USE OF NORTH SLOPE GAS FOR HEAT AND ELECTRICITY IN THE RAILBELT

DRAFT FINAL

REPORT

FEASIBILITY LEVEL ASSESSMENT

EBASCO

EBASCO SERVICES INCORPORATED

JANUARY 1983

ALASKA POWER AUTHORITY

USE OF NORTH SLOPE GAS FOR HEAT AND ELECTRICITY IN THE RAILBELT

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FEASIBILTY LEVEL

ASSESSMENT

PRELIMINARY
SUBJECT TO CHANGE
BASED ON REVIEW

EBASCO SERVICES INCORPORATED

with

FRANK MOOLIN & ASSOCIATES

and

ALASKA ECONOMICS INCORPORATED

FEBRUARY 1983

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SUMMARY

1.0 SUMMARY

1.1 PURPOSE

The purpose of this study is to examine the technical and environmental feasibility of several alternatives for the utilization of North Slope natural gas to generate electricity for use in the Railbelt Region, and to develop conceptual level, order of magnitude cost estimates for each alternative. The alternatives are grouped into three scenarios based on selected generating locations, and the study is based on the medium and low growth forecasts of Railbelt electrical needs provided by previous studies. One scenario also provides for the development of a residential and commercial natural gas distribution system in Fairbanks.

Previous reports developed for this feasibility assessment have detailed the existing data and assumptions to be used in developing the scenarios, the technical and economic bases for establishing power generating technologies, and the factors to be considered in facility siting and corridor selection. Potential environmental effects are detailed in this report. The previous reports are appended to this report for completeness.

1.2 STUDY APPROACH

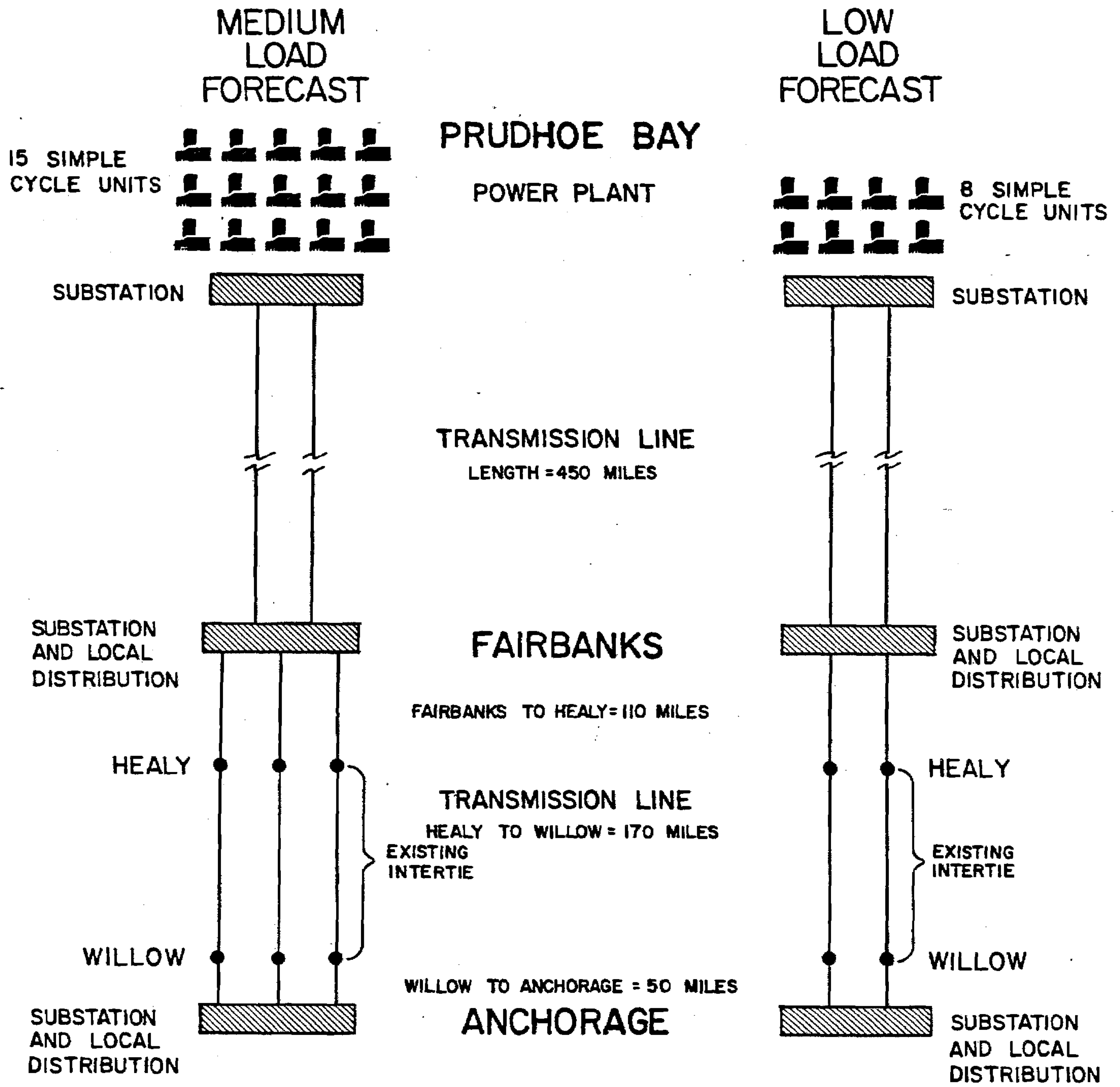
An initial survey of the electrical demand growth forecasts and the availability and characteristics of North Slope gas provided a basis for establishing candidate power generating technologies. Meetings and discussions with knowledgeable officials and industry representatives were held to focus the study on factors unique to each region, and factors unique to North Slope natural gas. Candidate generating sites and routing corridors (both electrical and natural gas) were evaluated. Forecasts of potential natural gas demand in Fairbanks and details for a gas distribution system were prepared.

Much of the above was completed prior to performing cost estimating tasks. While this study uses assumptions consistent with previous studies of other electrical generating scenarios for the Railbelt, cost estimating tasks have not included fuel cost derivation nor the development of cost of power values. Comparisons with alternative electric generating scenarios are therefore outside the scope of this study. Such comparisons can be considered as a logical extension of these studies which may be performed by the Alaska Power Authority.

1.3 SCOPE

The scope of the study was defined by the Alaska Power Authority to consist of three distinct scenarios. Each scenario was evaluated for its feasibility to meet the medium and low load forecasts of recent previous studies which examined the electrical demand requirements of the Railbelt Region. The first scenario is characterized by the generation of electricity on the North Slope using simple cycle combustion turbines fired by untreated natural gas. A major, new transmission line system would be required from the North Slope to Fairbanks, with substantial improvements to the transmission system connecting Fairbanks and Anchorage. Figure 1-1 is a depiction of the North Slope scenario showing the major differences between the medium and low load cases. The medium load forecast requires 15 units with a total capacity of almost 1400 megawatts (MW), two 500 kilovolt (kV) circuits from the North Slope to Fairbanks, and three 345 kV circuits from Fairbanks to Anchorage. The low load forecast can be met with 8 units (700 MW), two 500 kV circuits from the North Slope to Fairbanks, and two 345 kV circuits from Fairbanks to Anchorage. The present worth of costs of the medium load forecast is \$3.8 billion versus \$2.7 billion for the low load forecast. Both costs are in 1982 dollars and do not include fuel costs.

The second scenario consists of two distinct parts: a generating facility in the Fairbanks area and a gas distribution system in Fairbanks. Transmission of the gas to Fairbanks from the North Slope would require construction of a high pressure gas pipeline, although



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NORTH SLOPE GAS FEASIBILITY STUDY

NORTH SLOPE SCENARIO

FIGURE I-1

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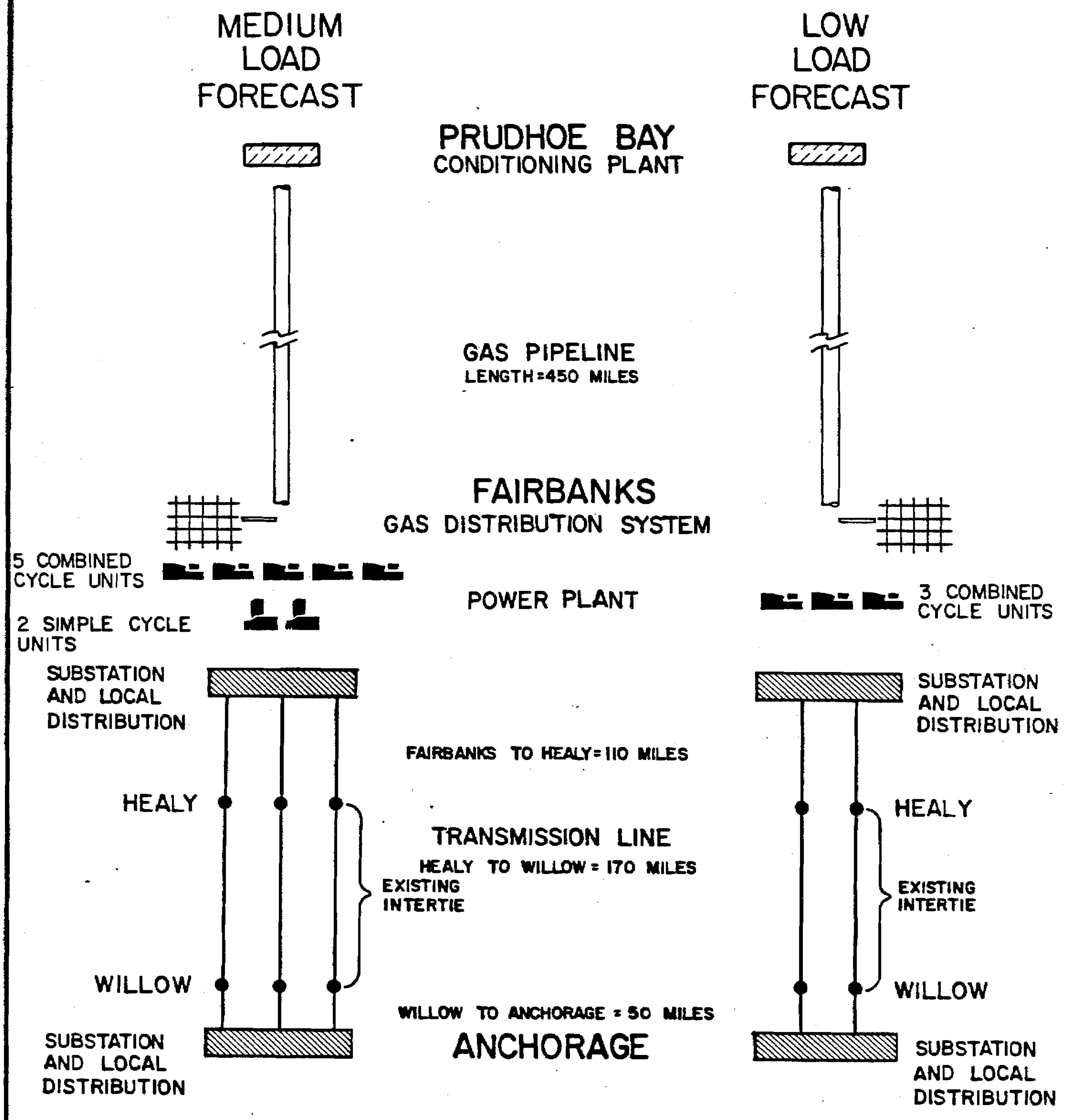
the size of the pipeline would be somewhat smaller than that proposed for the Alaska Natural Gas Transportation System (ANGTS). Electrical power generation near Fairbanks would use combined cycle plants consisting of gas-fired combustion turbines, waste heat recovery boilers and steam turbines. A gas conditioning facility would be required on the North Slope.

The Fairbanks generating scenario is depicted in Figure 1-2 which shows that five combined cycle and two simple cycle units are required to meet the year 2010 medium load forecast (1400 MW). The low load forecast (700 MW) requires three combined cycle units. The Fairbanks generating scenario requires a 22 inch diameter gas pipeline from the North Slope to Fairbanks and includes a natural gas distribution system to meet residential and commercial heating needs. Three 345 kV transmission circuits from Fairbanks to Anchorage are required for the medium forecast and two for the low load forecast. Present worth of costs of the electrical generating scenarios, excluding fuel costs, in 1982 dollars is $5.2 billion (medium forecast) or $3.4 billion (low forecast). The present worth of costs for the Fairbanks gas distribution system is $0.9 billion for the medium load forecast and $1.1 billion for the low load forecast.

The third scenario is contingent on the construction of a major natural gas pipline from the North Slope to tidewater on the Kenai Peninsula. Delays in the construction of ANGTS have renewed interest in such an all-Alaska pipeline. This system is described in the Governor's Economic Committee on North Slope Natural Gas Report (1983) entitled "Trans Alaska Gas System: Economics of an Alternative for North Slope Natural Gas." The Kenai electric generating scenario incorporates the anticipated energy demand from this system's tidewater facilities into the Railbelt's demand forecasts. Fuel for the power plant will be derived from a blend of waste gas from the conditioning facilities and sales gas. A major transmission line would also be required from near tidewater to the load center in Anchorage. The existing transmission



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NORTH SLOPE GAS FEASIBILITY STUDY

FAIRBANKS SCENARIO

FIGURE I-2

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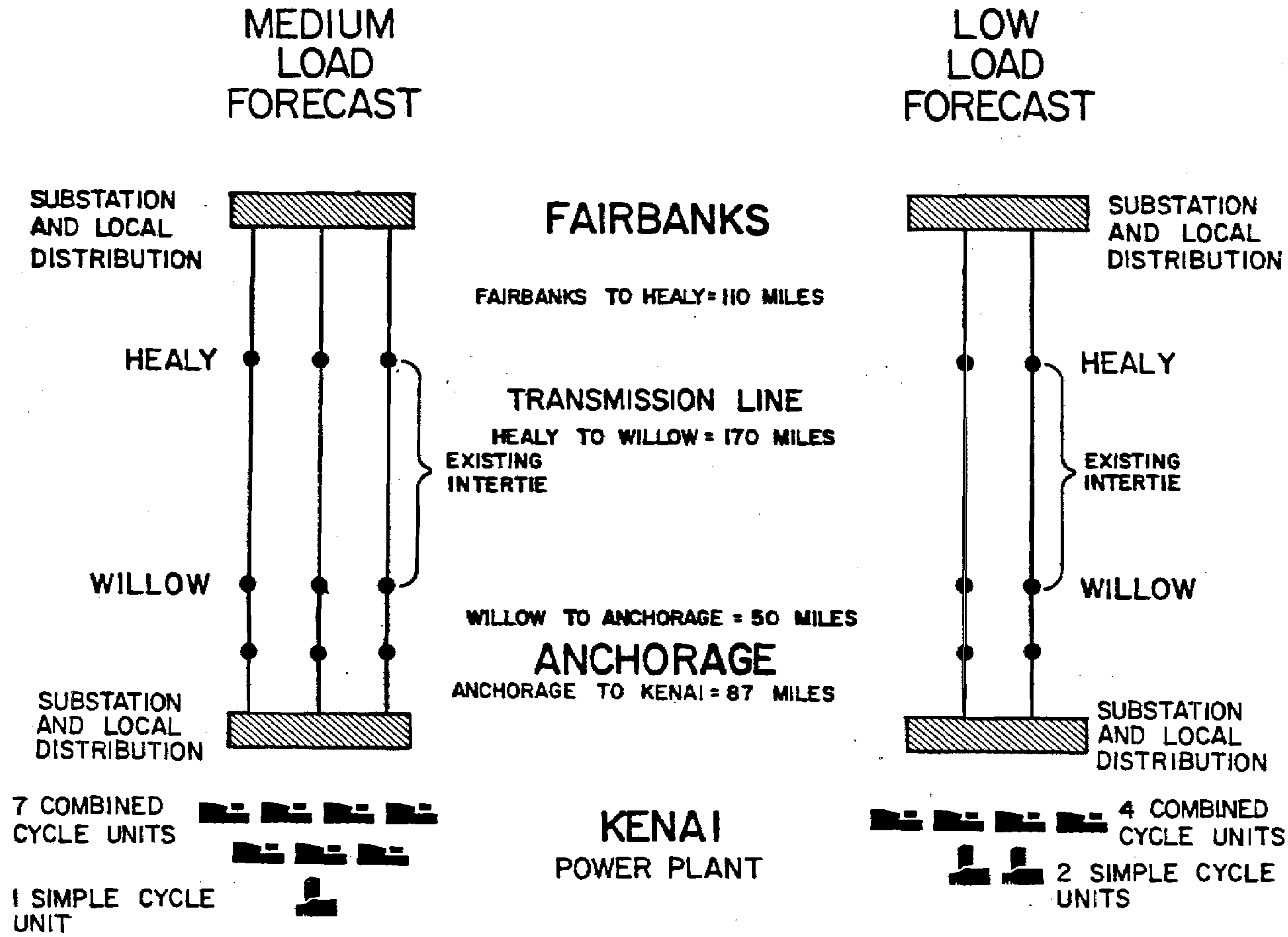
line from Anchorage to Fairbanks would have to be up-graded to handle the generating capacity.

The Kenai scenario (Figure 1-3) includes seven combined cycle units and one simple cycle unit to meet the energy demand in 2010 for the medium load forecast, and four combined cycle units and two simple cycle units for the low load forecast. In order to provide a highly reliable electric transmission system from Anchorage to Fairbanks, two parallel 345 kV circuits are required, even though a single circuit would be adequate in the low load forecast. Underwater cable crossing of Turnagain Arm is cost effective, with two 500 kV circuits from Kenai to Anchorage. Cost estimations, excluding the pipeline and gas processing facilities as well as fuel costs in 1982 dollars, result in a present worth of costs for the medium load forecast of $2.0 billion, and $1.7 billion for the low load forecast.

1.4 RESULTS

This work has resulted in the development of several scenarios for meeting the electrical generating needs of the Railbelt region using North Slope natural gas for fuel. Each scenario has been refined to establish schedules of generating capacity additions consistent with medium and low load forecasts through the year 2010. Chapter 2 and Chapter 3 detail the North Slope Power Generation scenario for the medium and low forecasts, respectively. Chapter 4 and Chapter 5 detail the Fairbanks scenario, while Chapter 6 and Chapter 7 describe the Kenai Power Generation scenario.

Engineering and cost evaluations of technologies capable of using natural gas to generate electricity provide a consensus for the use of gas fired combustion turbines. For the Fairbanks and Kenai scenarios, the turbines are exhausted through waste heat recovery boilers to power steam turbines.



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NORTH SLOPE GAS FEASIBILITY STUDY

KENAI SCENARIO

FIGURE I-3

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All of the scenarios will require substantial construction of electric transmission lines. A power plant on the North Slope separates the generation and load centers by almost 900 miles, requiring special transmission system design considerations to obtain a stable and reliable system. Generation near Kenai, on the other hand, requires a 500 kV underwater crossing of Turnagain Arm.

Socioeconomic and environmental effects of generating significant amounts of electricity are substantial in both the construction and operation of the system. However, no effect would appear to preclude any of the scenarios. Both air and water pollution control measures associated with gas fired combustion turbines are generally modest compared to other technologies.

Cost estimates are provided for each forecast of all three scenarios. Because each scenario is distinctly different, except for providing the required electricity, cost comparisons should not be the sole factor in evaluating the desirability of any scenario. However, within the scope of this study, Kenai generation shows the least cost because it does not factor in the cost of the Trans Alaska Gas System and its associated processes. The Fairbanks scenario is the most costly because it includes a 450 mile natural gas pipeline, and a gas conditioning facility on the North Slope. The North Slope scenario is in the middle of the cost range and is characterized by the high capital cost of constructing high voltage transmission lines to Fairbanks.

SCENARIO I
NORTH SLOPE POWER GENERATION
MEDIUM LOAD

2.0 NORTH SLOPE POWER GENERATION

MEDIUM LOAD FORECAST

The first scenario, under the medium load forecast, centers on a major electric generating station on the North Slope at Prudhoe Bay, near the source of natural gas used to fuel the station. By the year 2010, the station would consist of 15 simple cycle combustion turbines capable of generating almost 1400 megawatts (MW) of power to serve the Railbelt. North Slope power generation does not require the construction of major gas pipelines, but does require construction of 500 kilovolt (kV) electric transmission lines from the North Slope to Fairbanks and additional transmission lines of 345 kV from Fairbanks to Anchorage. Detailed analysis of the transmission system shows that a stable and reliable system can be designed despite the generation and major load centers being over 800 miles apart. The total construction costs for the system described are $4.2 billion, with total annual operation and maintenance costs of $1.1 billion. The present worth of these costs excluding fuel costs is $3.8 billion as of 1982. Environmental and socioeconomic effects of this scenario are substantial, but none have been identified which would preclude the project.

2.1 POWER PLANT

The power generation technology selected for the North Slope scenario employs simple cycle combustion turbines utilizing 91 MW baseload, combustion turbine generators. The criteria and parameters which resulted in this selection are discussed in the Report on Systems Planning Studies (Appendix B).

2.1.1 General

Development of a North Slope site for the required generating units, construction and maintenance facilities, worker housing, and access facilities will be a major undertaking. In addition to continuously expanding facilities for maintenance and operation, there will be permanent construction facilities and a semi-permanent construction staff.

The scenario for utilizing simple cycle gas turbine-generators to generate power at the North Slope requires fifteen 91 MW (nominal) units for satisfying load demand under the medium load forecast. The units would be added in increments beginning in 1993. On the average, slightly less than one unit per year is required through the end of the study period in 2010. Incremental and total required new generation capacity for this scenario are summarized in Table 2-1.

The functional parts of the plant will consist of a gas supply system(s), the turbine-generators, various auxiliary and support systems, a central control facility, switchyards, and the northern terminus of the transmission line.

A single simple cycle unit will require approximately a 90 ft x 150 ft enclosure as shown in Figure 2-1. It is planned that the units be installed side by side as shown in Figure 2-2 up to the maximum of 15 units required for the medium load forecast. The site will include the 138 kV switchyard behind the units and a 500 kV transmission line termination centered on the planned maximum plant site. A 300 ft wide buffer area surrounding the site is planned, yielding a maximum total site acreage of 90 acres.

2.1.2 Combustion Turbine Equipment

The combustion turbine plant design envisioned is based on using currently available gas turbine units, rated by one manufacturer at approximately 77 MW each. Various other manufacturers' turbines of similar size could be used to satisfy the requirement of this study, but it must be pointed out that the specific plant output and various specific design parameters may be expected to change accordingly.

