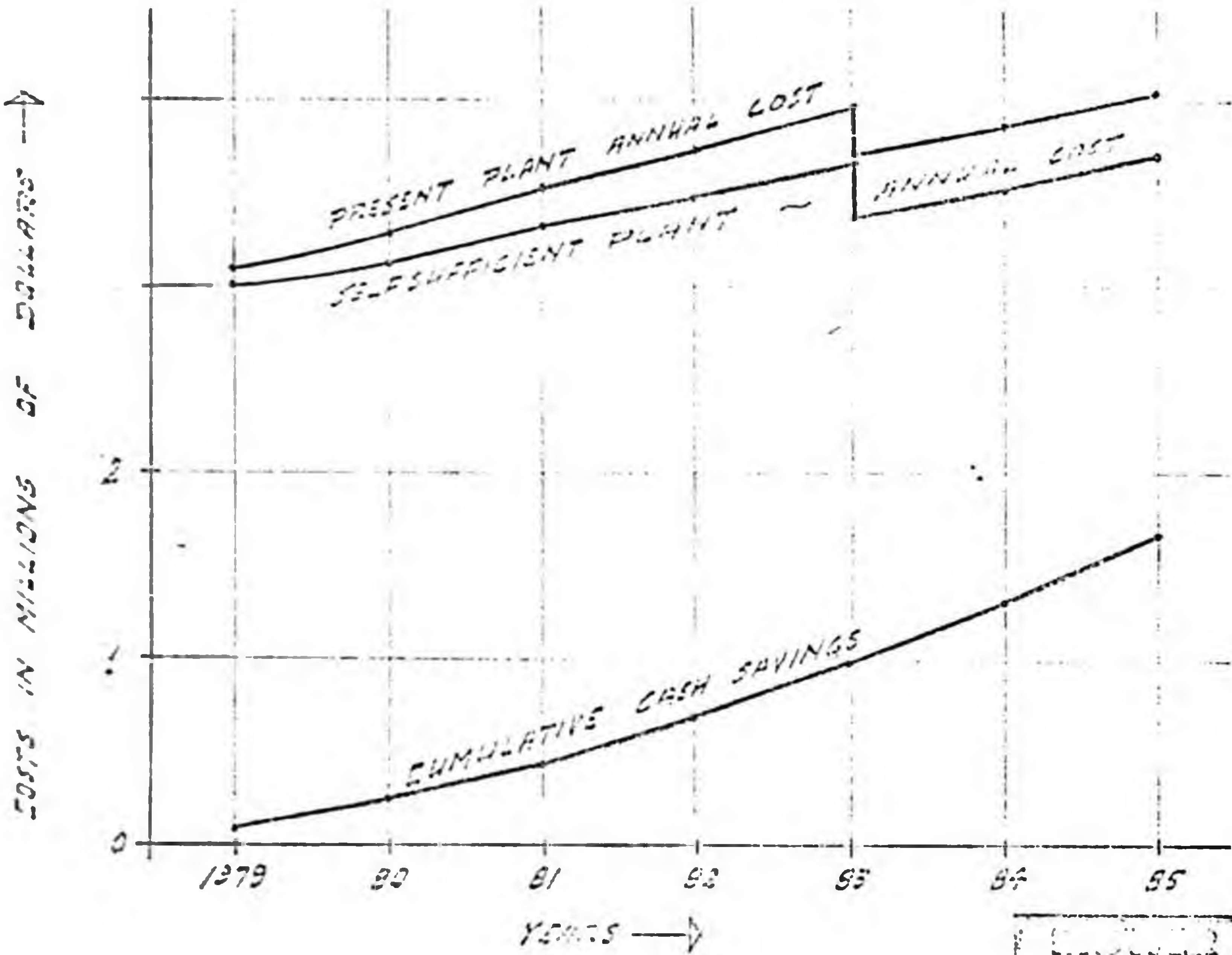
Therefore, capital investment will pay off between four and five years.

UNIVERSITY OF ALASKA, FAIRBANKS
PRESENT PLANT vs SELF-SUFFICIENT PLANT

ITEMIZED ANNUAL COST COMPARISON
(In Thousands of Dollars)

YEAR	1979	1980	1981	1982	1983	1984	1985
PRESENT PLANT Projected Average Annual Costs							
Bond Payment	505	504	501	503	499	201	200
Operation & Maintenance	840	900	960	1020	1080	1140	1200
Fuel & Electricity	1740	1870	2060	2190	2380	2510	2610
Total Annual Cost	3085	3274	3521	3713	3959	3851	4010
SELF-SUFFICIENT PLANT Estimated Average Annual Costs							
Bond Payment-Note 1	863	862	859	861	857	559	558
Operation & Maintenance	970	1040	1110	1180	1255	1330	1400
Fuel	1170	1220	1360	1420	1550	1620	1750
Total Annual Cost	3003	3122	3329	3461	3662	3509	3708
Annual Saving of Self-Sufficient Plant	82	152	192	252	297	342	302
CUMULATIVE CASH SAVINGS	82	234	426	678	975	1317	1619

Note 1. Includes $358,000 per year for Self-Sufficient Plant



Anchorage, Alaska

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March 30, 1976

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Mr. Gerald V. Neubert
Office of Institutional Studies
& Physical Facilities Development
University of Alaska
Fairbanks, Alaska 99701

Subject: Energy Utilization Study

Dear Jerry:

Attached find two graphs I prepared this afternoon which should help answer your recent questions. The first graph shows the projected cash requirement for the power plant addition. This graph basically shows a million dollars total requirement through February 1978. Contract for construction should be awarded at approximately that time and the balance of funds due between that time and August 1978. Notice that the estimate has gone from $3,400,000 to $3,514,000. The additional $114,000 represents the interest paid from the start of the contract in May 1976 to the start of the plant in August 1978. I believe this time frame is more than reasonable and we could expect a reduction in the total project time rather than any extension.

The second graph shows a total cash savings to the University through 1985. This cash savings was arrived at using an average of the minimum and maximum cost projections. I would expect this average to be on the conservative side of the board. Net savings were calculated by taking the average gross fuel savings, subtracting the amortization, subtracting additional operation and maintenance costs to arrive at a net cash savings per year. Amortization was figured on $3,514,000 utilizing twenty years and eight percent. Figure returned is $358,000 per year. Total net cash savings to the University estimated through 1985 would be $1,686,000. We feel the $3,514,000 is a very conservative estimate and should leave a contingency of between five and eight percent. The 1.4 multiplier used to estimate the cost base of $2,800,000 should cover adequately the above mentioned contingency, six percent engineering fee and the University's five percent burden.