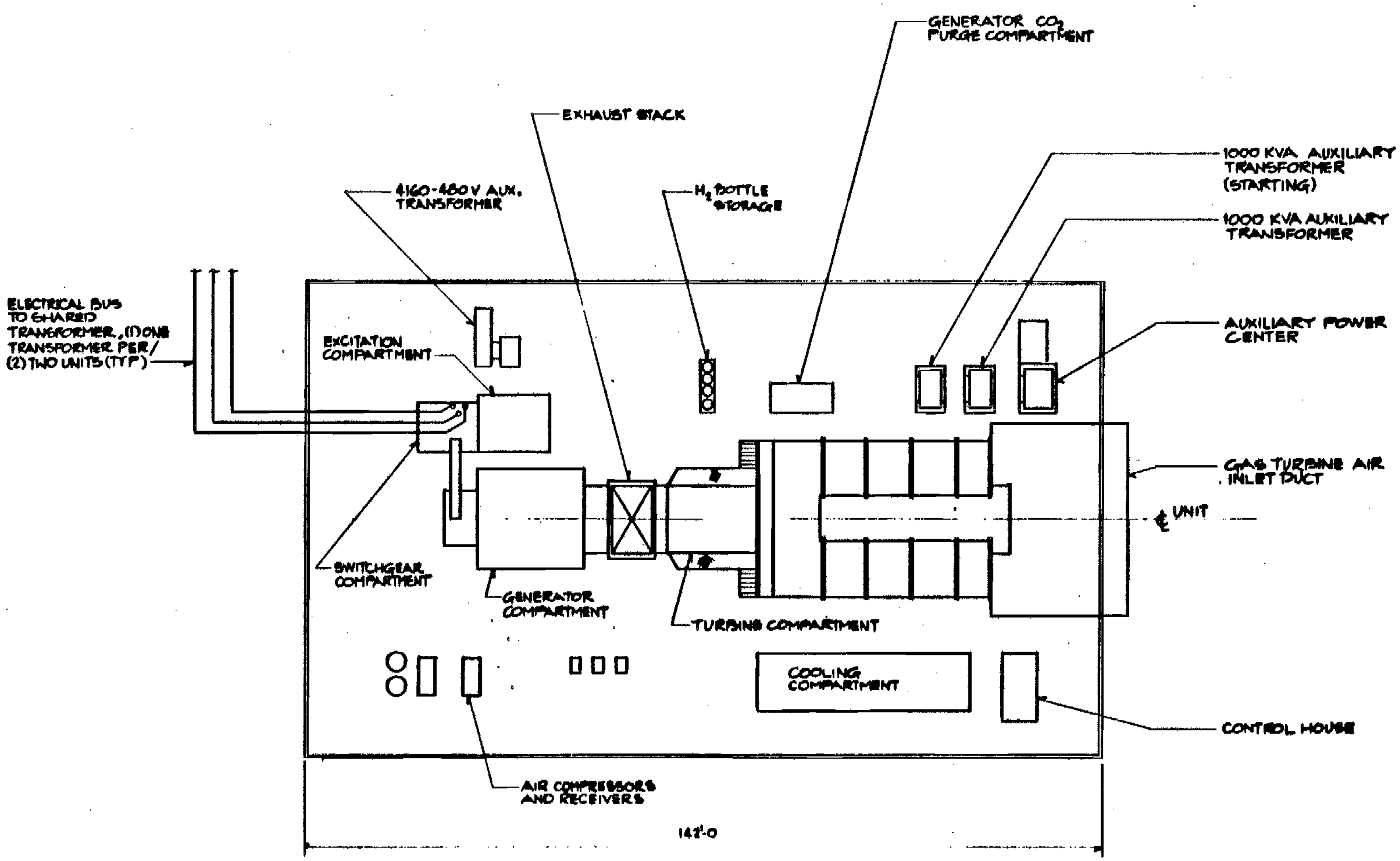
TABLE 2-1

NEW CAPACITY ADDITIONS AND FUEL REQUIREMENTS
NORTH SLOPE POWER GENERATION - MEDIUM LOAD FORECAST

Year	New Capacity (MW) (Increment/Total)	Gas Required (MMSCFY)1/ 2/
1990	0/0	0.
1991	0/0	0.
1992	0/0	0.
1993	91/91	6,574.6
1994	0/0	6,574.6
1995	91/182	13,149.1
1996	91/273	19,778.7
1997	91/364	26,287.3
1998	91/455	32,861.9
1999	0/455	32,861.9
2000	91/546	39,546.7
2001	0/546	39,436.4
2002	182/728	52,585.6
2003	0/728	52,585.6
2004	91/819	59,325.0
2005	182/1001	63,546.9
2006	91/1092	66,548.2
2007	91/1183	69,538.7
2008	91/1274	72,540.2
2009	0/1274	75,530.6
2010	91/1365	78,532.0

1/ MMSCFY = million standard cubic feet per year.

2/ Values as calculated are shown for purposes of reproducibility only and do not imply accuracy beyond the 100 MMSCFY level.



PLAN - 77 MW NOMINAL RATING/SIMPLE CYCLE PLANT

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NORTH SLOPE GAS FEASIBILITY STUDY

SIMPLE CYCLE GAS TURBINE GENERAL ARRANGEMENT

FIGURE 2-1

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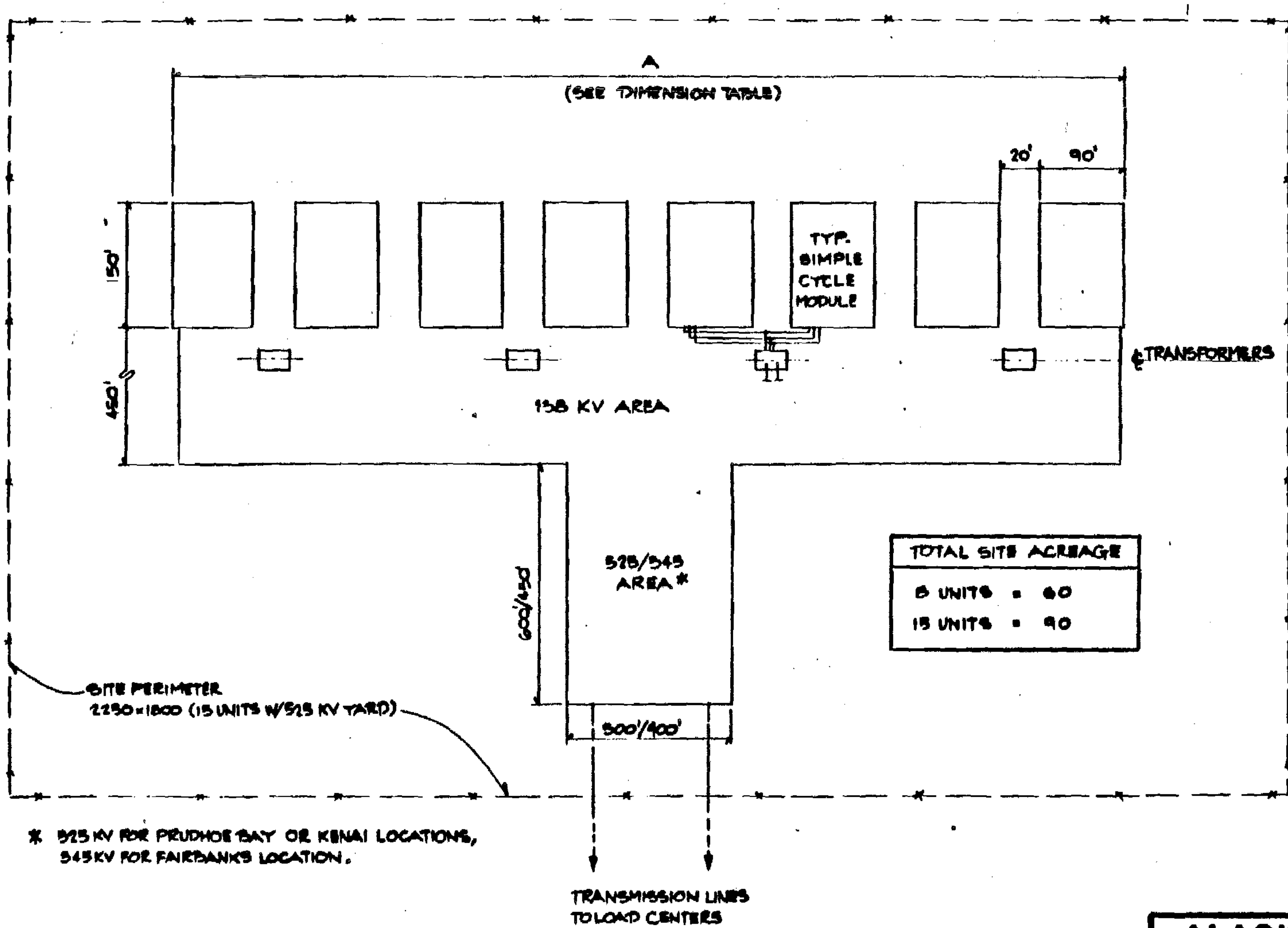

TOTAL SITE ACREAGE		
5 UNITS	=	60
15 UNITS	=	90

* 525 KV FOR PRUDHOE BAY OR KENAI LOCATIONS,
345 KV FOR FAIRBANKS LOCATION.

DIMENSION 'A'	NO. OF COMPLETE SIMPLE CYCLE UNITS
90	1
310	3
530	5
750	7
970	9
1190	11
1410	13
1630	15

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NORTH SLOPE GAS FEASIBILITY STUDY

SIMPLE CYCLE GAS TURBINE
SITE PLAN
NORTH SLOPE

FIGURE 2-2

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At International Standards Organization (ISO) referenced conditions (59°F and sea level) plant performance will consist of a net unit output of 77 MW. The ISO heat rate of the units will be approximately 11,900 Btu/kWh (HHV). For the actual conditions existing at the North Slope (average annual temperature of 9°F and sea level) the rating of the turbines is approximately 91 MW and the heat rate is 11,500 Btu/kWh (HHV).

Each combustion turbine is a large frame industrial type with an axial flow multi-staged compressor and power turbine on a common shaft. The combustion turbine is directly coupled to an electric generator, and can be started, synchronized, and loaded in about one half hour under normal conditions.

The gas turbine generators are "packaged" units and as such include all auxiliary equipment. The package generally includes:

1. 13.8 kV switchgear which houses the generator grounding transformer, and generator air circuit breaker.
2. Nonsegregated phase (iso-phase) bus work which runs from the generator to the main transformer.
3. A master control panel for overall operation and monitoring.
4. A transformer (13.8/4.16 kV) sized to support the ancillary load (estimated to be 2 MVA).
5. A 4.16 kV switchgear with air circuit breakers for other loads (e.g. 800 HP [horse power] cranking motor). The largest load (gas compressor) is fed from the plant common 4.16 kV switchgear.
6. Electrical protection equipment.

Each combustion turbine generator package also includes an inlet air filtration system, fuel system, lubricating oil cooling system, and various minor subsystems as required, furnished by the manufacturer.

The design parameters for each combustion turbine with generator are presented in Table 2-2. Inlet air preheating using a heat exchanger will also be necessary.

2.1.3 Fuel Supply

Annual fuel requirements for power generation at the North Slope will be 6.5 BCFY (billion cubic feet per year) in 1993 and grow to 78 BCFY by 2010 for the medium growth forecast. Maximum potential firing rate for the medium load growth scenario will be 2.5×10^5 SCFM (standard cubic feet per minute) in the year 2010.

Fuel requirements on a year by year basis will vary with installed generating capacity and are shown in Table 2-1. These gas demands were generated based on an average annualized unit heat rate of 11,500 Btu/kWh (HHV) for the simple cycle gas turbines at average ambient conditions.

The HHV of the fuel gas is assumed to be 1046 Btu/SCF (LHV 942 Btu/SCF). These values reflect the fact that no gas conditioning facilities will be required for the North Slope scenario.

The gas supply system will consist of piping from one or more of the existing North Slope natural gas gathering centers, a pressure reduction station and an in-plant distribution system. The supply and distribution system will be designed for maximum flexibility to operate any configuration of the available gas turbines. The pressure reduction system will be required to assure a constant gas supply pressure at 250 psig.

2.1.4 Switchyard

The circuit diagram of the power plant switchyard is shown in Figure 2-3. Two generators will be connected to the two primary windings of the 250 MVA 13.8/138 kV transformers. The bus arrangement will use a breaker and a half scheme. Two 750 MVA 138/525 kV

TABLE 2-2

COMBUSTION TURBINE WITH GENERATOR DESIGN PARAMETERS

Turbine Type:[1/] Simple-cycle, single-shaft, three bearing.

Generator Type: Hydrogen-cooled unit rated 130 MVA at 13.8 kV, with 30 psig hydrogen pressure at 10°C.

Performance: - (Each Turbine - at ISO Conditions)

Heat Rate (LHV)	10,700 Btu/kWh
Air Flow	609 lbs/sec
Turbine Exhaust Temp	995°F
Turbine Inlet Temp	1985°F
Inlet Pressure Drop	3.5 in. water
Exhaust Pressure Drop	0.5 in. water
Overall Dimensions	38 ft. wide by 118 ft. long by 32 ft. high

Combustion Turbine Features:

Accessories include starting motor, motor control center for all base-mounted motors, lubrication system, hydraulic control system.

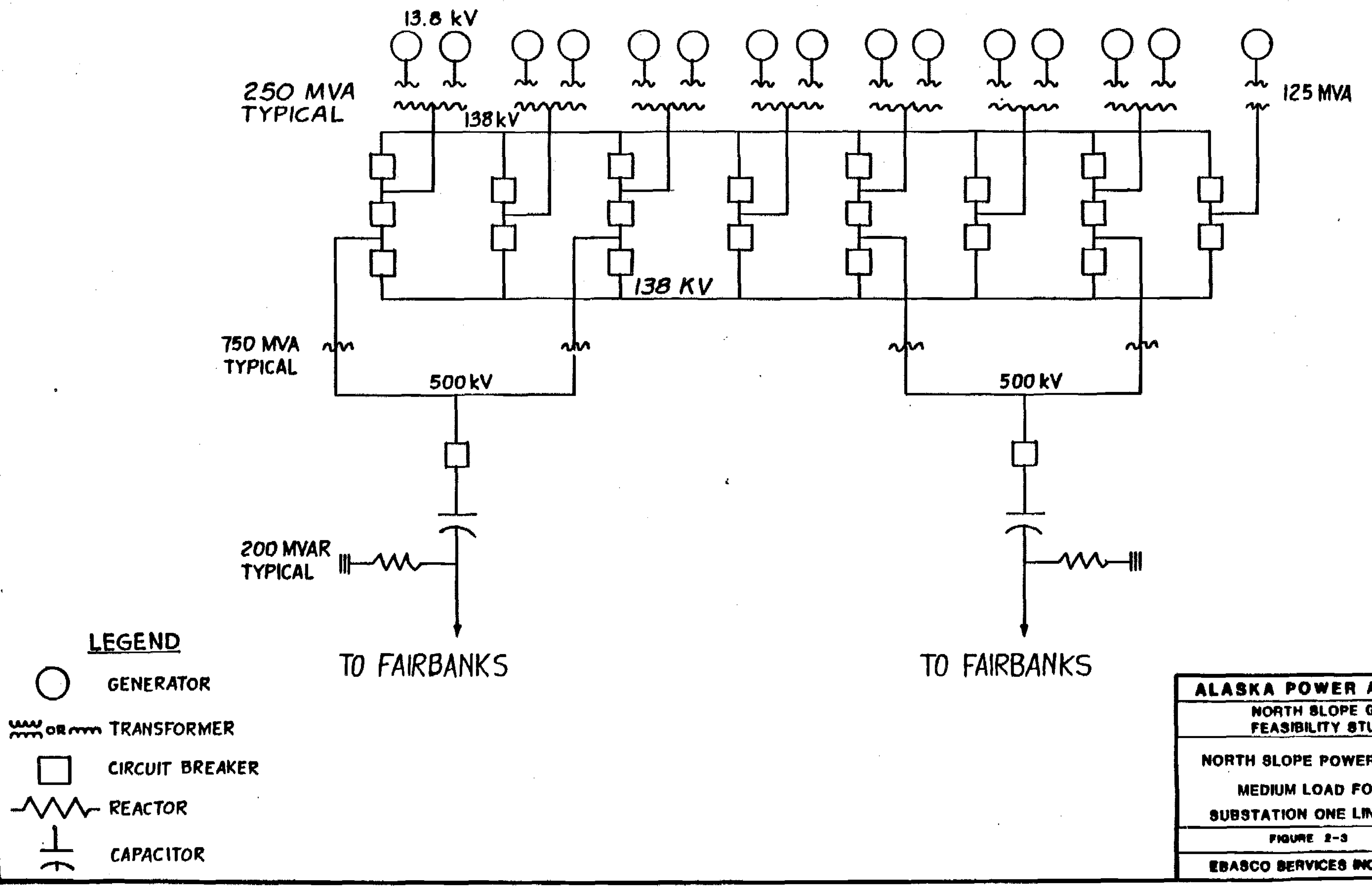
Excitation compartment complete with static excitation equipment.

Switchgear compartment complete with generator breaker, potential and current transformers, disconnect link for auxiliary feeder, and a power takeoff.

Fuel system capable of utilizing natural gas, mixed gas fuel, or liquid fuel.

Fire protection system (low pressure CO_2).

1/ Based on General Electric MS7001.



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NORTH SLOPE GAS
FEASIBILITY STUDY

NORTH SLOPE POWER GENERATION
MEDIUM LOAD FORECAST
SUBSTATION ONE LINE SCHEMATIC

FIGURE 2-3

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autotransformers will supply each of the transmission line circuits. Each of the transmission lines will have a circuit breaker. On the line side of the circuit breakers will be the series capacitors and the shunt reactors. This arrangement has the advantage of being flexible as far as operation is concerned, and can be expanded easily. The system's flexibility is demonstrated in Figure 2-4, which shows the initial development associated with the installation of the first generator. There are seemingly more circuit breakers than necessary in this initial circuit; their purpose is to facilitate future expansion work.

The grounding mat of the switchyard is connected to four insulated 1000 kCM[1/] cables which terminate in a grounding rod system driven into the sea floor. The ground mat is also connected to the two counterpoises[2/] which run under the entire length of the transmission line.

2.1.5 Power Plant Support System Descriptions

The auxiliary systems described in this section represent generally the minimum necessary to operate a simple cycle combustion turbine facility. These systems include water supply, waste management, fire protection, electrical, and lubricating oil systems.

Plant makeup water will be derived from an assumed existing lake of at least 150 acres to supply the needs of two water systems: a potable water system for the plant and the camp, and a service water system. The potable water system will be designed to supply water for the maximum crew on hand through completion of the final unit. Service water will be provided to all units for maintenance, construction uses

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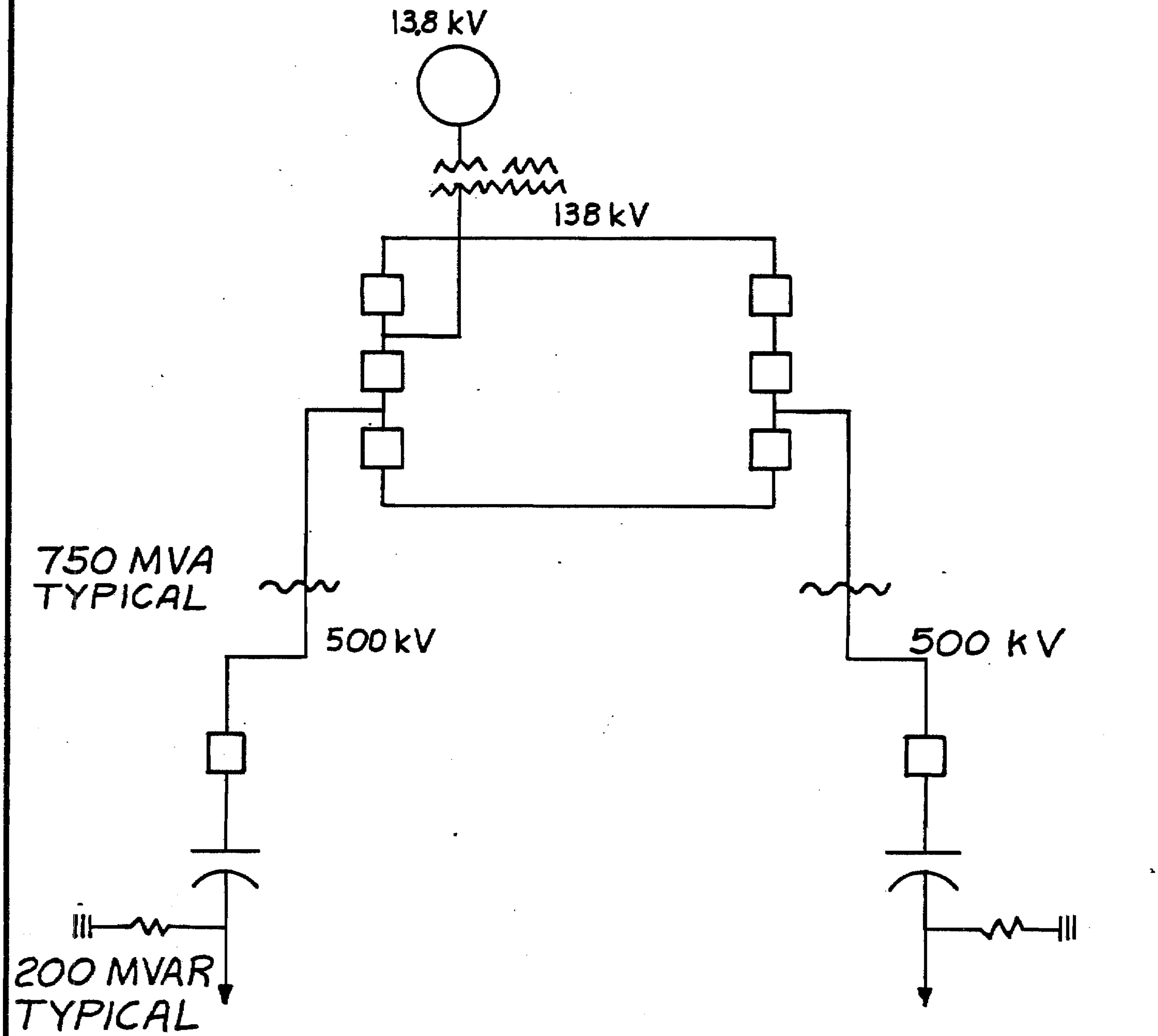
1/ kCM stands for thousands of circular mils, a measure of the cross-section of a cable.

2/ Counterpoises are buried grounding cables, running under transmission lines, which are necessary in areas with poorly conducting soils.



LEGEND

GENERATOR

TRANSFORMER

CIRCUIT BREAKER

REACTOR

CAPACITOR

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NORTH SLOPE POWER GENERATION
MEDIUM LOAD FORECAST
INITIAL STAGE OF SUBSTATION
DEVELOPMENT

FIGURE 2-4

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and area cleaning. A water injection system should not be required for NO_x control on the North Slope (see Section 2.4.1 for further explanation).

Waste control systems for the plant will consist of control and processing through oil/water separation treatment of all floor drainage from operating and maintenance areas. This treated effluent and domestic wastes will be transported to an existing sanitary waste treatment facility. Because the natural gas supply is low in sulfur content, no sulfur dioxide (SO_2) emissions control will be required.

Due to the climatic conditions existing during most of the year, fire protection will be based on standard halon systems rather than water systems. Automatic halon systems will be installed for high risk areas, and manual systems will be used for low risk areas. Also, each system selected shall be compatible with any of the specific hazards it is intended to combat.

A system for storing both clean and dirty lubricating oil shall be included. The system will include a central storage area and portable units capable of transporting, replacing, and/or cleaning the lubricating oil in an operating gas turbine.

2.1.6 Construction and Site Services

The construction and operation of a simple cycle power plant will require a number of related services to support all work activities at the site. These site services will include the following for the North Slope power plant:

(1) Access

(2) Construction Water Supply

(3) Construction Transmission Lines

(4) Construction Camp

Access

Gravel roads with a 5 foot minimum gravel base will be required to connect the plant site with the existing road network at the North Slope. It is expected that no more than 2 miles of new road construction will be required.

It is anticipated that all personnel travel will be by air with pre-arranged commercial charter carriers to Deadhorse Airport. All perishable goods, mail, and rush-cargo, will be flown in. Equipment for construction will be flown in only under extraordinary circumstances.

The site will use the existing marine landing facilities during the six week "thaw" period to receive all major equipment and supplies. A fenced interim storage area will be provided. The Dalton Highway (Haul Road) from Fairbanks will be utilized for smaller shipments to the site.

Construction Water Supply

A complete water supply, storage and distribution system will be installed. Due to the nature of the site, a heated and insulated one-million gallon water storage tank will be incorporated into the camp's design, with one-half of this storage capacity dedicated to fire protection needs. The water supply will be derived from an existing lake.

Construction Transmission Lines

Power requirements during the construction phase will be supplied by constructing a 69 kV transmission line tapped from the area's existing transmission system.

Construction Camp Facilities

A 200 (maximum) bed labor camp will be provided unless an existing camp can be utilized. All personnel housed in this camp will be on single status. Provisions will be made to accommodate a work force of both men and women by providing separate facilities.

The 200 bed camp will accommodate the maximum required workforce for those years when two turbines will need to be installed and started up at the same time. For other years, a workforce of 50 to 100 (maximum) is anticipated. This camp will also be used to house operating personnel.

2.1.7 Operation and Maintenance

Plant Life

Each gas turbine will have a 30 year life expectancy. It is expected that the gas turbine units will be overhauled in accordance with manufacturer's suggestions and good operating practice for the life of the units.

Heat Rate of Units

Unit heat rates for the plants will vary, depending on ambient conditions at the sites. It is common practice for gas turbine manufacturers to quote heat rates in terms of the lower heating value (LHV) of the fuel. However, since fuel is purchased based on higher heating values (HHV), HHV figures are used in the balance of this report. The site specific HHV heat rate is 11,500 Btu/kWh. ISO conditions give a heat rate of 10,700 Btu/kWh (LHV) for base load operation.

Scheduled and Forced Outage Rate

It is expected that the forced outage rate will be about 8 percent. Operational experience on other plants indicates higher forced outages in the first few years, but this is attributed to operational adjustments required for a new plant. It is expected that a slight increase in forced outages will occur as the plant ages.

Scheduled outages will be an additional 7 percent based on two periods of regular semi-annual maintenance requiring shut down and one 5 week period every three years for overhaul.

Operating Workforce

The number of personnel required to operate a plant of this type can vary widely, depending on plant utilization and system operating practices. Based on Electrical Power Research Institute Operational Development Group study figures, and considering the severity of climate and operational failure, an on-duty operating and maintenance workforce of 10 persons will be required starting in 1993, when one unit is operating. This will grow as units are added until an on-duty force of approximately 50 persons will be required for the 15 units operating in 2010. Assuming a 12 hour shift and a 7-day-on, 7-day-off work schedule, the total required workforce will vary from 40 to 200 personnel.

2.1.8 Site Opportunities and Constraints

Climate is the single most important site characteristic affecting design at the North Slope. As previously mentioned, the 77 MW rating of the turbine is based on ISO conditions with an ambient temperature of 59°F. As the ambient temperature decreases, the capacity of these units increases. At 0°F, the rated capacity of these units is 122 percent of the capacity at 59°F, or approximately 94 MW. The heat rate decreases as the temperature decreases, and at 0°F is 97.5 percent of that at 59°F, or approximately 11,600 Btu/kWh (HHV). Clearly a cold climate site such as the North Slope offers some operational performance advantages. This is especially true since the cold weather also produces the annual peak loads for the Railbelt area. The average annual temperature at the North Slope site is 9°F resulting in an average annual unit capacity and heat rate of 91 MW and 11,500 Btu/kWh (HHV), respectively.

The remoteness of the site combined with the climatic conditions present the most significant problems to construction of this scenario. The short construction season and the cost of construction at the North Slope generally dictate that as much prefabrication as possible be performed prior to shipping units to the site. In addition the arrival of shipments via barge will be delayed until mid-summer when the Arctic coast becomes free of ice. This further shortens the construction season for shipped materials and may require storage over winter for completion of construction the following summer.

2.2 TRANSMISSION SYSTEM

2.2.1 Overview of the System

For reasons of reliability, two parallel circuits have been considered. The design criteria used in the study are presented in Table 2-3. Additional details regarding system design and alternatives are presented in Appendix D. The 450-mile length of the proposed transmission system between the North Slope and Fairbanks will be interrupted by two intermediate switching stations, one at Galbraith Lake and one at Prospect Camp; this will establish three almost exactly equal 150-mile-long segments.

The two circuits will originate in the Prudhoe Bay/Deadhorse area of the North Slope. Each circuit will be supplied by two 750 MVA transformers, protected by one circuit breaker and compensated with a series capacitor bank and shunt reactor. The two circuits will be

TABLE 2-3

TRANSMISSION LINE DESIGN CRITERIA

Temperature range:	-60°F to +86°F
Wind loads:1/	25 lbs per sq. ft above the Arctic Circle and 8 lbs/sq. ft. below it; 2.3 lbs/sq. ft. at +86°F
Ice on conductor:	1.5" radial thickness with 8 lbs/sq. ft. wind load at 32°F
Snow on ground:	36" north of the Arctic Circle and 24" south of it
Clearance to ground:	minimum 38 feet with snow on the ground
Tension in conductors:	maximum 50% of rated tensile strength
Gradient on conductor surface:2/	maximum 18 kV per centimeter

1/ 25.0 lbs per square foot corresponds to 100 mph wind
8.0 lbs per square foot corresponds to 55 mph wind
2.5 lbs per square foot corresponds to 30 mph wind

2/ To reduce corona losses and mitigate radio and television interference located on opposite sides of the road for the first 60 miles, to Pump Station 2. South of the 60 mile mark, the line may not necessarily be located on the two sides of the road.

The first switching station will be at Galbraith Lake approximately 150 miles south of Prudhoe Bay. Immediately south of the switching station is a 30-mile portion of the route where the suitable terrain narrows, possibly requiring the two circuits to be placed on single towers. In the Atigun Pass area the slopes of the mountainside are not overly rugged and the two circuits could be constructed a few hundred feet up the slopes from the roadway. The Atigun Pass section is about 5 miles long and reaches an elevation of approximately 5,000 feet, the highest point of the transmission system.

The second switching station will be located at Prospect Camp. It will be identical to the one at Galbraith Lake. The line will cross the Yukon River near the Yukon River Bridge, and will terminate in the Fairbanks area.

2.2.2 Voltage Selection

Three voltage levels were investigated in detail: 500 kV AC, 765 kV AC, and ±350 kV DC (see Appendix D). Each of these are capable of transmitting the required power from the North Slope to Fairbanks. A comparative cost study has been made using the methodology and cost figures supplied by Commonwealth Associates (1978). The study indicated that all three versions are within ±10% as far as capital investment is concerned, which is within the expected range of accuracy of these types of calculations. Therefore, all three can be considered to be equal with respect to capital cost. The 500 kV alternative was chosen for detailed cost estimating because this version represents the most conventional approach and would likely have the best reliability.

2.2.3 Towers

Tubular steel H-frame towers will be utilized for the line; their average height will be 90 feet and the average span will be 1000 feet. There will be one dead end tower at approximately every 10 miles, or in other terms 2% of the towers will be dead end.[1/]

Special consideration has been given to the crossing of the Yukon River, about 1000 feet downstream from the highway bridge. The required span will be approximately 3000 feet. At the selected location the right (north) bank of the river is a flat, low floodplain, but an approximately 300-foot hill rises at the left (south) bank making the design of the crossing easier. The span will be between two lattice type dead end towers, one approximately 120 feet tall at the north shore and the other approximately 100 feet tall on the top of the hill at the south end of the span. This arrangement should pose no greater hazard to waterborne traffic than does the bridge.

2.2.4 Conductors

Bundled conductors will be used for the line with two conductors per bundle at 18 inches apart. Except for the Yukon River crossing, Chukar conductor, a 1780 kCM ACSR[2/] conductor with a rated strength of 51,000 lbs and an outside diameter of 1.6 inches, should be used. With a 1000-foot average span, the maximum sag will be 42 feet, which, with a 95 feet tall tower, will provide adequate clearance to ground. In satisfying all appropriate design criteria, the conductors will be oversized with respect to current carrying capacity, consequently, one circuit will be capable of carrying almost twice the required medium forecast power. The line will be provided with spacer dampers.

1/ A dead end tower is capable of withstanding a conductor break, preventing structural failure of the transmission system from proceeding beyond a dead end tower.

2/ ACSR - aluminum conductor, steel reinforced cable.

For the Yukon River crossing a special conductor with an ultimate strength of 235,500 lbs may have to be ordered, such as 61x5 strand Alumoweld from the Copperweld Company. With the recommended towers, minimum clearance to high water will be 70 feet during the summer and 45 feet in the winter. Construction of the span will be done during the winter months when ice cover permits working over the river bed. Special vibration studies must precede actual design and vibration recording instruments must be installed after erection.

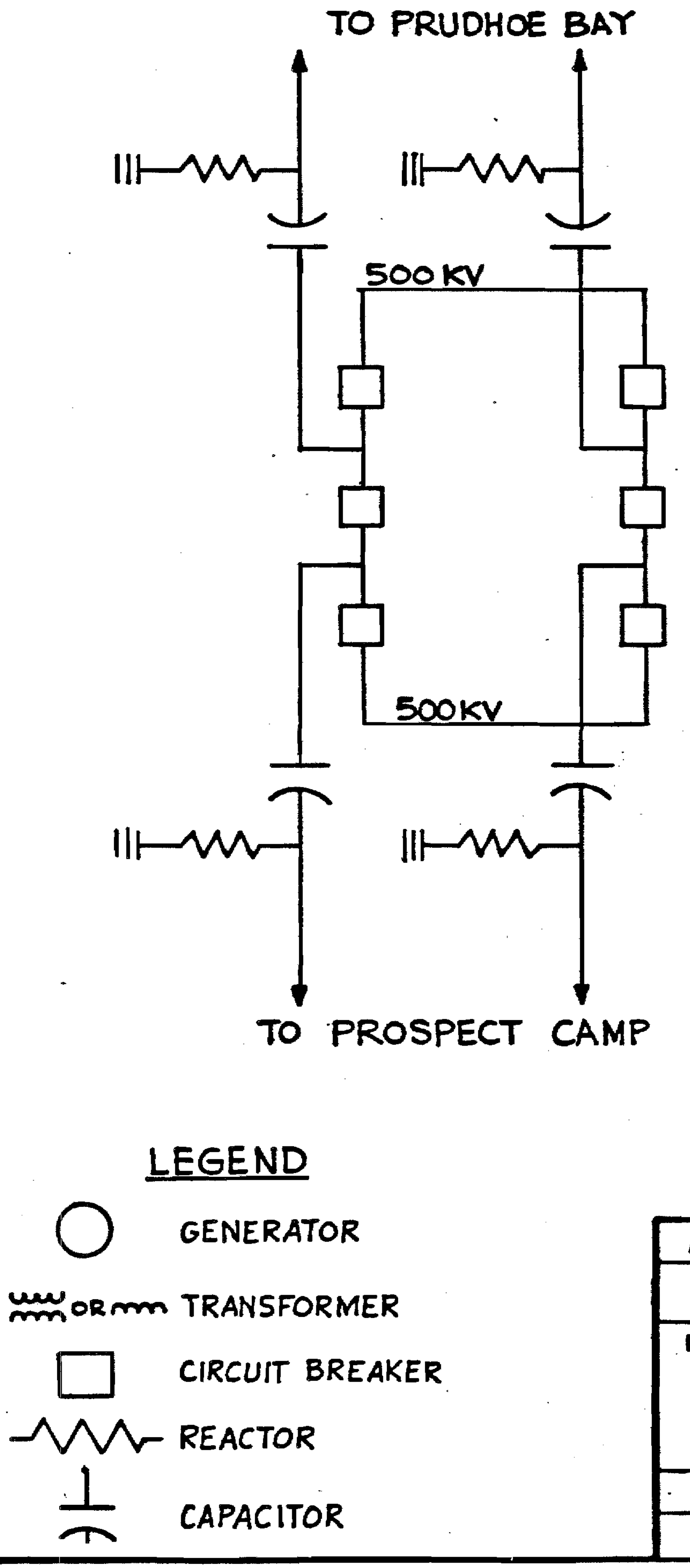
2.2.5 Insulators

Suspension insulators, such as type 5-3/4" x 10" x 50 K lb, will be used. Two strings in a V configuration will hold the conductor bundle. Normally, 25 insulators are in each string.

For the first 60 miles from Prudhoe Bay fog type insulators will be installed and the number of insulators in the strings will be double that provided for the remainder of the route. Also, fixed insulator washing installations will be provided at each tower, based on the experience that Sohio has operating 69 kV lines at the North Slope. A tank truck equipped with pumps, hoses and other equipment will perform the annual washing in the fall.

2.2.6 Switching Stations

The two switching stations at Galbraith Lake and at Prospect Camp will divide each of the line circuits into three, almost equal, 150 mile long segments. The circuit schematic can be seen in Figure 2-5. The arrangement is conventional. The intermediate switching stations will make it possible to switch a shorter segment out of the system in case of a fault of a circuit, instead of the entire line length; this will improve the stability, hence the reliability, of the power system.



ALASKA POWER AUTHORITY

NORTH SLOPE GAS
FEASIBILITY STUDY

NORTH SLOPE POWER GENERATION
MEDIUM LOAD FORECAST
TYPICAL TWO LINE
SWITCHING STATION SCHEMATIC

FIGURE 2-5

EBASCO SERVICES INCORPORATED

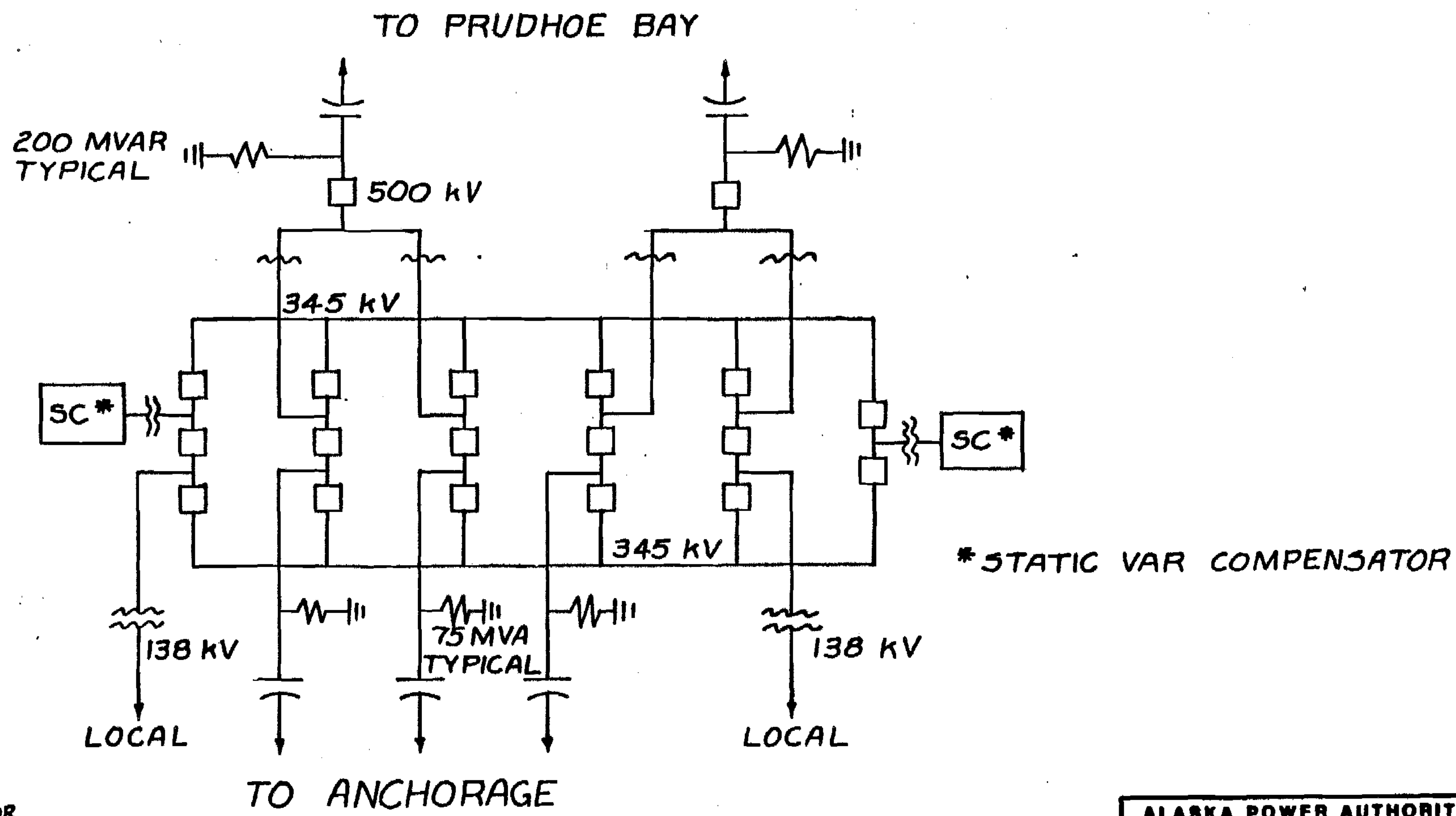
2.2.7 Fairbanks Substation

The Fairbanks substation one line schematic is shown in Figure 2-6. Two 500 kV line circuits, originating at Prudhoe Bay, will be connected to the substation, through either one 1500 MVA or two 750 MVA 345/525 kV transformers. Three 345 kV circuits will leave the substation in the direction of Anchorage. Two transformers will provide power for local area loads. The bus will be at 345 kV. The schematic shows two static VAR compensators connected to the bus through dedicated transformers. These static compensators will not necessarily be located where shown in Figure 2-6; their connections to the system are described in detail in Appendix D. The circuitry will use breaker and a half or double breaker arrangements. The substation will be designed so that the loss of one line, transformer, circuit breaker or compensator allows uninterrupted operation at full power.

2.2.8 Construction

Five camps will be used to house the work force; each camp will serve about a 90-mile section of the line for most of the construction period. The number of people will vary between 41 and 155 per camp, including the camp crew. The one exception is the period of building the gravel pads, when a total of 2400 people will have to be housed during the first summer of construction, which may require the opening of additional camps.

A 100' x 100' gravel pad must be constructed to serve as the base of each tower, and every 18 miles 300'x 1200' pads will serve as marshalling yards. Fifteen crews, with the aid of helicopters, can erect the towers during a six month work period. The last operation will be the stringing, which can be done by 5 crews, each with helicopter assistance. The switchyards will be constructed during the time that the line is stringed.



LEGEND

GENERATOR

OR TRANSFORMER

CIRCUIT BREAKER

REACTOR

CAPACITOR

ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

NORTH SLOPE POWER GENERATION
MEDIUM LOAD FORECAST
FAIRBANKS SUBSTATION SCHEMATIC

FIGURE 2-6

EBASCO SERVICES INCORPORATED

Pad building will take place in one summer using two 10-hour shifts. All other operations, except for surveying, will each take six months to perform and will be scheduled for fall and spring when the soil is frozen, but when enough daylight is available to work at least one 8-hour shift.

2.2.9 Operation and Maintenance

The least reliable equipment will be the series capacitors. The cost of a series compensated 500 kV line is about the same as that of an uncompensated 765 kV line. The 765 kV alternative should be investigated in more detail during detailed design of the line. The trade-offs of not having series capacitors are wider rights-of-way, increased problems due to contamination near Prudhoe Bay and increased difficulties to construct the two circuits through Atigun Pass.

2.2.10 Communications

To provide adequate communications, a microwave system will be installed. The North Slope-Fairbanks line will require 16 repeater stations. Five channels will be required, at least, one for supervisory voice communication, one for data transmission, one for relaying, one for service communication (below 4 kHz) and for alarm (above 4kHz), and one spare channel. Each repeater station will have a radio transceiver to maintain voice communication between vehicles and the dispatcher, using the service voice channel.

In addition, each transmission line circuit segment will be provided with a line carrier, mainly to provide redundancy for vital transfer trip functions.

Though this project assumed a dedicated microwave system, the project proponent may consider leasing microwave channels from ALASCOM. Several options, including direct satellite link, may be cost effective.

2.2.11 Siting Opportunities and Constraints

An inspection of the route indicated that most of the route should not cause significant construction problems. However, three areas are of some concern. The first 60 miles of the line south from the North Slope is a tundra area; civil engineering design and construction methods will have to be carefully investigated. Second, the grounding problems posed by frozen soil require that a bare copper conductor, called a counterpoise, be buried under each circuit along the entire length of the transmission line and be connected to the ground mats of all the substations and switching stations. Third, crossing Atigun Pass, as mentioned earlier, will require careful design; here the counterpoises may have to be routed farther from the circuits or be carried on the towers.

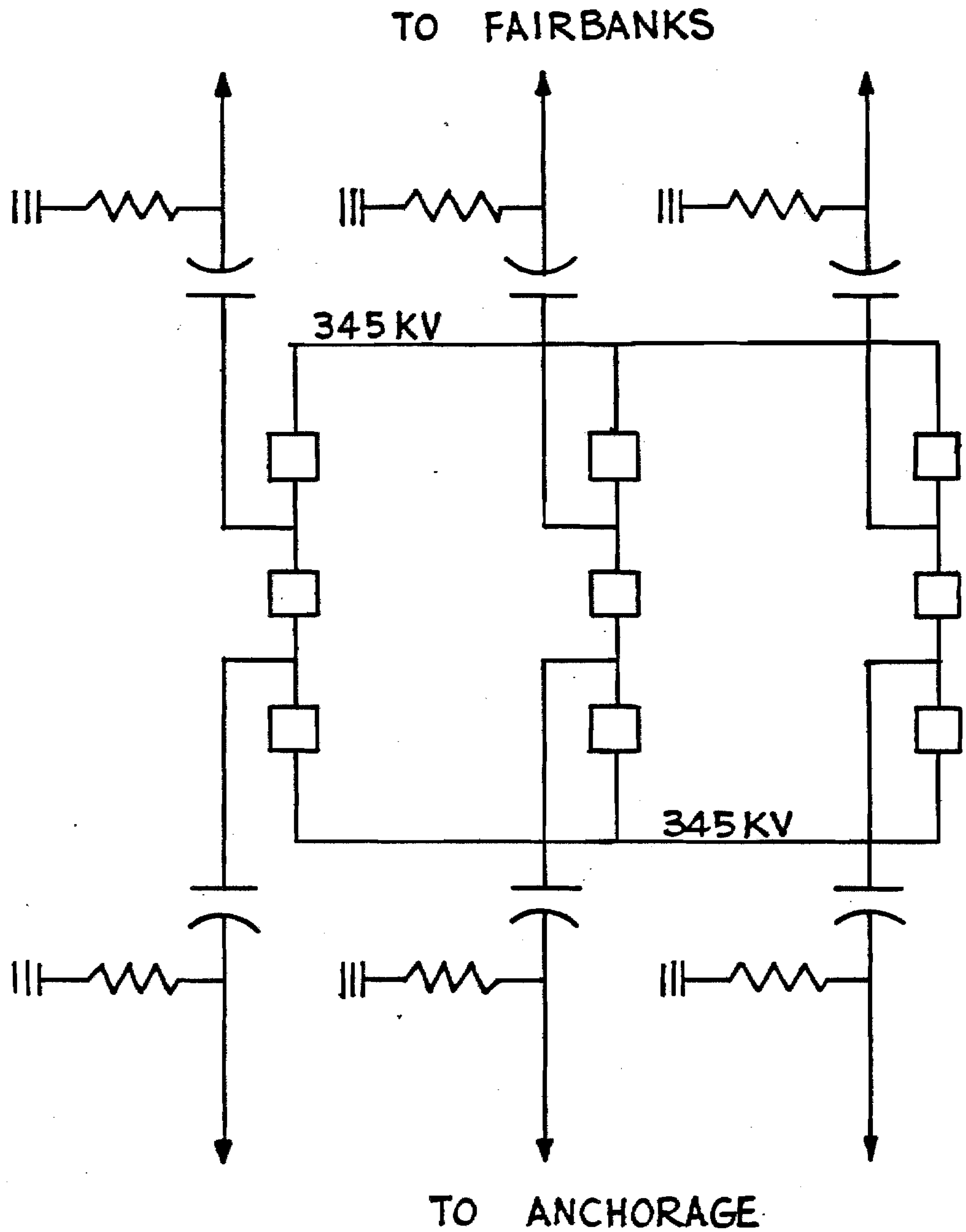
2.2.12 Fairbanks to Anchorage Line

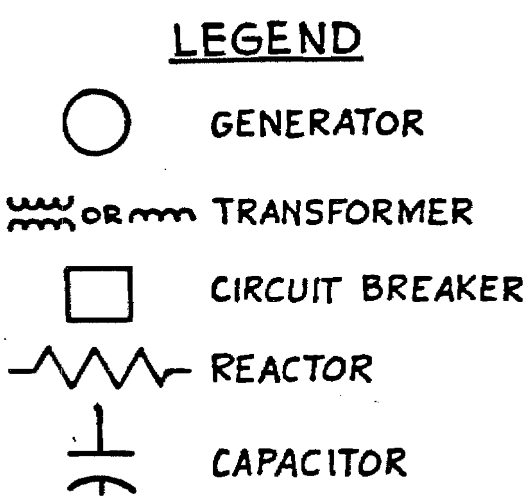
System studies performed by Ebasco (see Appendix D) indicate that 345 kV is a suitable voltage for this transmission line. This voltage is compatible with the 345 kV Intertie under construction. Therefore, two new 345 kV lines will be built and the Intertie will be extended fully between Fairbanks and Anchorage.

At the time of writing this report, the detailed design of the Intertie is available. Based on this information, the designs of the Intertie extension and the two new lines are assumed to be the same as the Commonwealth Associates (1981) design. The only additions will be the intermediate switching station, shown in Figure 2-7, the series capacitors and the shunt reactors.

2.2.13 Anchorage Substation

The Anchorage substation will be the termination of the three 345 kV line circuits. The substation bus will be 138 kV, as can be seen in Figure 2-8. All other details will be similar to that described for the Fairbanks substation (Section 2.2.7).





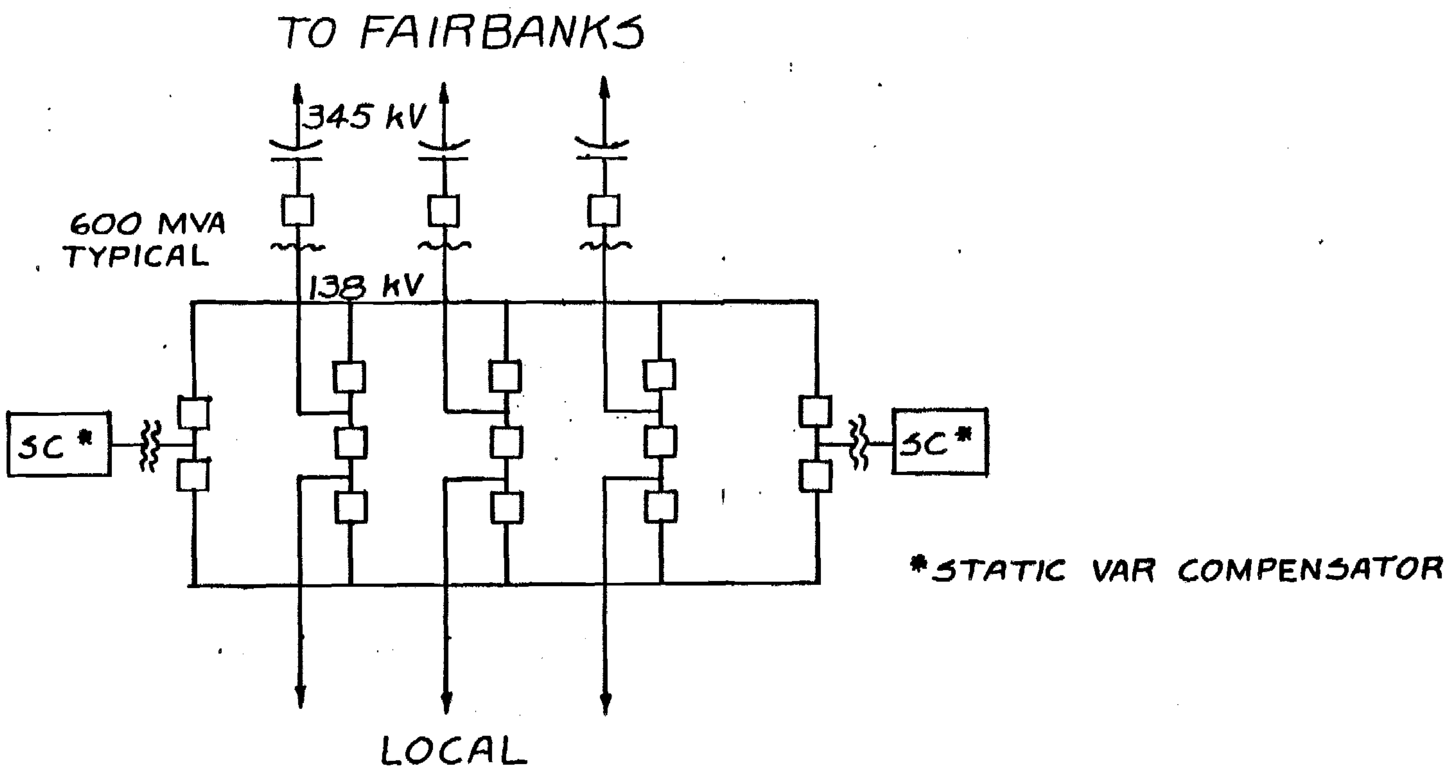
ALASKA POWER AUTHORITY

NORTH SLOPE GAS
FEASIBILITY STUDY

NORTH SLOPE POWER GENERATION
MEDIUM LOAD FORECAST
TYPICAL THREE LINE
SWITCHING STATION SCHEMATIC

FIGURE 2-7

EBASCO SERVICES INCORPORATED



LEGEND

GENERATOR

OR TRANSFORMER

CIRCUIT BREAKER

REACTOR

CAPACITOR

ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

NORTH SLOPE POWER GENERATION

MEDIUM LOAD FORECAST

ANCHORAGE SUBSTATION SCHEMATIC

FIGURE 2-8

EBASCO SERVICES INCORPORATED

2.3 COST ESTIMATES

2.3.1 Construction Costs

2.3.1.1 Power Plant

To support the derivation of total systems costs which are presented in Section 2.3.4, order-of-magnitude investment costs were developed for the major bid lines items common to a 77 MW (ISO conditions) natural gas fired simple cycle combustion turbine and a 220 MW (ISO conditions) natural gas fired combined cycle plant. These costs are presented in Tables 2-4 and 2-5. The costs represent the total investment for the first unit to be developed at the site. Additional simple cycle units will have an estimated investment cost of $53,560,000 while additional combined cycle units will have an estimated investment cost of $218,820,000. The cost differential for additional units is due to significant reductions in line items 1 and 15, improvements to Site and Off-Site Facilities, and reductions in Indirect Construction Cost and Engineering and Construction Management.

For the North Slope power generation scenario only simple cycle unit costs have been used in the total system cost analysis (Section 2.3.4). Combined cycle costs were developed to support the cost sensitivity analysis performed in conjunction with the system planning studies (Appendix B).

2.3.1.2 North Slope to Fairbanks Transmission Line

Transmission line order-of-magnitude investment cost estimates for the North Slope to Fairbanks connection are presented in Table 2-6. These estimates are based on two 500 kV lines of 1400 MW capacity with series compensation, and two intermediate switching stations.

TABLE 2-4

ORDER OF MAGNITUDE INVESTMENT COSTS
77 MW SIMPLE CYCLE COMBUSTION TURBINE
(January, 1982 Dollars)

Description[1]	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
1. Improvements to Site	385	4,800	5,185
2. Earthwork and Piling	605	1,710	2,315
3. Circulating Water System	0	0	0
4. Concrete	25	450	475
5. Structural Steel Lifting Equipment, Stacks	675	1,230	1,905
6. Buildings	4,625	1,710	6,335
7. Turbine Generator	11,200	2,700	13,900
8. Steam Generator and Accessories	0	0	0
9. Other Mechanical Equipment	460	985	1,445
10. Piping	200	2,100	2,300
11. Insulation and Lagging	30	450	480
12. Instrumentation	100	300	400
13. Electrical Equipment	1,500	10,800	12,300
14. Painting	5	90	95
15. Off-Site Facilities[2]	500	9,000	9,500
SUBTOTAL	$20,310	$36,325	$56,635
Freight Increment			1,015
TOTAL DIRECT CONSTRUCTION COST			$57,650
Indirect Construction Cost			3,505
SUBTOTAL FOR CONTINGENCIES			61,155
Contingencies (15%)			9,175
TOTAL SPECIFIC CONSTRUCTION COST			70,330
Engineering and Construction Management			2,300
TOTAL CONSTRUCTION COST			$72,630

1/ The following items are not addressed in the plant investment pricing: laboratory equipment, switchyard and transmission facilities, spare parts, land or land rights, and sales/use taxes.

2/ Costs for construction camp and construction workforce travel included in Construction Labor category.

TABLE 2-5

ORDER OF MAGNITUDE INVESTMENT COSTS
220 MW COMBINED CYCLE PLANT
(January, 1982 Dollars)

	Description[1/]	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
1.	Improvements to Site	385	4,800	5,185
2.	Earthwork and Piling	1,860	5,460	7,320
3.	Circulating Water System	0	0	0
4.	Concrete	100	2,160	2,260
5.	Structural Steel Lifting Equipment, Stacks	900	2,400	3,300
6.	Buildings	12,575	4,560	17,135
7.	Turbine Generator	30,300	10,500	40,800
8.	Steam Generator and Accessories	9,600	18,000	27,600
9.	Other Mechanical Equipment	5,625	11,705	17,330
10.	Piping	1,470	12,000	13,470
11.	Insulation and Lagging	290	2,880	3,170
12.	Instrumentation	1,700	1,200	2,900
13.	Electrical Equipment	4,500	36,000	40,500
14.	Painting	25	360	385
15.	Off-Site Facilities[2/]	500	9,000	9,500
	SUBTOTAL	$69,830	$121,025	$190,855
	Freight Increment			3,490
	TOTAL DIRECT CONSTRUCTION COST			$194,345
	Indirect Construction Cost			8,760
	SUBTOTAL FOR CONTINGENCIES			203,105
	Contingencies (15%)			30,465
	TOTAL SPECIFIC CONSTRUCTION COST			233,570
	Engineering and Construction Management			7,000
	TOTAL CONSTRUCTION COST			$240,570

1/ The following items are not addressed in the plant investment pricing: laboratory equipment, switchyard and transmission facilities, spare parts, land or land rights, and sales/use taxes.

2/ Costs for construction camp and construction workforce travel included in Construction Labor category.

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TABLE 2-6

ORDER OF MAGNITUDE INVESTMENT COSTS
NORTH SLOPE TO FAIRBANKS TRANSMISSION SYSTEM
(January 1982 Dollars)

Description 1/	Material ($1000)	Construction 2/ Labor ($1000)	Total Direct Cost ($1000)
Switching Stations	33,335	26,100	59,435
Substations	58,655	44,941	103,596
Energy Management System	12,900	12,000	24,900
Steel Towers and Fixtures	822,212	873,012	1,695,224
Conductors and Devices	63,962	149,760	213,722
Clearing	0	85,200	85,200
SUBTOTAL	$991,064	$1,191,013	$2,182,077
Land and Land Rights 3/			36,000
Engineering and Construction Management			152,750
TOTAL CONSTRUCTION COST			$2,370,827

1/ The investment costs reflect two 500 kV lines, 1400 MW capacity with series compensation and two intermediate switching stations. A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes have not been included.

2/ Construction camp facilities and services are included in the Construction Labor cost category.

3/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

2.3.1.3 Fairbanks to Anchorage Transmission Line

Transmission line order-of-magnitude investment cost estimates for the Fairbanks to Anchorage connection are presented in Table 2-7. These estimates are based on two new 345 kV lines, in parallel with series compensation and an intermediate switching station. The investment cost estimates also reflect upgrading from 138 kV to 345 kV of the Willow-Anchorage and Healy-Fairbanks segments of the existing grid.

2.3.2 Operating and Maintenance Costs

2.3.2.1 Power Plant

The power plant operating and maintenance (O&M) costs were derived to support the system planning studies (Appendix B). They reflect a review of figures from previous Railbelt studies, operation of other utilities, and salary requirements and expendable materials. The O&M costs for this scenario are estimated to be $0.0063 per killowatt hour (6.3 mils/kWh).

2.3.2.2 Transmission Line Systems

Annual operating and maintenance costs (January 1982 dollars) have been developed for the scenario's required transmission line facilities and total $35 million per year. These costs should be viewed as an annual average over the life of the system. Actual O&M costs should be less initially, and increase with time.

2.3.3 Fuel Costs

For the economic analyses which follow fuel costs were treated as zero. This approach permits fuel cost and fuel price escalation to be treated separately; and makes possible subsequent sensitivity analyses of the Present Worth of Costs for this scenario based upon a range of fuel cost and cost escalation assumptions.

TABLE 2-7

ORDER OF MAGNITUDE INVESTMENT COSTS
FAIRBANKS TO ANCHORAGE TRANSMISSION SYSTEM
(January 1982 Dollars)

Description[1]	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Switching Station	14,112	12,445	26,557
Substations	62,308	41,716	104,024
Energy Management Systems	12,300	10,960	23,260
Steel Towers and Fixtures	216,495	305,085	521,580
Conductors and Devices	33,678	78,361	112,039
Clearing	0	83,144	83,144
SUBTOTAL	$338,893	$531,711	$870,604
Land and Land Rights[2]	0	0	27,600
Engineering and Construction Management			60,950
TOTAL CONSTRUCTION COST			$959,154

1/ The investment costs reflect two new 345 kV lines, 1400 MW capacity with series compensation and an intermediate switching station, and upgrading of the Willow-Anchorage and Healy-Fairbanks segments of the existing grid to 345 kV.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

2.3.4 Total System Costs

The total system for the North Slope scenario, medium load forecast, consists of simple cycle gas turbines and an extensive transmission line system. No gas conditioning facilities or pipeline are required. Total annual systems costs reflect the relative simplicity of this system.

The methodology and assumptions utilized to derive the systems' costs which are presented below have been previously described in the Report on Systems Planning Studies (Appendix B). This methodology is consistent with previous studies of electric generating scenarios for the Railbelt, specifically Acres American, Inc. (1981), Susitna Hydroelectric Project Feasibility Report and Battelle (1982), Railbelt Electric Power Alternatives Study.

Annual capital costs for the system are presented in Table 2-8. Annual non-fuel operating and maintenance costs are presented in Table 2-9. These escalate at a rate of 2 percent/year above inflation. Total annual systems costs are then summarized in Table 2-10.

For scenario comparisons, the present worth of total annual costs for the North Slope medium load forecast has been calculated. Assuming a 3 percent discount rate and excluding fuel costs, the 1982 present worth of costs is $3.7 billion. The values are in 1982 dollars.

2.4. ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATIONS

Development of a gas fired simple cycle combustion turbine facility at the North Slope and transmission facilities to bring the energy to the Railbelt region will engender a variety of significant environmental effects. Precise quantification of environmental impacts will require more detailed site-specific analysis. However, most major potential

TABLE 2-8

TOTAL ANNUAL CAPITAL EXPENDITURES
NORTH SLOPE POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)1/

Calendar Year	Electricity Generation2/ Unit A	Unit B	Transmission Line	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	0.	0.
1986	0.	0.	0.	0.
1987	0.	0.	0.	0.
1988	0.	0.	0.	0.
1989	0.	0.	1,803.30	1,803.3
1990	0.	0.	418.45	418.5
1991	19.07 3/	0.	823.50	842.6
1992	53.56	0.	334.76	388.3
1993	0.	0.	0.	0.
1994	53.56	0.	0.	53.6
1995	53.56	0.	0.	53.6
1996	53.56	0.	0.	53.6
1997	53.56	0.	0.	53.6
1998	0.	0.	0.	0.
1999	53.56	0.	0.	53.6
2000	0.	0.	0.	0.
2001	53.56	53.56	0.	107.1
2002	0.	0.	0.	0.
2003	53.56	0.	0.	53.6
2004	53.56	53.56	0.	107.1
2005	53.56	0.	0.	53.6
2006	53.56	0.	0.	53.6
2007	53.56	0.	0.	53.6
2008	0.	0.	0.	0.
2009	53.56	0.	0.	53.6
2010	0.	0.	0.	0.
Total	$715.	$107.	$3,380.	$4,202.

1/ Values as calculated are shown for purposes of reproducibility only, and should not be taken to imply the indicated accuracy of significant figures.

2/ Unit A refers to first unit built in a given year and Unit B to the second unit built.

3/ Construction of campsite and site preparation for all units.

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TABLE 2-9

TOTAL ANNUAL NON-FUEL O&M COSTS
NORTH SLOPE POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generation	Transmission System	Total
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	0.	0.	0.
1990	0.	0.	0.
1991	0.	0.	0.
1992	0.	0.	0.
1993	3.767	35.0	38.8
1994	3.767	35.0	38.8
1995	7.535	35.0	42.5
1996	11.334	35.0	46.3
1997	15.063	35.0	50.1
1998	18.831	35.0	53.8
1999	18.831	35.0	53.8
2000	22.661	35.0	57.7
2001	22.598	35.0	57.6
2002	30.133	35.0	65.1
2003	30.133	35.0	65.1
2004	33.995	35.0	69.0
2005	36.414	35.0	71.4
2006	38.134	35.0	73.1
2007	39.848	35.0	74.8
2008	41.567	35.0	76.6
2009	43.281	35.0	78.3
2010	45.001	35.0	80.0
Total	$463.	$630.	$1,093.

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TABLE 2-10

TOTAL ANNUAL SYSTEMS COST
NORTH SLOPE POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Capital Expenditures	O & M Costs	Total Expenditures
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	1,803.3	0.	1,803.3
1990	418.5	0.	418.5
1991	842.6	0.	842.6
1992	388.3	0.	388.3
1993	0.	38.8	38.8
1994	53.6	38.8	92.4
1995	53.6	42.5	96.1
1996	53.6	46.3	99.9
1997	53.6	50.1	103.7
1998	0.	53.8	53.8
1999	53.6	53.8	107.4
2000	0.	57.7	57.7
2001	107.1	57.6	164.7
2002	0.	65.1	65.1
2003	53.6	65.1	118.7
2004	107.1	69.0	176.1
2005	53.6	71.4	125.0
2006	53.6	73.1	126.7
2007	53.6	74.8	128.4
2008	0.	76.6	76.6
2009	53.6	78.3	131.9
2010	0.	80.0	80.0
Total	$4,202.	$1,093.	$5,295.
Present Worth @ 3%	$3,156.	$600.	$3,757.

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environmental concerns related to this scenario have been identified, and may be categorized as follows:

1. Air Resource Effects
2. Water Resource Effects
3. Aquatic Ecosystem Effects
4. Terrestrial Ecosystem Effects
5. Socioeconomic Effects

Each of these subject areas is discussed in the following subsections. Power plant characteristics related to each of these subject areas is summarized in Table 2-11.

2.4.1 Air Resource Effects

Development of the North Slope generating facility may be governed in large part by air quality considerations. The federal Clean Air Act and the Alaska rules for air quality control require the generating facility to meet both atmospheric emission and ambient air quality standards. Emission standards are defined in terms of New Source Performance Standards (NSPS) and Best Available Control Technology (BACT). NSPS apply generically to combustion turbines, and set a ceiling of emission levels that cannot be exceeded. Because gas-fired power plants are relatively clean, NSPS levels do not pose a constraint to the development of this generating facility. BACT requirements are determined on a case-by-case basis, taking into account energy, environmental, and economic impacts, but are never less stringent than NSPS.

The Prevention of Significant Deterioration (PSD) program protects relatively clean areas from undergoing substantial degradation through ambient air quality standards. The PSD increments for particulates and sulfur dioxide have not been exhausted on the North Slope, and

TABLE 2-11

ENVIRONMENT RELATED FACILITY CHARACTERISTICS
SIMPLE CYCLE COMBUSTION TURBINES

NORTH SLOPE POWER GENERATION - MEDIUM LOAD FORECAST

Air Environment	
Emissions	
Particulate Matter	Below standards
Sulfur Dioxide	Below standards
Nitrogen Oxides	Emissions variable within standards - dry control techniques would be used to meet calculated NO_x standard of 0.014 percent of total volume of gaseous emissions. This value calculated based upon new source performance standards, facility heat rate, and unit size.
Physical Effects	Maximum structure height of 50 feet
Water Environment	
Plant Water Requirements	50 GPM
Plant Discharge Quantity, Including Sanitary Waste and Floor Drains	Less than 50 GPM
Land Environment	
Land Requirements	
Plant and Switchyard	90 acres
Construction Camp	5 acres
Socioeconomic Environment	
Construction Workforce	Approximately 200 personnel at peak construction (power plant only)
Operating Workforce	Approximately 200 personnel employed in the year 2010 (power plant only)

therefore do not constrain development. PSD increments for nitrogen oxides, the major pollutant from combustion turbines, have not been established. However, general PSD requirements dictate that Best Available Control Technology be used to reduce nitrogen emission levels.

In the case of combustion turbines, BACT usually consists of using water or steam injection techniques to control emission levels by reducing combustion temperatures. Unfortunately, water or steam injection in the Prudhoe Bay area causes undesirable levels of ice fog. Furthermore, water or steam injection requires fresh water supplies that are generally not economically available on the North Slope. For these reasons, air quality regulatory agencies have not defined BACT for the North Slope to include using water or steam injection to control nitrogen oxides. Imposition of the requirement for water or steam injection would add substantial costs and significantly decrease the relative feasibility of this scenario. For the purposes of this study it is assumed that water injection for NO_x control would not be required.

Even with no water injection requirement, air quality regulations would not be likely to hamper installation of a gas-fired power plant in the Prudhoe Bay area. However, a judicious siting effort would still be necessary to avoid compounding any air pollution problems from existing facilities.

The construction of two 500 kV transmission lines between the North Slope and Fairbanks would result in temporary air quality impacts. The use of heavy equipment and other construction vehicles would generate fugutive dust and exhaust emissions. Slash burning of material to clear the right-of-way would produce emissions. The impacts from these construction-related activities are expected to be small because the emissions would be widely dispersed and occur in unpopulated or sparsely populated areas.

The long term impacts from operation of the transmission lines are expected to be negligible. The transmission lines would generate small amounts of ozone which would be undetectable at ground levels and would not cause problems with nearby vegetation.

The air quality impacts of constructing the transmission lines from Fairbanks to Anchorage would result from activities similar to those mentioned above. The impacts are expected to be of approximately the same magnitude, although the amount of slash material to be burned would be greater within this corridor and would be within proximity to more populated areas.

The long term impacts from transmission line operations would be similar to those of the Prudhoe Bay-Fairbanks transmission line corridor.

2.4.2 Water Resource Effects

The principal effects of the proposed generating facility on the water resources of the Prudhoe Bay area include consumptive withdrawals from freshwater sources (existing lakes) for potable supplies and miscellaneous uses such as equipment wash-down. Because the generating station will require minor volumes of water and will be served by existing waste treatment facilities in the area, water resources effects associated with these uses will not be significant.

For the medium load forecast, the site must have access to approximately 50 gpm. This water will be taken from a nearby freshwater lake of sufficient size so that the lake level and hydrologic balance is not significantly affected.

Transmission line construction between the North Slope and Fairbanks may impact the quality of surface water resources through erosion caused by land disturbance, but has little or no impact on water supplies. Erosion control, especially in steep terrain or areas of susceptible soils, will be a major requirement imposed by permits issued for right-of-way clearing and construction of the transmission and related facilities, such as access roads. For example, the BLM land use plan for the Prudhoe Bay-Fairbanks Utility Corridor (BLM 1980) within which the transmission facilities would be routed, specifically requires protection of stream banks and lake shores by restricting activities to prevent loss of riparian vegetation.

Construction activities of the transmission lines between Fairbanks and Anchorage would result in temporary impacts. The transmission lines would cross several large rivers and numerous creeks, resulting in temporary stream siltation, bank erosion, and the potential for accidental spillage of lubricating oils and other chemicals into the watercourses. Construction equipment working along streambanks or crossing smaller streams could cause direct siltation of the watercourse or cause indirect stream bank erosion and siltation through the removal of vegetation and disturbance of permafrost. The effects of siltation could alter stream channels, fill ponds, or damage aquatic flora or fauna.

Significant effects on watercourses may be prevented by keeping construction activities out of channels and away from stream banks. Measures that could be taken to avoid impacts include a set back of 200 feet from watercourses for transmission structures as well as establishment of a buffer strip along major watercourses to minimize disturbance of vegetation and soils by construction equipment. In cases where watercourses must be crossed by construction equipment, such crossings could be conducted either during cold periods when the stream is frozen or in a manner to limit pollution or siltation. The use of helicopters to erect the towers will help to minimize overall construction impacts, since ground access requirements will be minimized.

2.4.3 Aquatic Ecosystem Effects

The major aquatic ecosystems of the North Slope area include the marine environment of the Beaufort Sea, the freshwater environments of the Sag and Put Rivers and their tributaries, and estuarine habitats at the rivers' mouths. Shallow lakes in the area do not support fish because of complete freezing in the wintertime. Deeper lakes may contain resident species such as stickleback, but in general, knowledge of these lakes is presently limited. In the rivers and estuaries, two groups of fish are considered important: river fish such as the grayling, and anadromous fish such as the the Arctic char and cisco. The anadromous species descend local rivers at ice-breakup to feed in the shallow littoral and sublittoral zone of the Beaufort Sea. They ascend these rivers in the autumn and overwinter in deep pools. These fish do not appear to undertake extensive migrations up the Sag or Put Rivers.

These fishery resources could be affected by construction and operation of a water supply intake, pipeline and access road construction, gravel mining in rivers which could affect overwintering and general habitat quality of the fish, and the need to cross larger river channels which could interfere with fish passage. The latter item may require the use of special culverts to maintain migratory routes. Each of these potential effects would be analyzed on a site-specific basis, and detailed impact avoidance or mitigation measures developed.

Aquatic ecosystems within the transmission line corridor will also require protection during project construction. Between the North Slope and Fairbanks, the transmission lines may cross as many as 150 waterbodies which are utilized by fish for migration, rearing, spawning, and/or wintering. Siting should avoid or minimize impact to spawning areas in approximately 35 waterbodies and to wintering areas in approximately 15 waterbodies. Information regarding specific waterbodies of concern is presented in Appendix C, Report on Facility Siting and Corridor Selection.

Counterpoise (ground cable) construction may require excavation in streambeds; this activity must be carefully planned (both spatially and temporally) and monitored in accordance with individual permit requirements. Conditions vary along the corridor, so that environmental protection stipulations imposed by the regulatory agencies will tend to be site-specific.

The transmission line corridor between Fairbanks and Anchorage makes as many as 100 crossings of rivers and streams and comes within one mile of numerous lakes and ponds. All of these waterbodies are important habitat for endemic and anadromous fisheries. Impacts to fisheries such as increased runoff and sedimentation could occur through clearing of the right-of-way and crossing of watercourses by construction equipment. The introduction of silt into streams can delay hatching, reduce hatching success, prevent swimup, and produce weaker fry. Siltation also reduces the benthic food organisms by filling in available intergravel habitat.

The potential adverse impacts can be reduced or eliminated through construction scheduling. Construction of the transmission lines during the winter would minimize erosion since the snow protects low vegetative cover that stabilizes soils. Ice bridges could be used by construction equipment for crossing spawning areas, where possible. Otherwise, where equipment would move through watercourses, construction could occur during periods when there are no eggs or fry in the gravel.

2.4.4 Terrestrial Ecosystem Effects

The North Slope area and specifically the river delta areas provide a variety of habitats that are important to a diversity of plants and animals. Project related impacts which require special consideration include: 1) direct habitat elimination through the construction of project facilities, access roads, and gravel borrow areas; 2) indirect habitat elimination resulting from access roads which impede drainage or which generate significant traffic related dust; and 3) restrictions to large mammal movements, especially caribou.

Construction of the powerplant, switchyard, construction camp and related access roads will disturb approximately 65 acres of land. All construction equipment should be restricted to areas covered with a gravel pad. Tundra adjacent to the generating facility should not be disturbed.

Because the generating facility will be located within the Prudhoe Bay industrial complex, terrestrial habitat impacts engendered by this project will be an added increment to those which have already occurred as a result of oil field development. Final siting efforts should include evaluation of the factors listed above, and will be the mechanism through which highly significant terrestrial impacts can be avoided, particularly the indirect impacts and migratory blockages. The direct impacts of habitat removal due to facility construction are generally unavoidable, but can be minimized through careful site planning and construction management.

Construction of the transmission line facilities will require vegetative clearing in forested areas. Clearing should be restricted to the following categories of vegetation:

1. Trees and brush which may fall into a structure, guy, or conductor

2. Trees and brush into which a conductor may blow during high winds.

3. Trees and brush within 20 feet of a conductor, and trees within 55 feet of the line centerline.

4. Trees or brush that may interfere with the assembly and erection of a structure.

Between the North Slope and Fairbanks, much of the area south of Nutirwik Creek will require clearing of trees within the right-of-way. Because two lines will be built and trees within 55 feet of the line will be cleared, the total width of cleared vegetation will be 220 feet. Over the length of the line, approximately 7000 acres will be cleared.

The transmission line corridor passes through a wide variety of terrestrial ecosystems, and is adjacent to several major federal land areas which have been protected, in part, for their wildlife values. The Bureau of Land Management (BLM) land use plan for the Utility Corridor (BLM 1980) has identified several areas as containing critical wildlife habitat. Specific management restrictions have not as yet been formulated; however, measures may be required for a number of areas. Details regarding these areas are given in Appendix C.

The land use plan also specifically requires protection of raptor habitat and critical nesting areas. Protection of crucial raptor habitats preserves the integrity of raptor populations and maintains predator-prey relationships.

Facilities and long term habitat alterations are prohibited within one mile of peregrine falcon nest sites unless specifically authorized by the U.S. Fish and Wildlife Service, because of the endangered species status of the peregrine falcon.

As the transmission line corridor generally avoids known nesting areas, the restriction may only apply to material sites. Information regarding specific raptor nesting areas and siting restrictions are presented in Appendix C.

It is unlikely that the transmission line would be sited in or near important Dall sheep habitat. A primary concern is aircraft traffic over critical wintering, lambing, and movement areas. Moose winter browse habitat in the Atigun and Sag River valleys is limited to areas of tall riparian willow. Habitat has already been eliminated by the construction of TAPS and further destruction of this habitat should be avoided or minimized. The willow stand along Oksrukuyik Creek, in particular, should not be disturbed.

System design must allow free passage for caribou, but these animals should not be a major consideration in siting. Carnivore/human interaction is a major concern in facilities design and in construction and operations methods, but not in siting considerations.

Line routing and tower siting should avoid or minimize disturbance of the treeline white spruce stand at the head of the Dietrich Valley, which has been nominated for Ecology Reserve status.

For the Fairbanks to Anchorage transmission line approximately 80 percent of the corridor is located in forested areas (Commonwealth Associates, 1982). Assuming two additional lines are built and the Intertie is extended, a total of about 8700 acres will be cleared. The principal impacts associated with clearing a right-of-way and construction of the transmission line are the alteration of existing habitats and subsequent disruption of wildlife species that use those habitats and disturbance to indigenous fauna and bird populations.

Most big game species would relocate during the construction of the transmission lines. The construction schedule should be flexible so as to avoid construction near calving and denning sites. The moose, which adapts to many different habitat types, would establish a subclimax community in the cleared right-of-way. The distribution of caribou is limited along the transmission line corridor but those that do occur in the vicinity of the right-of-way would be displaced. The caribou, however, generally utilize habitats with low vegetative cover, resulting in little alteration of caribou habitat.

Grizzly and black bears would relocate to avoid construction activity along the right-of-way, except where construction occurs near a den site during winter dormancy. Construction activity near denning areas should be avoided from October 1 through April 30. The alteration of habitats could temporarily affect bear use of the right-of-way but this impact is expected to be relatively short-term.

Wolves within the vicinity of the right-of-way would also be displaced during construction of the transmission line. While these impacts would be temporary, long term impacts would occur to the wolf if their principal prey species, such as caribou, sheep, and moose were adversely affected.

Dall sheep occur only at the northern end of the transmission line corridor and would be impacted only minimally by construction activities. The use of helicopters to construct the lines in the Moody and Montana Creek drainages could severely disturb sheep in the vicinity of Sugarloaf Mountain.

The impact to the regional populations of any of the small game species is expected to be negligible. Small game species are expected to relocate during construction activities and re-invade the right-of-way once construction is over.

In heavily forested areas along the corridor, the right-of-way clearing could provide an improved habitat for most of the small game species that utilize subclimax communities.

Migratory waterfowl are susceptible to disturbance from construction activities from mid-April to the end of September when they are nesting and brood rearing. Construction activities should be restricted from May through August in areas with active trumpeter swan nesting territories. Collisions with transmission lines, guywires, and overhead groundwires are another potential impact. To date, however, the levels of avian mortality from line collision have not been biologically significant (Beaulaurier et al 1982).

Furbearers are not expected to be greatly affected by construction activities except during the initial right-of-way clearing. Most furbearers will either adapt to the presence of the cleared right-of-way or undergo short-term impacts. The maintenance of a shrub community in the right-of-way will reduce the loss of individuals.

The impacts on nongame mammals and birds are expected to be insignificant. Some small mammals and nongame birds would undergo population shifts during construction activities but populations are expected to recover within one to two reproductive seasons. Raptors may lose some habitat as a result of clearing. Benefits of a cleared right-of-way could occur as some raptors could find that it provides hunting habitat or hunting perches not previously available.

2.4.5 Socioeconomic and Land Use Effects

Potential socioeconomic and land use effects of the North Slope scenario include both temporary impacts related to the influx of workers and permanent land use impacts.

Since the generating plant would be located within the Prudhoe Bay/Deadhorse industrial complex, the in-migrating work force would not significantly affect the social and economic structure of the region. The work force requirements are small in comparison to the existing size of the transient workforce in the Prudhoe Bay region. For 5 months of each year during the period 1993 through 2010 a maximum of 200 employees will be needed to assemble the prefabricated units of the plant. Housing facilities would be provided for the employees at the adjacent construction camp. During off-work periods, the majority of the employees would spend time outside of the borough. The operations work force is expected to be approximately 150 and will reside in the labor camp. The spending of wages earned by the employees within the North Slope Borough is expected to be minimal due to the transience of the work force.

The use of land for an electrical generating plant would be compatible with the land uses of the industrial enclave. The Coastal Zone Management Program for the North Slope Borough has delineated zones of preferred development. Permanent facilities are allowed in the industrial development zone, consisting of the existing Prudhoe Bay/Deadhorse complex and the Pipeline/Haul Road Utility corridor (North Slope Borough 1978). The generating plant would be located within the preferred development zone.

Within the Prudhoe Bay/Deadhorse complex, the plant would be located to minimize interferences with existing or planned facilities, including buildings, pipelines, roads, and transmission lines. Land ownership and lease agreements will limit the land available for the electrical generating facility.

Socioeconomic and land use impacts related to construction and operation of transmission facilities between Prudhoe Bay and Fairbanks will be strictly controlled as a result of the guidelines and constraints for development within the designated utility corridor. Construction employees would be housed either at the pump stations or the permanent camp facilities constructed for the trans-Alaska oil pipeline. Construction activities would be consistent with the land use criteria developed by the BLM. The BLM has prepared land use plans for the utility corridor between Sagwon Bluffs and Washington Creek. Road and highway crossings would be minimized, and areas of existing or planned mineral development would be avoided.

Permanent facilities would be consolidated at carefully selected locations in the vicinity of Livengood Camp, Yukon Crossing, Five Mile Camp, Prospect, Coldfoot, Chandalar, and Pump Station #3. Existing facilities such as work pads, highways, access roads, airports, material sites and communications would be used to the maximum extent possible.

The schedule for constructing the transmission lines is approximately 3 years with activities occurring mainly during the autumn and spring of each year. A peak work force of 2400 employees would be required during the first year of construction when the pads would be built, and in subsequent years the total work force would be substantially reduced to approximately 500 in the second year, 600 in the third year, and 670 in the final year. It is expected that these workers will be hired from the Anchorage and Fairbanks union hiring halls.

Development of additional transmission facilities between Fairbanks and Anchorage would engender potentially more significant socioeconomic and land use impacts, since this segment is more populated and subject to future land use development. Temporary campsites would be provided to house the work crews at locations accessible by the Parks Highway or the Alaska Railroad. The work force requirements would be lower for this corridor because pads would not need to be constructed. The schedule for constructing the transmission lines is approximately 22 months. A peak work force of approximately 520 employees would be required during the last 6 months and the average work force would be approximately 300. These estimates do not include the helicopter crews. It is assumed that the project would utilize the labor pools of Fairbanks and Anchorage.

Impacts to local communities would be minimized through careful siting of the temporary work camps. It is expected that the work camps would be self-contained in order to keep to a minimum interaction between the construction workers and the local residents. The project is expected to have minor primary economic benefits since few, if any, residents would be employed on the project.

Land use impacts could include encroachment of the project on residential areas as well as preclude future residential development land available for homesteading. The most significant potential impact would be the crossing of recreation lands and the subsequent effects on recreation and aesthetic values these lands are meant to preserve.

SCENARIO I
NORTH SLOPE POWER GENERATION
LOW LOAD

The potential aesthetic impacts of the proposed new and additional transmission facilities are significant. The cumulative effects of these facilities and previous linear developments (e.g. TAPS) could result in significant degradation of the aesthetic character of pristine wilderness landscapes. The visibility of the transmission lines from existing travel routes (Dalton Highway, Parks Highway, etc.) will vary depending on distance, topography and intervening vegetation. Special care would be taken in selecting final route alignments in proximity to areas of special visual significance, such as national parks, or high visual sensitivity, such as areas within the viewing range of motorists on the Parks Highway. In locations where visual impacts cannot be avoided through careful routing or tower spotting, mitigating measures, such as the use of non-reflective paint or vegetative screening, can be employed.

3.0 NORTH SLOPE POWER GENERATION

LOW LOAD FORECAST

The North Slope power generation scenario, under the low load forecast, is conceptually the same as the medium growth case, except that units are phased in at a slower rate. By the year 2010, eight simple cycle combustion turbine units are required to produce 728 MW. The electric transmission system requires two 500 kV lines; however, series capacitors are not required to ensure system stability. Total system cost is estimated to be $3.3 billion, with annual operation and maintenance costs of $0.7 billion. The present worth of these costs excluding fuel costs is $2.7 billion as of 1982. Environmental effects of the project are substantial, but would not preclude construction.

Information presented in this section is designed to highlight only those conditions which are significantly different from those of the medium load forecast presented in Chapter 2.

3.1 POWER PLANT

This scenario requires eight 91 MW simple cycle gas turbines to satisfy the low load forecasted demand. The first of these will go on line in 1996 and the eighth in 2010. Additions are summarized in Table 3-1 and scenario details are addressed in Appendix B. Annual fuel requirements for power generation will start at 6.60 BCFY in 1996 and grow to 47.2 BCFY in 2010. The maximum potential firing rate in 2010 will be approximately 1.33 x 10^5 SCFM. Fuel requirements on an annual basis are also shown in Table 3-1.

With the exception of the switchyard, all details of individual plant items are identical to those described for the medium load case in Section 2.1. The switchyard for this scenario differs from the medium forecast design (Figure 2-3) in that there are no series capacitors

TABLE 3-1

NEW CAPACITY ADDITIONS AND FUEL REQUIREMENTS
NORTH SLOPE POWER GENERATION - LOW LOAD FORECAST

Year	New Capacity (MW) (Increment/Total)	Gas Required[1/] (MMSCFY)
1990	0/0	0
1991	0/0	0
1992	0/0	0
1993	0/0	0
1994	0/0	0
1995	0/0	0
1996	91/91	6,596.6
1997	91/182	13,149.1
1998	0/182	13,149.1
1999	0/182	13,149.1
2000	0/182	13,182.1
2001	0/182	13,149.1
2002	91/273	19,723.7
2003	91/364	26,287.3
2004	0/364	26,364.2
2005	182/546	39,216.5
2006	0/546	39,436.4
2007	0/546	39,436.4
2008	91/637	44,284.9
2009	0/637	45,736.1
2010	91/728	47,187.4

[1/] Values as calculated are shown for reproducibility only, and do not imply accuracy beyond the 100 MMSCFY level.

installed and the facility is smaller in size. The circuit diagram is shown in Figure 3-1. Only four 13.8/138 kV generator transformers are needed, and each transmission line circuit is supplied by only one 750 kVA 138/500 kV transformer. The initial installation is essentially the same as in Figure 2-4 except that the series capacitors are not required.

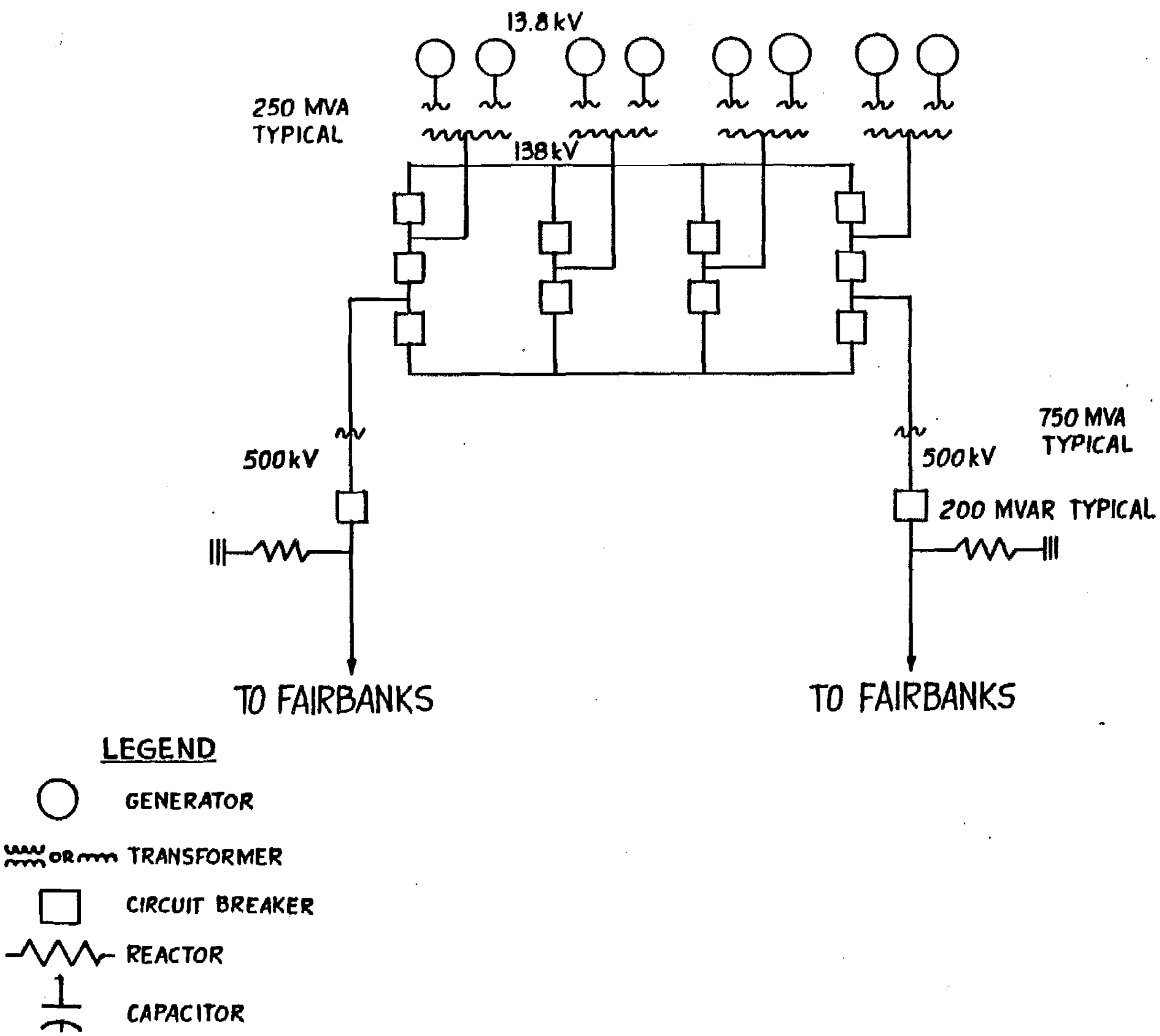
Personnel required for operation and maintenance will be less for this scenario than for the medium load forecast. Ten on-duty personnel will be required in 1996 for the first unit. This number will increase to approximately 35 on-duty personnel when 8 units are operating in 2010. The total two-shift, full year, work force would therefore range from 40 to 140 for the study period.

3.2 TRANSMISSION SYSTEM

The North Slope to Fairbanks, and the Fairbanks to Anchorage transmission systems for the low load forecast scenario do not differ significantly from the medium forecast designs. A voltage of 500 kV is cost effective for the line between the North Slope and Fairbanks; however, for this case, series capacitors will not be needed. For the Fairbanks-Anchorage section, two 345 kV lines with series compensation are sufficient. That is, one new 345 kV line will be constructed and the Healy-Fairbanks and the Willow-Anchorage segments of the existing grid will be upgraded from 138 kV to 345 kV.

The number and sizes of the intermediate switching stations remain unchanged. There are two such stations on the 500 kV line (without any series capacitors), at Galbraith Lake and at Prospect Camp. There is only one switching station on the 345 kV line from Fairbanks to Anchorage, but in this case it has to be at the midpoint of the line, i.e., some 30 miles north of the Devil's Canyon switchyard of the medium forecast scenario.

The substation at Fairbanks and Anchorage are slightly scaled down from those described in Section 2.3 and Figures 2-5 and 2-6.



ALASKA POWER AUTHORITY

NORTH SLOPE GAS
FEASIBILITY STUDY

NORTH SLOPE POWER GENERATION
LOW LOAD FORECAST
SUBSTATION ONE LINE SCHEMATIC

FIGURE 3-1

EBASCO SERVICES INCORPORATED

3.3 COST ESTIMATES

3.3.1 Construction Costs

The capital cost of each simple cycle gas turbine is the same as that presented in Section 2.3 for the medium load forecast.

The order of magnitude investment costs of the transmission line systems are presented in Table 3-2 and 3-3. Table 3-2 presents the estimates for two 500 kV, 700 MW capacity lines without series compensation, and two intermediate switching stations. Table 3-3 contains the estimates for one new 345 kV line, 700 MW capacity, with series compensation and an intermediate switching station, and the required upgrading of the Willow-Anchorage and Healy-Fairbanks transmission lines.

3.3.2 Operating and Maintenance Costs

Power plant operating and maintenance (O & M) costs are the same for both the medium and low load forecasts, 6.3 mils/kWh. Transmission line O & M costs are estimated to be $30 million per year. These costs should be viewed as an annual average over the life of the system. Actual O&M costs should be less initially and will increase with time.

3.3.3 Fuel Costs

For the economic analyses which follow fuel costs were treated as zero. This approach permits fuel cost and fuel price escalation to be treated separately; and makes possible subsequent sensitivity analyses of the Present Worth of Costs for this scenario based upon a range of fuel cost and cost escalation assumptions.

3.3.4 Total System Costs

The total system for the North Slope low load forecast, like the North Slope medium growth forecast, consists only of simple cycle combustion turbines and a transmission line system.

TABLE 3-2

ORDER OF MAGNITUDE INVESTMENT COSTS
NORTH SLOPE TO FAIRBANKS TRANSMISSION SYSTEM
(January 1982 Dollars)

Description 1/	Material ($1000)	Construction Labor 2/ ($1000)	Total Direct Cost ($1000)
Switching Stations	20,440	19,253	39,693
Substations	35,518	28,694	64,212
Energy Management System	12,900	12,000	24,900
Steel Towers and Fixtures	822,212	873,012	1,695,224
Conductors and Devices	63,962	149,760	213,452
Clearing	--	85,200	85,200
SUBTOTAL	$954,762	$1,167,919	$2,122,681
Land and Land Rights 3/			36,000
Engineering and Construction Management			148,600
TOTAL CONSTRUCTION COST			$2,307,281

1/ The investment costs reflect two 500 kV lines, 700 MW capacity without series compensation and two intermediate switching stations. A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes have not been included.

2/ Construction camp facilities and services are subsumed in the Construction Labor cost category.

3/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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TABLE 3-3

ORDER OF MAGNITUDE INVESTMENT COSTS
FAIRBANKS TO ANCHORAGE TRANSMISSION SYSTEM
(January 1982 Dollars)

Description 1/	Material ($1000)	Construction 2/ Labor ($1000)	Total Direct Cost ($1000)
Switching Station	8,857	8,414	17,271
Substation and Switching Station	32,958	30,872	63,830
Energy Management Systems	12,300	10,960	23,260
Steel Towers and Fixtures	129,214	182,083	311,291
Conductors and Devices	20,049	53,183	73,232
Clearing	--	41,572	41,572
SUBTOTAL	$203,378	$327,084	$530,456
Land and Land Rights 2/			14,400
Engineering and Construction Management			37,130
TOTAL CONSTRUCTION COST			$581,986

1/ The investment costs reflect one new 345 kV line, 700 MW capacity without series compensation and an intermediate switching station, and upgrading of the Willow-Anchorage and Healy-Fairbanks segments of the Intertie to 345 kV.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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The methodology and assumptions utilized to derive the systems' costs which are presented below have been previously described in the Report on Systems Planning Studies (Appendix B). This methodology is consistent with previous studies of electric generating scenarios for the Railbelt, specifically the Acres American, Inc. (1981), Susitna Hydroelectric Project Feasibility Report and Battelle (1982), Railbelt Electric Power Alternatives Study.

The annual capital expenditures are presented in Table 3-4. Annual non-fuel O&M costs are presented in Table 3-5. The summary of all annual costs in presented in Table 3-6. The 1982 present worth of costs for this scenario (in 1982 dollars) is $2.7 billion, exclusive of fuel costs.

3.4 ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATIONS

The power plant for the low load forecast will consist of 8 simple cycle units, in contrast to 15 units for the medium load forecast. Most environmental impacts will therefore be correspondingly smaller than the medium load forecast. Environment related power plant characteristics are summarized in Table 3-7.

Air emissions will be approximately one-half the medium growth value and will not pose constraining air quality problems. Approximately 25 gpm of fresh water will be pumped from a nearby lake to provide equipment wash-down and potable water supplies. Wastewater discharges will be less than 25 gpm and will be discharged to the existing facilities in the area.

Aquatic resources, as for the medium load forecast, will not be significantly affected. Plant acreage, including the construction camp and switchyard, will be approximately 65 acres, as compared to 95 acres for the medium load forecast. Terrestrial impacts, such as tundra disturbance and habitat elimination, are correspondingly less.

TABLE 3-4

TOTAL ANNUAL CAPITAL EXPENDITURES
NORTH SLOPE POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)1/

Calendar Year	Electricity Generated2/ Unit A	Unit B	Transmission Line	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	0.	0.
1986	0.	0.	0.	0.
1987	0.	0.	0.	0.
1988	0.	0.	0.	0.
1989	0.	0.	0.	0.
1990	0.	0.	0.	0.
1991	0.	0.	0.	0.
1992	0.	0.	1,540.1	1,540.1
1993	0.	0.	358.0	358.0
1994	19.07 3/	0.	704.6	723.7
1995	53.56	0.	286.4	340.0
1996	53.56	0.	0.	53.6
1997	0.	0.	0.	0.
1998	0.	0.	0.	0.
1999	0.	0.	0.	0.
2000	0.	0.	0.	0.
2001	53.56	0.	0.	53.6
2002	53.56	0.	0.	53.6
2003	0.	0.	0.	0.
2004	53.56	53.56	0.	107.1
2005	0.	0.	0.	0.
2006	0.	0.	0.	0.
2007	53.56	0.	0.	53.6
2008	0.	0.	0.	0.
2009	53.56	0.	0.	53.6
2010	0.	0.	0.	0.
TOTAL	$394.	$54.	$2,889.	$3,337.

1/ Values as calculated are shown for purposes of reproducibility only, and should not be taken to imply the indicated accuracy of significant figures.

2/ Unit A refers to the first unit built in a given year and Unit B to the second unit built.

3/ Construction of camp site and site preparation for all units.

TABLE 3-5

TOTAL ANNUAL NONFUEL OPERATING AND MAINTENANCE COSTS
NORTH SLOPE POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars))

Calendar Year	Electricity Generated	Transmission Line	Total
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	0.	0.	0.
1990	0.	0.	0.
1991	0.	0.	0.
1992	0.	0.	0.
1993	0.	0.	0.
1994	0.	0.	0.
1995	0.	0.	0.
1996	3.8	30.0	33.8
1997	7.5	30.0	37.5
1998	7.5	30.0	37.5
1999	7.5	30.0	37.5
2000	7.5	30.0	37.5
2001	7.5	30.0	37.5
2002	11.3	30.0	41.3
2003	15.1	30.0	45.1
2004	15.1	30.0	45.1
2005	22.6	30.0	52.6
2006	22.6	30.0	52.6
2007	22.6	30.0	52.6
2008	25.4	30.0	55.4
2009	26.2	30.0	56.2
2010	27.0	30.0	57.0
TOTAL	$229.	$450.	$679.

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TABLE 3-6

TOTAL ANNUAL COSTS
NORTH SLOPE POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars))

Calendar Year	Capital Expenditures	O & M Costs	Total Expenditures
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	0.	0.	0.
1990	0.	0.	0.
1991	0.	0.	0.
1992	1,540.1	0.	1,540.1
1993	358.0	0.	358.0
1994	723.7	0.	723.7
1995	340.0	0.	340.0
1996	53.6	33.8	87.4
1997	0.	37.5	37.5
1998	0.	37.5	37.5
1999	0.	37.5	37.5
2000	0.	37.5	37.5
2001	53.6	37.5	91.1
2002	53.6	41.3	94.9
2003	0.	45.1	45.1
2004	107.1	45.1	152.2
2005	0.	52.6	52.6
2006	0.	52.6	52.6
2007	53.6	52.6	106.2
2008	0.	55.4	55.4
2009	53.6	56.2	109.8
2010	0.	57.0	57.0
Total	$3,337.	$679.	$4,016.
Present Worth @ 3%	$2,345.	$360.	$2,705.

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TABLE 3-7

ENVIRONMENT RELATED POWER PLANT CHARACTERISTICS
NORTH SLOPE POWER GENERATION - LOW LOAD FORECAST

Air Environment	
Emissions	
Particulate Matter	Below standards
Sulfur Dioxide	Below standards
Nitrogen Oxides	Emissions variable within standards - dry control techniques would be used to meet calculated NO_x standard of 0.014 percent of total volume of gaseous emissions. This value calculated based upon new source performance standards, facility heat rate, and unit size.
Physical Effects	Maximum structure height of 50 feet
Water Environment	
Plant Water Requirements	25 GPM
Plant Discharge Quantity Including Sanitary Waste and Floor Drains	Less than 25 GPM
Land Environment	
Land Requirements	
Plant and Switchyard	60 acres
Construction Camp	5 acres
Socioeconomic Environment	
Construction Workforce	Approximately 115 personnel at peak construction
Operating Workforce	Approximately 140 personnel

Impacts associated with the transmission line from the North Slope to Fairbanks are identical to those discussed for the medium load forecast (Section 2.4). From Fairbanks to Anchorage only one line in addition to the Intertie will be necessary, in contrast to two new lines for the medium load forecast. Cleared acreage within the right-of-way will be approximately 5200 acres, as compared to 8700 acres for the medium load forecast. Impacts associated with vegetative clearing, including erosion, sedimentation, and habitat disturbance, are correspondingly less than those discussed in Section 2.4.

Construction of the project according to the low demand forecast would result in a smaller workforce than under the medium demand forecast as well as a shorter work schedule. The construction workforce is forecasted to be 115 employees, or a 40 percent reduction over the 200 employees forecasted for the medium growth scenario. The operations workforce is predicted to be 140 persons, which is 70 percent of the workforce requirements of the medium growth forecast.

Construction of the first generation unit would begin in 1996 compared to 1993 under the medium growth forecast. For five months of each of eight years during the period 1996-2010 a prefabricated unit of the plant would be assembled. During off-work periods, the majority of the employees would spend time outside of the North Slope Borough. The spending wages earned by the employees within the borough is expected to be minimal due to the transience of the workforce.

Despite the differences in workforce requirements and schedule between the low and medium growth forecasts, the socioeconomic impacts would be expected to be similar. The relatively low level of impact can be attributed to the location of the generating plant within the Prudhoe Bay/Deadhorse industrial complex, which is isolated from communities.

The workforce requirements and schedule for construction of the transmission lines is almost identical to that of the medium forecast scenario, and, therefore, socioeconomic impacts will be essentially the same as those discussed in Section 2.4.

SCENARIO II
FAIRBANKS POWER GENERATION
MEDIUM LOAD

4.0 FAIRBANKS POWER GENERATION

MEDIUM LOAD FORECAST

Fairbanks power generation, under the medium load forecast, requires a gas conditioning plant on the North Slope, a medium diameter pipeline to the Fairbanks area, an electric generating station at the pipeline terminus, and electrical transmission capacity between Fairbanks and Anchorage. The North Slope gas conditioning plant will remove carbon dioxide (12% by volume of the raw gas) and natural gas liquids. Initial and final peak delivery volumes are anticipated to be 230 MMSCFD and 407 MMSCFD, respectively, using a 22 inch diameter pipeline operating at 1260 pounds per square inch of pressure. The pipeline will be buried. Initially, three gas compressor stations along the pipeline route will be required, increasing to 10 in the year 2010.

The electric generating station necessary to produce almost 1400 MW of capacity in 2010 will consist of 5 combined cycle units, each consisting of two gas fired combustion turbines paired with two waste heat recovery boilers and one steam turbine generator, and 2 simple cycle gas turbines, which can be paired with waste heat recovery boilers to form a sixth combined cycle unit after 2010. Transmission lines to carry the power to the load center in Anchorage will require two additional (total of 3) 345 kV lines from Fairbanks to Anchorage.

This scenario also includes the construction of a natural gas distribution system in Fairbanks to serve residential and commercial space and water heating needs. Forecasting a fuel demand which replaces existing fuels is speculative, but highest demand (including growth) is based on 100 percent penetration of the potential market. In Fairbanks, in 2010, this is estimated to be as much as 63 MMSCFD.

Costs for shared facilities have been apportioned between the electric generating facility and the residential/commercial gas distribution system. Given this apportionment, construction of the gas conditioning facilities, gas pipeline, power generating facilities and transmission systems, is estimated to cost $6.2 billion. Total annual operation and maintenance costs are estimated to be $0.8 billion. The present worth of these costs excluding fuel costs is $5.2 billion. Construction costs for the Fairbanks gas distribution system total $1.1 billion, with total annual operating and maintenance costs totalling $86 million. The present worth of costs for this system is $0.9 billion.

4.1 NORTH SLOPE TO FAIRBANKS NATURAL GAS PIPELINE

The design of the gas pipeline and the gas conditioning facilities proceeded on the basis of preliminary gas demand calculations (detailed in Appendix A). Subsequent refinement of total peak demand for the Fairbanks scenario based on domestic gas distribution and electric usage (detailed in Appendix E and Appendix B respectively) did not require design changes in the pipeline but resulted in small differences in gas demands in the sections that follow. The pipeline gas demands are as follows:

Pipeline Design (Preliminary Demand)	Medium Load Forecast (MMSCFD)
Power Generation	
Annual Average Demand	186
Daily Peak Demand	307
Residential/Commercial	
Annual Average Demand	27
Daily Peak Demand	76
Totals	
Annual Average Demand	213
Daily Peak Demand	383

The refined values on which the Fairbanks gas distribution system and the electric generating unit additions depend are as follows:

Utility Systems Design (Refined Demand)	Medium Load Forecast (MMSCFD)
Power Generation Peak Daily Demand	271
Residential/Commercial Peak Daily Demand	63
Totals Peak Daily Demand	334

The refined gas demand is about 50 MMSCFD less than the preliminary value, an amount insufficient to necessitate pipeline design changes.

4.1.1 Gas Conditioning Plant

Gas to be transmitted through the pipeline will first be conditioned on the North Slope. The conditioning facility will receive the gas from the production fields, treat it, and compress it to 1260 psig and a temperature of 25 to 30°F. Initial design delivery volume will be 230 MMSCFD; however, the plant will be capable of expansion to 407 MMSCFD as future demand increases. These values are based on total Fairbanks gas demand, compressor station requirements and a pipeline availability of 96.5 percent. The gas delivery and quality specifications are presented in Table 4-1.

The process assumed for carbon dioxide removal is Allied Chemical's SELEXOL physical solvent process, the same process selected for use with ANGTS. A mechanical refrigeration process will control hydrocarbon dewpoint. Water dewpoint control will be accomplished in the dehydration equipment located in the existing Prudhoe Bay Unit gas/crude oil separation sites called Gathering Centers and Flow Stations. The hydrogen sulfide content of the feed gas is very low. It was therefore assumed that no process equipment will be required for either water dewpoint control or hydrogen sulfide removal.

TABLE 4-1

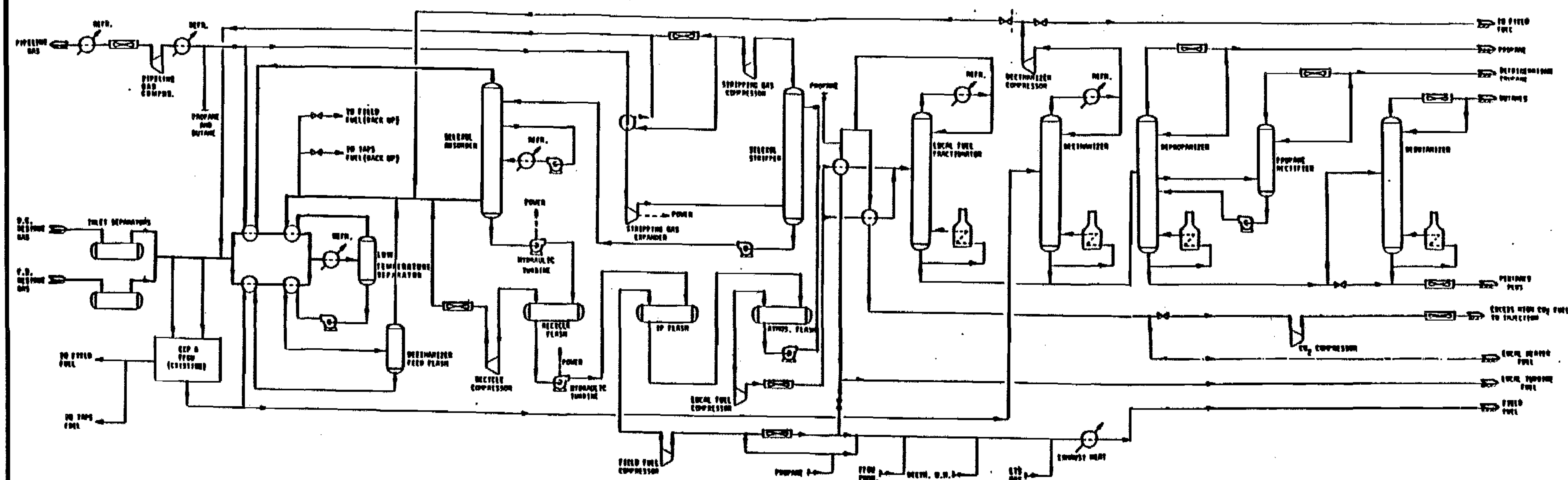
GAS DELIVERY AND QUALITY SPECIFICATIONS

Parameter	Specifications
Initial Delivery Volume	230 MMSCFD
Ultimate Delivery Volume	407 MMSCFD
Delivery Pressure	1260 psig
Delivery Temperature	25-30°F
Carbon Dioxide Content (max.)	2.0 volume %
Hydrogen Sulfide Content (max.)	1.0 grain/100 SCF
Hydrocarbon Dewpoint (max.)	-10°F @ 1000 psia
Water Dewpoint (max.)	-25°F @ 1000 psia

A simplified process flow diagram illustrates the basic process flow of the conditioning facilities (Figure 4-1). Two trains will be installed, one for continuous operation and the other as a spare. Feed gas, originating from the gas/crude separators, will be compressed in the Gathering Centers and Flow Stations and flow to the inlet separation unit. The inlet gas streams will be metered, and any solids or free liquids in the gas will be removed at this point. The feed gas will flow first to the natural gas liquids (NGL) extraction section for hydrocarbon dewpoint control. The gas will then flow to the SELEXOL section where the carbon dioxide is removed. The conditioned gas will then go to the gas compressors where it will be boosted to pipeline pressure, then refrigerated for transmission. SELEXOL solvent characteristically absorbs, along with the carbon dioxide, a significant quantity of hydrocarbons, particularly the heavier hydrocarbons. During the regeneration of the SELEXOL solvent, both the carbon dioxide and hydrocarbons are flashed from the solvent, producing a low Btu gas. The gas will be utilized within the facility to offset some of the energy requirements.

The hydrocarbon liquids from the NGL Extraction and SELEXOL flash gas will be separated in the fractionation unit into propane, butanes, and pentanes-plus products to facilitate disposal. Some propane will be used for heating value control of certain fuel streams. The remaining propane will be injected into the pipeline gas. The butanes will be either injected into the pipeline gas up to hydrocarbon dewpoint limits or into the crude oil delivered to the Trans Alaskan Pipeline System (TAPS) as is presently accomplished at the existing central compression facility for gas reinjection. The pentanes-plus will be injected into the same crude oil stream.

The facilities will require approximately 175,000 total installed horsepower including motors, power recovery units and gas turbines. The bulk of this horsepower will be developed by 9 operating gas turbines with 6 spare gas turbines. The major auxiliary systems will include refrigeration, offsite and general utilities, and power generation facilities.



ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

GAS CONDITIONING FACILITY

FIGURE 4-1

EBASCO SERVICES INCORPORATED

The remoteness and severe environmental conditions at the North Slope impose limitations on both the process and mechanical design of the facilities. All equipment, will therefore be housed in totally enclosed modules. Modules, with contained equipment, will be fabricated prior to shipment to the North Slope. They will be sea-lifted to the North Slope by ocean-going barges. At Prudhoe Bay they will be offloaded by crawler transporters or rubber-tired vehicles and moved to their pile supports on graveled sites.

A critical timing factor in any construction program at Prudhoe Bay is the limited time period during which the sea lanes are passable. Major plant components can only be delivered via ocean-going barges during the short (4-6 weeks) period each year when the sea lanes are not blocked by ice. Failure to deliver any critical major component during the scheduled period could effectively delay full-capacity startup by one full year.

4.1.2 Pipeline

4.1.2.1 Pipeline and Route

Gas to be transported will be provided to the pipeline from the gas conditioning plant. Pipeline quality gas will be a hydrocarbon mixture with approximately 88 percent methane, and a gross higher heating value of approximately 1100 Btu/SCF. The pipeline will be designed and operated to maintain the soil around the buried sections of the pipeline in a frozen state. The operating temperature of the gas in the pipeline will be between 0°F and 32°F under normal conditions. However, during transient periods, the gas in the line may exceed 32°F or may go down to as low as -5°F for short periods of time.

The proposed pipeline route originates in the Prudhoe Bay area in northern Alaska (refer to Appendix C). The pipeline will connect to the gas conditioning plant at the metering station, designated Milepost 0. The pipeline route, which assumes the ANGTS right-of-way, follows TAPS in a southerly direction to about Milepost 274 near Prospect Creek. The pipeline route then follows TAPS in a southeasterly direction to about Milepost 480, the assumed location of the power plant metering station. A tap will be provided at Milepost 455 near Fox to supply gas to Fairbanks for residential and commercial uses.

The pipeline will cross 15 major streams requiring special construction considerations, such as heavy wall pipe, continuous concrete coating or set-on concrete weights. At the Yukon River an existing aerial crossing will be used.

There will be 20 uncased road crossings, 27 road crossings with 28 inch casings, and 8 road crossings with 36 inch casings. The pipeline will cross TAPS at 21 locations, the TAPS fuel gas line at 13 locations, and other pipelines at 3 locations.

The basic assumption that this pipeline will follow the ANGTS right-of-way is a major one. Pipeline design and subsequently cost could be greatly affected if this right-of-way could not be used. Significant areas of concern would include the narrow Atigun Pass area and the Yukon River crossing.

4.1.2.2 Pipeline Design

The pipeline design pressure will be 1260 psig, based on current proven technology for resistance to crack propogation at low temperatures. The pipeline has been designed for the daily peak flow required to satisfy the gas demand associated with the medium forecast assuming a pipeline availability of 96.5 percent. The following flowrates were used for the hydraulic design of the pipeline:

Annual Average Flow (MMSCFD)	213/0.965 = 220
Daily Peak Flow(MMSCFD)	383/0.965 = 397

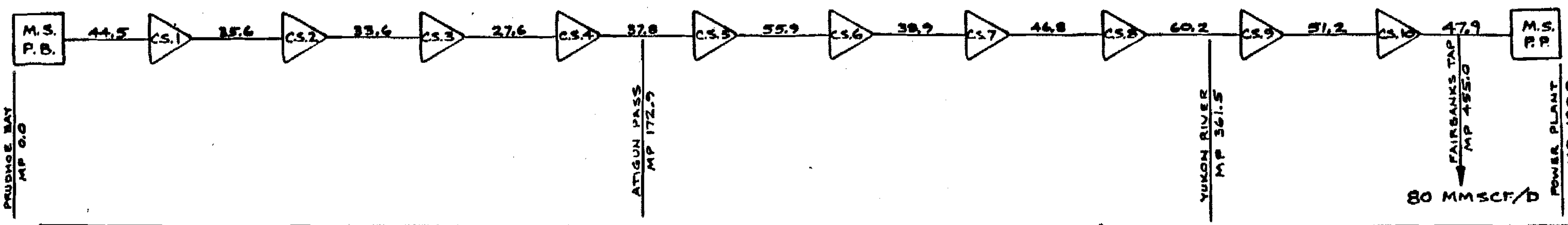
Initial annual average daily capacity of the pipeline will be 127 MMSCFD with a peak daily load of 227 MMSCFD during extreme cold weather periods.

The peak daily flowrate will require a pipeline outside diameter of 22 inches. The pipe shall be API 5LX or API 5LS Grade X70 with a minimum wall thickness of 0.275 inches for the majority of the length. At road crossings, bridges, and within public road right-of-ways, the minimum wall thickness will be 0.330 inches. These thicknesses are based on the entire pipeline being located in a Class 1 location as defined in CFR 49, Part 192.

The peak daily flowrate requires 10 compressor stations of approximately 3400 HP each. The average daily flowrate will require only 3 compressor stations, Stations 2, 4 and 7. The compressor stations are at the locations selected by ANGTS and use the same numbering system. The delivery pressure to the power plant will be 1038 psig. Figure 4-2 summarizes this flowrate condition. Compressor station fuel consumption will be approximately 1 MMSCFD per operating station.

A total of 28 mainline block valve assemblies will be provided at a nominal spacing of 20 miles including the initial compressor sites where the mainline valves will be installed in the station bypass loop. Seven of the 28 block valves will be installed at the additional station sites to facilitate system expansion. Pig launchers and receivers will be installed at the compressor and metering stations.

The pipe will be installed in a buried mode, using the proposed ANGTS construction techniques. Pipe ditches will be selected from several basic types, based on site-specific conditions. Special ditch configurations will be required to provide for the mitigation of frost heave effects in areas having frost-susceptible soils.



TOTAL 480 MILES, 22" O.D. PIPELINE, WALL THICKNESS = 0.275 INCH MINIMUM

		M.S. PRUDHOE BAY	C.S. 1	C.S. 2	C.S. 3	C.S. 4	C.S. 5	C.S. 6	C.S. 7	C.S. 8	C.S. 9	C.S. 10	M.S. POWER PLANT
STATION	STATION DESIGNATION	M.S. PRUDHOE BAY	C.S. 1	C.S. 2	C.S. 3	C.S. 4	C.S. 5	C.S. 6	C.S. 7	C.S. 8	C.S. 9	C.S. 10	M.S. POWER PLANT
	MILEPOST (MILES)	0.0	44.5	80.1	113.7	141.3	179.1	235.0	273.9	320.7	380.9	432.1	480.0
	ELEVATION (FEET)	21	362	825	1525	3050	3158	1220	1315	1730	880	1520	500
	STATION INLET VOLUME (MMSCF/D)	407	407	406	405	404	403	402	401	400	399	398	318
	TOTAL FUEL (MMSCF/D)	—	1	1	1	1	1	1	1	1	1	1	—
	STATION OUTLET VOLUME (MMSCF/D)	407	406	405	404	403	402	401	400	399	398	397	318
	STATION SUCTION PRESSURE (PSIG)	1260	1047	1063	1057	1031	1063	1124	1095	1039	1028	971	1038
	STATION DISCHARGE PRESSURE (PSIG)	1260	1245	1245	1245	1230	1230	1260	1260	1230	1230	1145	—
COMPRESSION	COMPRESSOR SUCTION PRESSURE (PSIG)	—	1031	1047	1041	1015	1047	1108	1079	1023	1012	955	—
	COMPRESSOR DISCHARGE PRESSURE (PSIG)	—	1259	1259	1259	1244	1244	1274	1274	1244	1244	1159	—
	COMPRESSION RATIO	—	1.218	1.200	1.206	1.222	1.186	1.148	1.178	1.213	1.226	1.210	—
	HORSEPOWER REQUIRED	—	3400	3150	3200	3400	2900	2300	2750	3200	3250	3400	—

ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

HYDRAULIC SUMMARY
MEDIUM FORECAST
PEAK DAILY FLOW

FIGURE 4-2

EBASCO SERVICES INCORPORATED

Pipeline corrosion control will be provided by a combination of external coating and a cathodic protection system that will be compatible with the sacrificial zinc anode system used on the adjacent TAPS pipeline. The pipeline will be hydrostatically tested to 1.25 times the maximum allowable operating pressure.

4.1.3 Compressor and Metering Stations

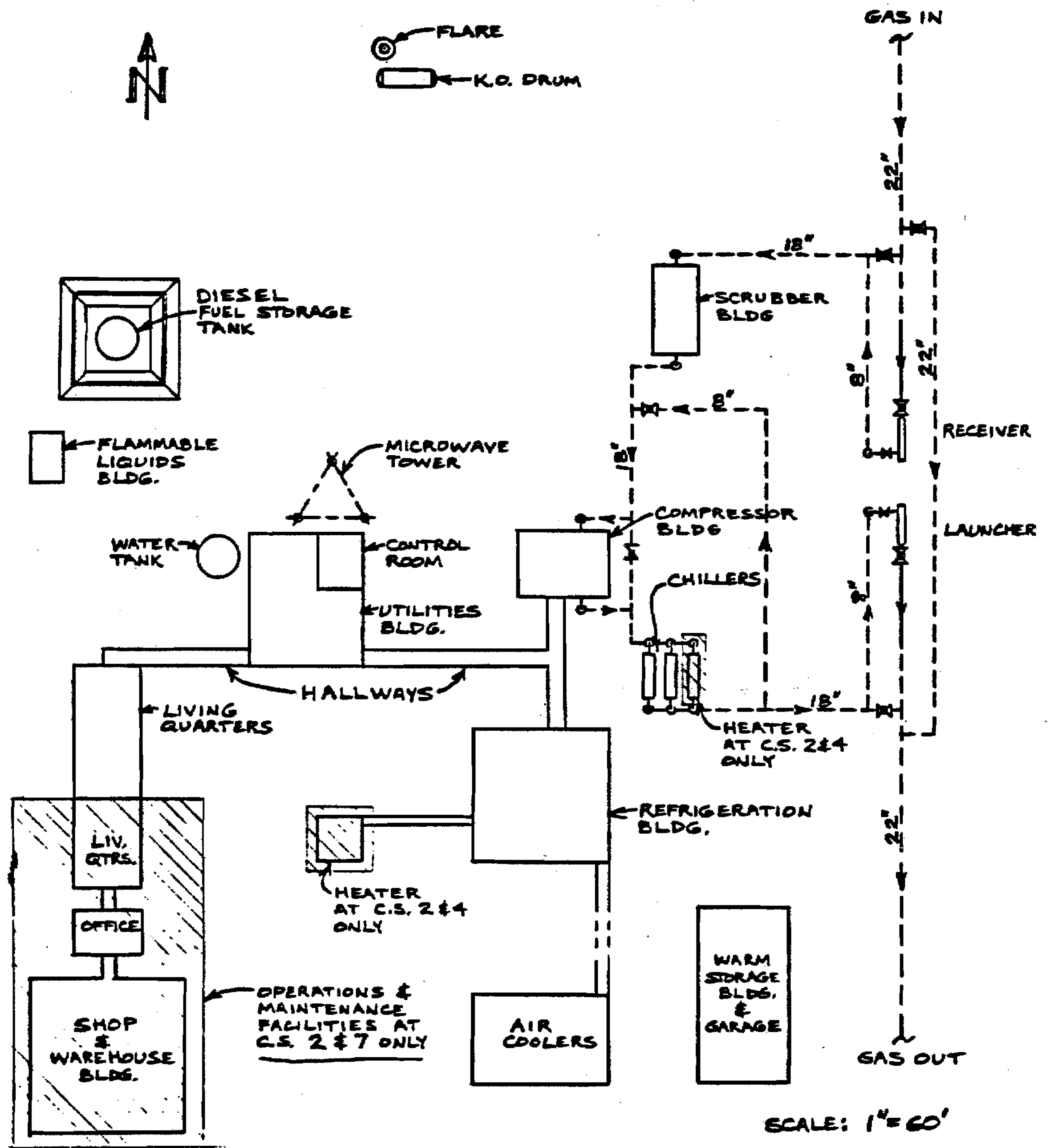
Two metering stations will be provided. One will measure the quantity of gas supplied to the pipeline from the gas conditioning plant at the North Slope, and the other will measure the gas delivered to the power plant just south of Fairbanks. Details of the compressor and metering stations design are provided in the Figures 4-3 and 4-4.

Each compressor station site will require about 10 acres, and the metering stations about 1.5 acres of land. Compressor stations will include buildings for the compressors, refrigeration equipment, utilities and control room, flammable liquids storage, warm storage and garage, a gas scrubber unit, living quarters and interconnecting hallways. Additional living quarters, office, and shop and warehouse building will be included at compressor stations 2 and 7.

Two refrigeration units will be provided at every compressor station to maintain the pipeline gas temperature. Gas heaters will be provided at compressor stations No. 2 and No. 4 to assure that gas temperatures will be maintained above the hydrocarbon dewpoint of the mixture under all operating conditions. Pipeline gas will be used to power the drivers for the gas compressors, refrigerant compressors and electric generators. Compressor station and metering station design and equipment are summarized in Tables 4-2 through 4-10.

4.1.4 Supervisory Control System

A supervisory control system will be provided to operate the pipeline system, perform related system balancing, and coordinate functions with the gas conditioning plant at the North Slope and the Fairbanks power plant.



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NORTH SLOPE GAS FEASIBILITY STUDY

TYPICAL COMPRESSOR STATION LAYOUT

FIGURE 4-3

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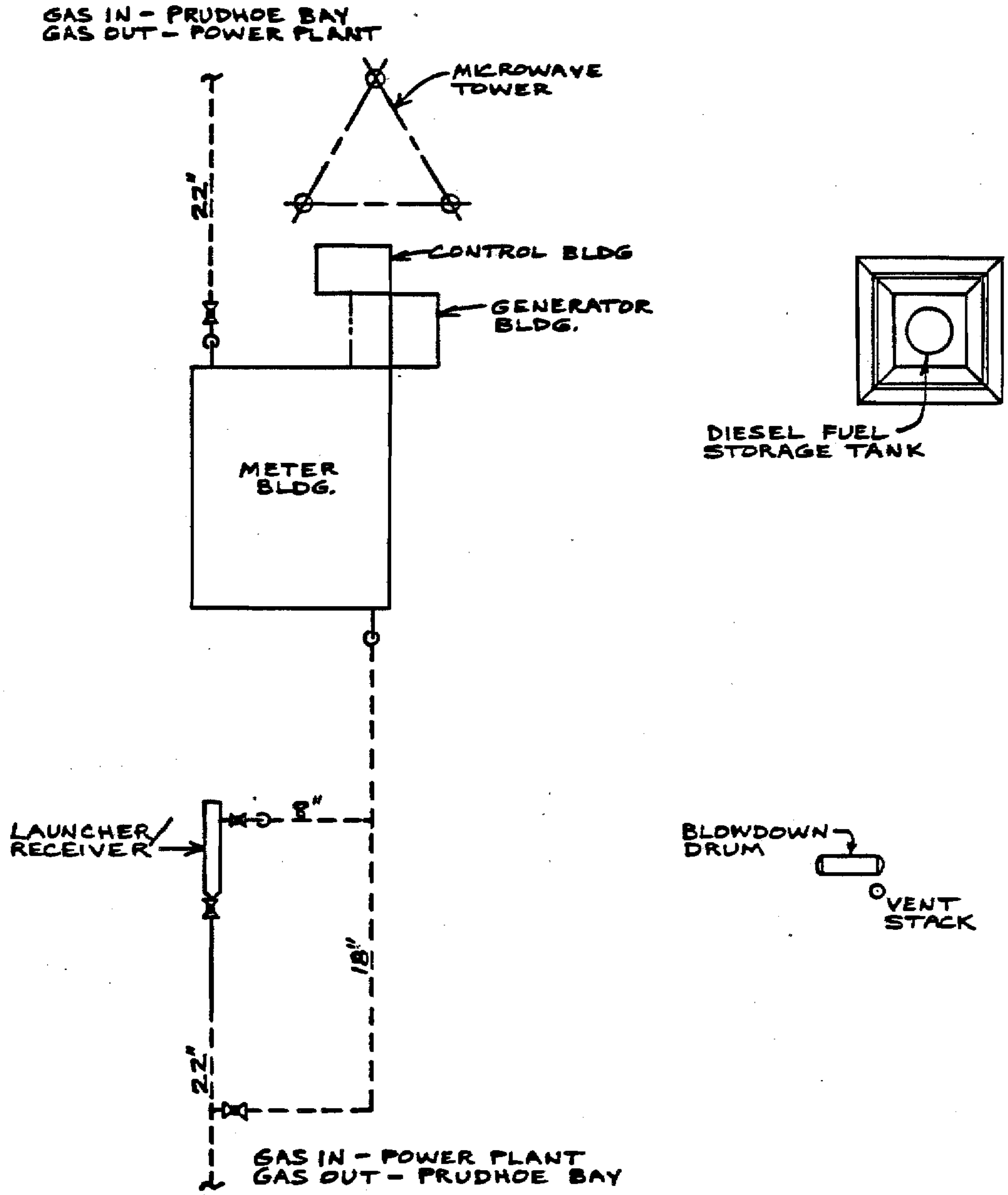

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NORTH SLOPE GAS FEASIBILITY STUDY

TYPICAL METERING STATION LAYOUT

FIGURE 4-4

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TABLE 4-2

PIPE DETAILS

	Major piping - 1260 psig design pressure
a.	22" O.D. x 0.406" wall API 5LX, GR. X70 pipe
b.	18" O.D. x 0.750" wall ASTM A333, GR. 6 pipe
c.	16" O.D. x 0.656" wall ASTM A333, GR. 6 pipe
d.	12" XS ASTM A333, GR. 6 pipe
e.	10" XS ASTM A333, GR. 6 pipe
f.	8" STD. WT. ASTM A333, GR. 6 pipe
NOTE:	API 5LX piping to have additional specifications for -50°F Charpy Impact requirements and chemical requirements for improved weldability.

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TABLE 4-3

CIVIL DESIGN DETAILS

---

a. All buildings and heated components will be elevated on steel pile foundations above a gravel pad to allow free air circulation under the structures. The pile embedment will be adequate to prevent frost jacking of the structures. Non-heated facilities will be supported by a granular fill and sand pad.

b. Snow loads will be 60 psf

c. Earthquake design will be Zone 3

d. Wind loads will be:

30 psf	30' height
40 psf	30'-50' height
50 psf	50'-100' height
60 psf	100' height

e. Ambient temperature range -70°F to +80°F

f. Structural steel - inside heated structures, will use normal steel materials. Outside heated structures, will use suitable low temperature steels.

g. The diesel fuel storage tank will be placed over an impermeable liner covering the entire diked area.

TABLE 4-4

BUILDING DETAILS

---

a. All buildings will be pre-engineered insulated-panel metal structures, suitable for their intended use.

b. Buildings suitable for truck transportation through size or modularization will be prefabricated.

c. Hazardous materials storage buildings will be mechanically ventilated. Ventilation rates will be four air changes per hour for normal ventilation and 15 air changes per hour for emergency conditions.

d. The sizes of buildings will be as follows:

Scrubber bldg.	20' x 40' x 24' eave height
Compressor bldg.	30' x 40' x 20' eave height
Refrigeration bldg.	60' x 60' x 30' eave height
Warm Storage bldg.	40' x 80' x 20' eave height
Utilities bldg.	50' x 60' x 16' eave height
Living quarters (except C.S. 2 & 7)	30' x 60' x 16' eave height
Flammable Liquids Bldg.	15' x 20' x 10' eave height
Living quarters (C.S. 2 & 7)	30' x 100' x 16' eave height
Office (C.S. 2 & 7)	20' x 30' x 8' eave height
Shop and Warehouse (C.S. 2 & 7)	70' x 70' x 20' eave height
Hallways	6'-8" wide x 10' eave height
Meter bldg.	40' x 50' x 20' eave height
Generator bldg.	10' x 15' x 10' eave height
Control bldg.	10' x 15' x 10' eave height

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TABLE 4-5

COMPRESSOR AND GAS SCRUBBER DETAILS

Main Compressors - 1 each per compressor station

a. Compressor - 1280 psig min. design pressure
   1.23 pressure ratio
   6000 ft. adiabatic head
   2750 ACFM

b. Gas Turbine Driver - 3800 ISO Horsepower
   gas fueled

c. Typical Equipment - Solar Centaur Gas Turbine Natural Gas Compressor Set with a C-304 Single Stage Compressor, or equal.

Gas Scrubber - (1) each per station

a. Designed to remove 99.5% of all solid and liquid particles 1 micron and larger.

b. Design flowrates will range from 130 to 400 MMSCF/D.

c. Typical Equipment - Peco Robinson filter and liquid-gas separator, Model 75H-56-FG372, or equal.

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TABLE 4-6

REFRIGERATION SYSTEM AND GAS HEATER DETAILS

Refrigeration System

a. Refrigeration system will be a compression/expansion type using Freon gas and a gas turbine driver for the refrigerant compressors.

b. Chillers will be shell and tube with natural gas in the tubes at 1280 psig and Freon in the shell.

c. Condensers will be air cooled with multiple electric driven fans.

d. Required capacity will be 1650 tons (2200 HP).

e. The system will be comprised of two parallel 50% refrigeration trains to meet the total required capacity.

f. Typical Equipment - Two (2) 825 ton (1100 HP) refrigeration trains using Solar Saturn Gas Turbine Compressor Sets, or equal.

Gas Heater - One (1) each at Compressor Stations 2 and 4 only

a. Designed to add 5,000,000 Btu/hr. to heat the pipeline gas during low flow winter conditions.

b. Equipment will be a gas fired heater and utilize a water/glycol solution to heat the gas in a shell and tube heat exchanger.

TABLE 4-7

COMPRESSOR STATION
ELECTRICAL SYSTEM AND CONTROL SYSTEM DETAILS

Electrical System

a. Each station will be self-sufficient in electric power with its own power generation and distribution system.

b. Power will be 480 V., 3 phase, 60 Hz.

c. Main generators will be two (2) 800 KW continuous duty dual-fueled gas turbine driven generator sets, one will normally supply the station load and one will be standby.

d. Emergency (lifeline) generator will be one (1) 200 KW diesel engine driven generator connected to the essential services bus.

e. The emergency generator will be located in the warm storage building or another location remote from the main generators in the utilities building.

f. Typical Equipment:
Main generators - Solar Saturn GSC-1200, or equivalent
Emergency generator - Caterpiller 3406 TA, or equivalent

Control System

a. Each station will have a control system designed for completely remote and unattended operation.

b. The station Central Control Unit (CCU) will be linked by communications to the Operations Control Center (OCC).

c. Each individual piece of station equipment will have its individual control system which in turn will be controlled by the CCU which is the master controller.

d. The OCC input to the CCU will primarily be start/stop commands and setpoint changes.

e. The OCC will have sufficient information transmitted to it to allow for full compressor station control.

TABLE 4-8

MISCELLANEOUS COMPRESSOR STATION SYSTEMS' DETAILS

a. Blowdown and Flare System will be sized for 100,000 lb/hr. of saturated light hydrocarbon gases and liquid storage capacity of 10,000 gallons.

b. Nitrogen Purge System - for purging.

c. Instrument and Utility Air System - Instrument air to be clean and dry for operating pneumatic control system components. Utility air for power tools and maintenance.

d. Fuel Gas Conditioning - Gas for station fuel requirements will be filtered, heated, reduced in pressure, and distributed at 500 psig.

e. Diesel Fuel - A diesel fuel storage and back-up fuel system will be provided for electric power generation and heating. The tank size will be 40,000 gallons to provide 14 days of capacity.

f. Fire Protection - Station fire protection will be provided by a Halon 1301 extinguishing system with a water/foam back-up system.

g. Water System - A single 40,000 gallon water tank will provide a source of water for potable uses as well as for the back-up water/foam fire system. The fire pump will be diesel driven. The potable water will be filtered, chlorinated, and distributed.

h. Sewage System - Sewage will be collected by a vacuum collection system. Final disposal will be through a septic system or a lagoon as site conditions warrant. Lagoon disposal will require secondary treatment and chlorination.

i. Heating System - The station will be heated by a water/glycol system utilizing waste heat from the station turbine generators. A combustion boiler unit will be provided as back-up to the waste heat system.

j. Cathodic Protection - A cathodic protection system will be provided to protect all buried piping, tank bottoms, and other structures in contact with the soil. The station will be electrically insulated by isolation flanges where the pipeline enters and leaves the compressor station property.

TABLE 4-9

METERS AND METERING STATION ELECTRICAL AND CONTROL SYSTEMS DETAILS

Meters

a. Each metering station will have 3 parallel meters with provisions for future addition of a fourth meter.

b. Meters will be concentric orifice plate with differential pressure transmitters.

c. Meter runs will be 12 inch diameter by 30' long.

Electrical System

a. Both metering stations will be powered by an outside commercial power source.

b. A 50 kW diesel-powered back-up generator will automatically come on line during a power failure.

Control System

a. Designed for remote and unattended operation.

b. Gas flow will be computed by a microprocessor-based flow computer with 100% redundancy.

c. The flow computer will be linked to the OCC by telecommunications.

TABLE 4-10

MISCELLANEOUS METERING STATION SYSTEMS' DETAILS

---

a. Blowdown drum and vent stack system

b. Nitrogen purge system

c. Diesel Fuel - A diesel fuel storage system will be provided for electric power generation.

d. Fire Protection - Fire protection will be provided by a Halon 1301 extinguishing system with a water/foam back-up system.

e. Heating System - Heating and ventilating will be by means of redundant gas-fired furnaces and warm air duct systems.

f. Cathodic Protection - A cathodic protection system will be provided to protect all buried piping, tank bottoms, and other structures in contact with the soil. The station will be electrically isolated by isolation flanges where the pipeline enters and leaves the compressor station property.

The supervisory control system master station will be located near the Fairbanks power plant at the operations control center (OCC). A communication system will provide the voice and data intertie to each compressor and metering station from the OCC. Each station will include a control system that will interface through the communication link to the OCC.

The OCC in Fairbanks will include the dispatcher console, which will provide the monitoring and control equipment necessary for centralized operation of the pipeline.

4.1.5 Communications System

The communications system will include voice and data transmission systems, the mobile radio system, and record communications. A basic communication system will be installed during the construction phase to provide voice and data links among the pipeline and compressor station camps, and the Fairbanks construction headquarters.

Mobile radio equipment will be provided to permit communication by field construction teams through a network of repeater stations to the camps, stations and other facilities. This basic communication system will later be modified to provide the operational communications system. This operational system will support the supervisory control system. Data communications will also be provided.

4.1.6 Operations and Maintenance Facilities

Operations and maintenance (O&M) facilities will be located at three sites along the pipeline: Compressor Stations 2 and 7, and the Fairbanks operations headquarters. Each O&M facility will include the following:

(1) Warehouse for storing project spare parts inventory.
(2) Maintenance shop, including maintenance equipment.
(3) District office.
(4) Living quarters for the O&M personnel.

The Fairbanks operations headquarters near the power plant will also house the OCC, the related supervisory control equipment, required power supplies and the communications system equipment.

Stations 2 and 7 will serve as shop and warehouse with both living quarters and maintenance facilities. The other stations will have small living quarters attached. It is anticipated that a staff of 5-6 will serve at each compressor station except stations 2 and 7, which will have a total of 16 each, including 6 maintenance personnel. This would then require a total staff of 80 for the medium load forecast peak demand (10 stations).

4.1.7 Construction and Site Support Services

Temporary facilities will include those facilities required to support the construction phase activities. These facilities will include the Fairbanks construction headquarters, the pipeline and compressor station construction camps, airfields, access roads, material (borrow) sites and disposal sites.

Thirteen pipeline construction camps will be provided along the route, including one located at the Fairbanks construction headquarters site. These camps will be capable of accommodating between 250 to 1,300 persons, depending on location and planned use.

The camps, once completed, will be turned over to contractors for operation. The twelve camps along the pipeline will be renovated generally in place using equipment and modules obtained mostly from the existing TAPS camps. Three compressor station construction camps will be provided by relocating and renovating equipment and modules available from eight existing TAPS pump station camps.

Airfields will consist of certain existing commercial airfields, as well as renovated private airfields previously built in support of TAPS. Material (borrow) sites are available along the pipeline route to provide construction materials, as well as areas to dispose of construction spoil. Maximum haul distances should be kept under 5 miles.

A pipe yard at Fairbanks will be provided to receive mainline pipe, store, externally coat, double-joint (weld) and insulate pipe as required. Access roads will be provided as needed to allow access to stations, borrow sites, pipeline spreads and related facilities.

4.2 POWER PLANT

The Report on System Planning Studies (Appendix B) concluded that combined cycle power plants are the most technically feasible and economical choice for satisfying demand when generating electrical power at a Fairbanks site. The individual combined cycle plants will consist of two gas turbines, each with a heat recovery steam generator and one steam turbine for a total of three turbine-generator sets.

4.2.1 General

The Fairbanks site will contain all required generating units, construction and maintenance facilities, various auxiliary and support systems, a central control facility and switchyards. This power generation scenario calls for five 242 MW combined cycle and two 86 MW simple cycle units to satisfy the demand for energy in the year 2010. The first unit, a simple cycle gas turbine, is required in 1993 and in subsequent years either gas turbines or steam turbines are added. Incremental and total required new generation capacity for this scenario are summarized in Table 4-11.

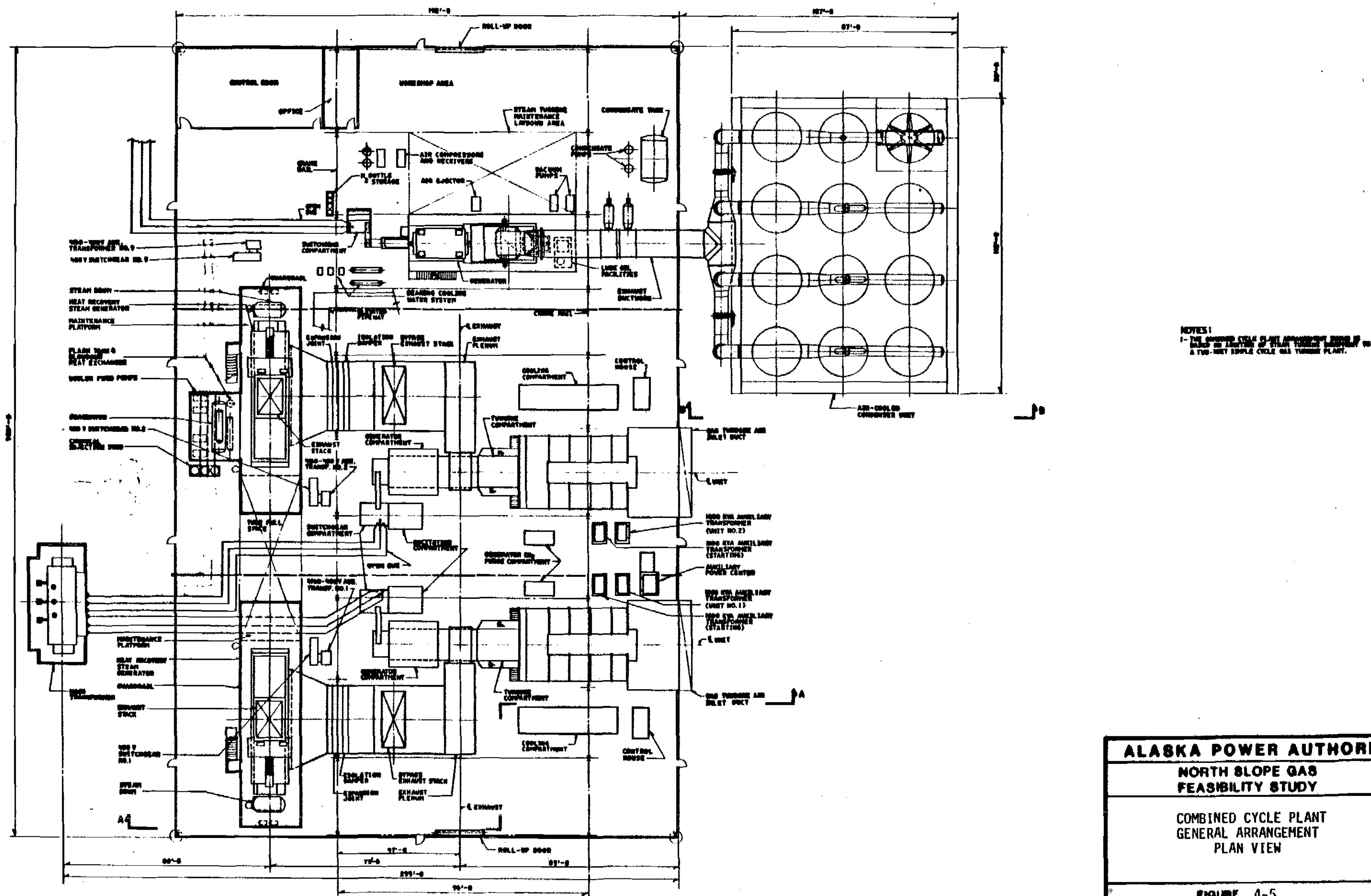
A single combined cycle unit will require an area with outside dimensions of 300 feet by 440 feet. The arrangement of the three turbine-generator sets, the air cooled condenser and auxiliary equipment is shown in Figures 4-5 and 4-6. The site plan shown in Figure 4-7 illustrates the planned installation method (side by side) for up to six units with switchyards. This arrangement will require a total area of approximately 150 acres.

TABLE 4-11

NEW CAPACITY ADDITIONS AND FUEL REQUIREMENTS
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST

Year	New Capacity (MW) (Increment/Total)	Gas Required[1/] (MMSCF)
1990	0/0	0.
1991	0/0	0.
1992	0/0	0.
1993	86/86	6,265.8
1994	0/86	6,265.8
1995	86/172	12,531.6
1996	70/242	12,633.1
1997	172/414	25,132.7
1998	70/484	25,202.9
1999	0/484	25,202.9
2000	86/570	31,551.3
2001	0/570	31,467.3
2002	156/726	37,804.3
2003	0/726	37,804.3
2004	86/812	44,188.1
2005	156/968	45,809.0
2006	86/1050	49,535.1
2007	86/1140	53,145.7
2008	70/1210	52,292.0
2009	86/1296	55,892.6
2010	86/1382	59,424.8

1/ Values as calculated are shown for reproducibility only, and do not imply accuracy beyond the 100 MMSCF level.



PLAN - 220 MW NOMINAL RATING/COMBINED CYCLE PLANT

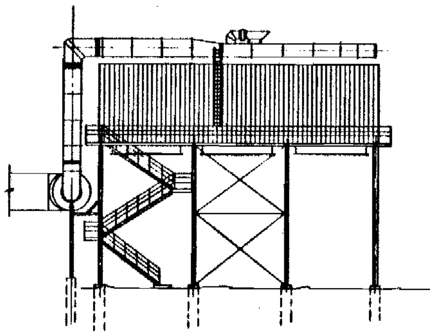
ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

COMBINED CYCLE PLANT
GENERAL ARRANGEMENT
PLAN VIEW

FIGURE 4-5

SCO[illegible]CES I[illegible]ORA[illegible]



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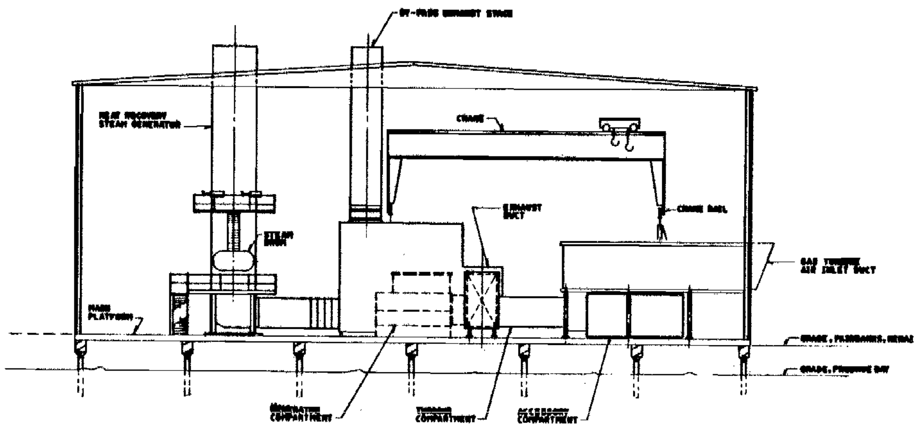


SECTION - A

ALASKA POWER AUTHORITY

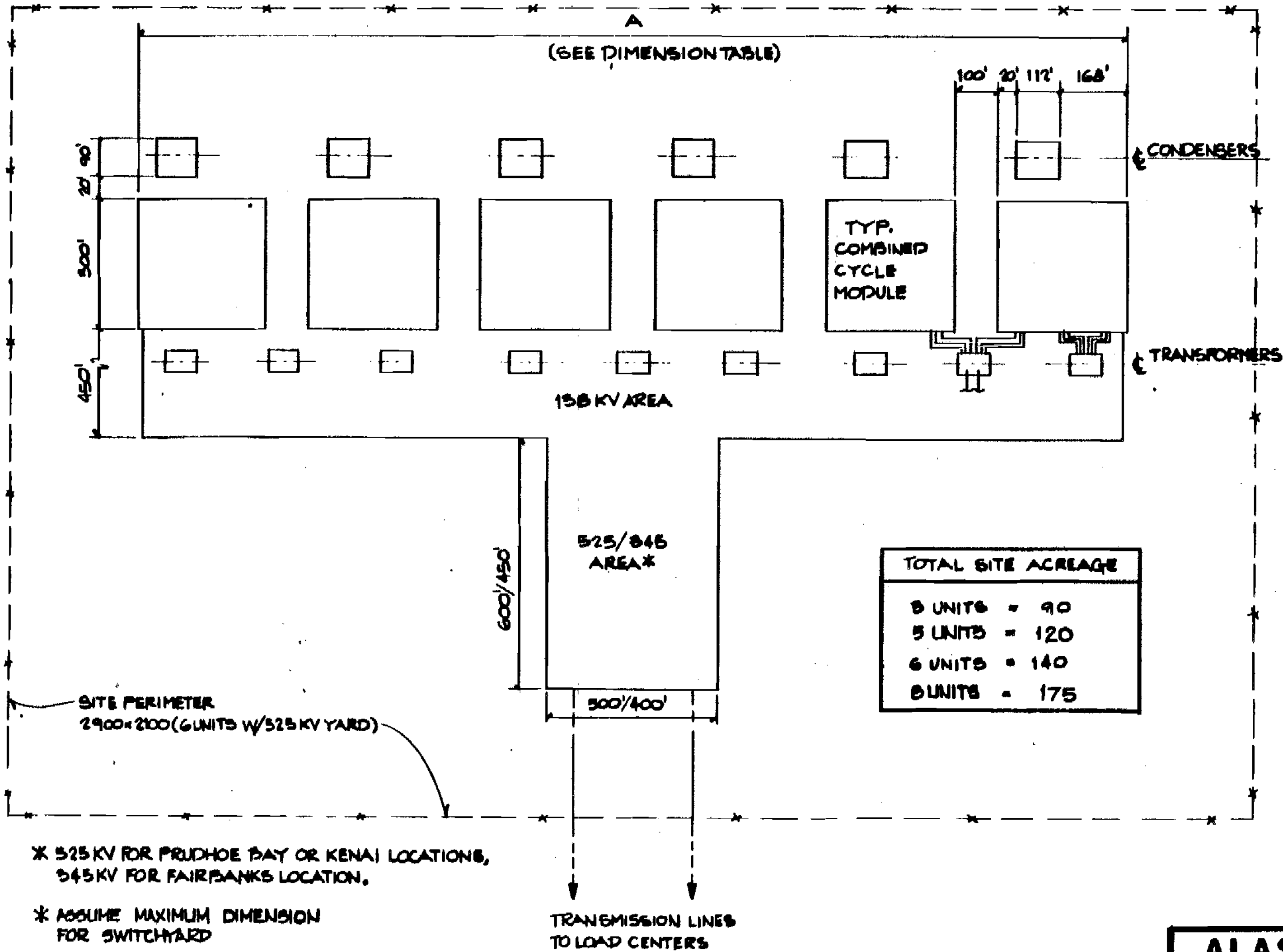
NORTH SLOPE GAS FEASIBILITY STUDY

COMBINED CYCLE PLANT
GENERAL ARRANGEMENT

ELEVATIONS

FIGURE 4-6

CO ES IN RAT



DIMENSION 'A'	NO. OF COMPLETE COMB. CYCLE UNITS
300	1
700	2
1100	3
1500	4
1900	5
2300	6
2700	7
3100	8

TOTAL SITE ACREAGE	
3 UNITS	90
5 UNITS	120
6 UNITS	140
8 UNITS	175

* 525 KV FOR PRUDHOE BAY OR KENAI LOCATIONS,
345 KV FOR FAIRBANKS LOCATION.

* ASSUME MAXIMUM DIMENSION
FOR SWITCHYARD

ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

COMBINED CYCLE PLANT
SITE PLAN
FAIRBANKS AND KENAI

FIGURE 4-7

EBASCO SERVICES INCORPORATED

The functional parts of the plant will be similar to those described in Section 2.0 for the gas turbine portion of the plant. The steam cycle will require the addition of heat recovery steam generators, steam and auxiliary system piping, a steam turbine generator, condenser, condensate polishing, water quality control systems, and an increase in the quantity of water used.

4.2.2 Combustion Turbine Equipment

All combustion turbine equipment will be identical to that described in Section 2.1.

4.2.3 Steam Plant

The heat recovery steam generators (HRSG) are considered part of the steam plant although physically the steam generators will be housed together with the gas turbines in a large common building.

Each heat recovery steam generator package, one at each gas turbine exhaust, will include the steam generator complete with ductwork from the combustion turbine to the steam generator, a bypass damper and bypass stack, and a steam generator exhaust stack. The steam generators will have a steam outlet pressure of 850 psig at 950°F. Each steam generator is designed to produce one half of the plant's normal flow for steam when supplied with feedwater at a temperature of 250°F. The heat recovery steam generators are designed for continuous operation. All steam generator controls will be located in a common area in the central control room.

During start-up and other load conditions, the bypass damper may be operated to provide operational flexibility. By opening the bypass damper and closing the louvered dampers, the combustion turbine exhaust is routed to the stack and does not reach the steam generator. Design parameters for the heat recovery steam generators are shown in Table 4-12. The flow diagram and anticipated heat balance for a single combined cycle unit is presented in Figure 4-8.

TABLE 4-12

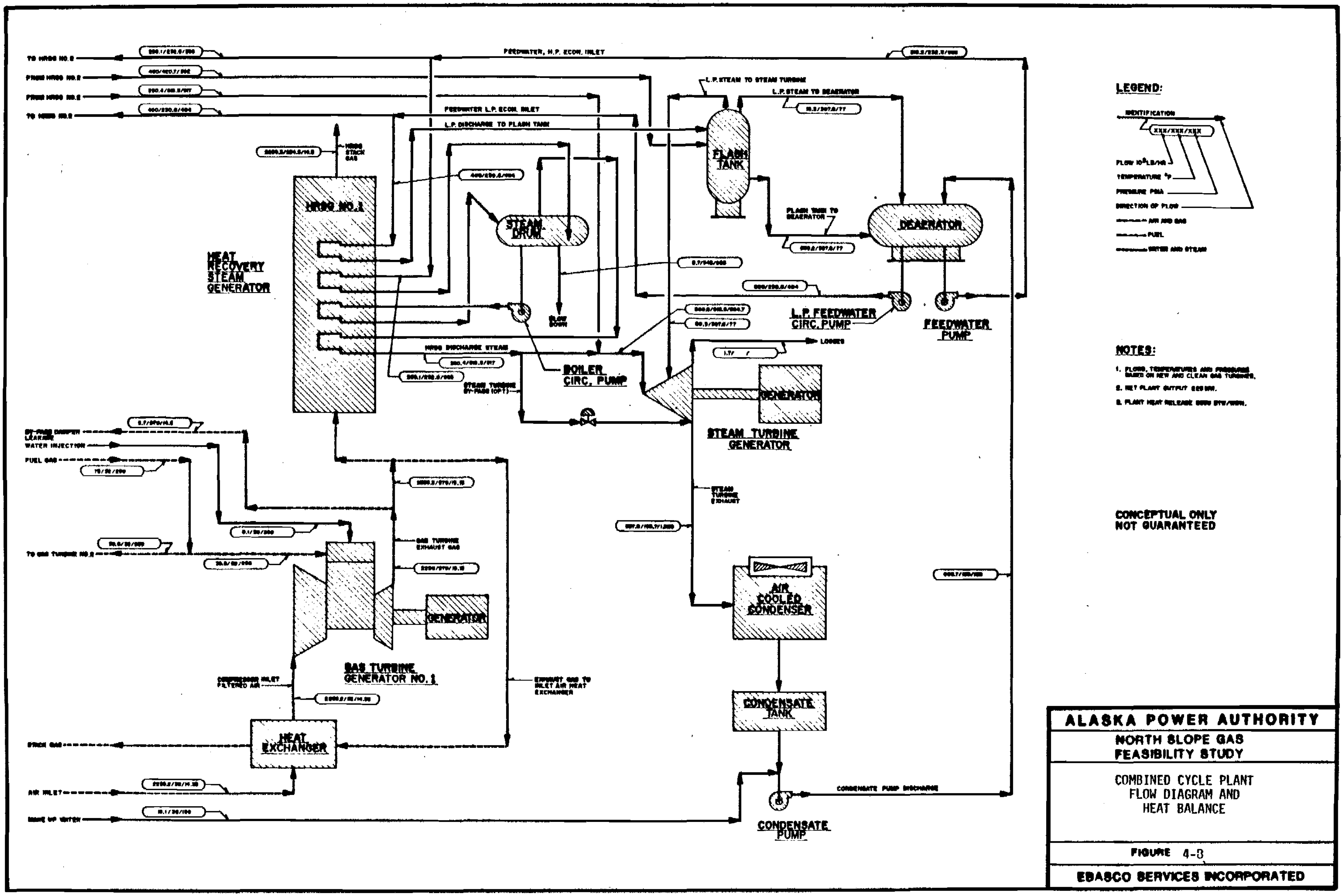
HEAT RECOVERY STEAM GENERATOR DESIGN PARAMETERS
(Two Required Per Unit)

Type:	Watertube, forced circulation	
Performance:	(Each Steam Generator)	
	Main Steam	
	Outlet Condition	850 psig, 950°F
	Quantity	250,400 lbs/hr

Steam production under normal operation will be achieved with an exhaust gas flow through the boiler of 2,286,000 lbs/hr at 970° F. Feedwater will be supplied to the HRSG at 250°F from the feedwater heater.

Heat Recovery Steam Generator Features

Feedwater Heater
Economizer
Evaporator Section with Steam Drum
Superheater Section
Economizer
Evaporator Section with Steam Drum
Exhaust Gas Bypass Dampers with Separate Stack



ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

COMBINED CYCLE PLANT FLOW DIAGRAM AND HEAT BALANCE

FIGURE 4-3

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The generator is rated 72 MW The unit auxiliary transformer is a three winding 15 MVA, 13.8/4.16/4.16 kV. The two secondary windings supply 4.16 kV buses 3A and 3B. The step-up transformer is rated 50 MVA, 18/138 kV.

The main steam produced in the heat recovery steam generators will be conveyed to a common turbine generator set. The turbine generator will be a tandem compound, multistage condensing unit, mounted on a pedestal with a top exhaust going to the air cooled condenser. Design parameters for the turbine generator are shown on Table 4-13. The turbine generator set will be furnished complete with lubricating oil and electrohydraulic control systems as well as the gland seal system, and the generator cooling and sealing equipment.

In addition to the combustion generators, steam generators and steam turbine, the building will also contain the feedwater pumps, condensate pumps, vacuum pumps, deaerator, instrument and service air compressors, motor control centers, control room, and diesel generator (see Figure 4-5). The diesel generator will be sized for black start-up service.

Heat will be rejected from the steam turbine cycle at the outside mounted air-cooled condenser where air flowing across cooling fins absorbs heat from the exhaust system. The condensate from the condenser will then flow to the condensate storage tank where it will be pumped back into the cycle.

Fuel requirements for this scenario will start at approximately 6.27 BCFY in 1993, when the first gas turbine starts delivering power, and increase to 59.43 BCFY in the year 2010. The maximum anticipated gas consumption rate, in the year 2010, with 1382 MW of capacity in operation, is 1.88×10^5 SCFM. Detailed annual gas use figures are presented in Table 4-11.

TABLE 4-13

STEAM TURBINE GENERATOR UNIT DESIGN PARAMETERS
(One Required Per Unit)
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST

Turbine Type:	Multistage, straight condensing, top exhaust	
Generator Type:	Hydrogen-cooled unit rated 72 MW at 13.8 kV with 30 psig hydrogen pressure at 10°C	
Performance:	Base Rating	72 MW
	Steam Inlet Pressure	850 psig
	Steam Inlet Temperature	950°F
	Exhaust Pressure	2" to 4" Hg
	Exhaust Temperature	108°F
	Speed	3600 RPM
Steam Turbine Generator Features:	Common base mounted with direct-drive couplings. Accessories include multiple inlet control valves, electric hydraulic control system, lubricating oil system with all pumps and heat exchangers for cooling water hook-up, gland steam system and generator cooling. Excitation compartment complete with static excitation equipment. Switchgear compartment complete with generator breaker potential transformers.	

2648B

4.2.4 Substation

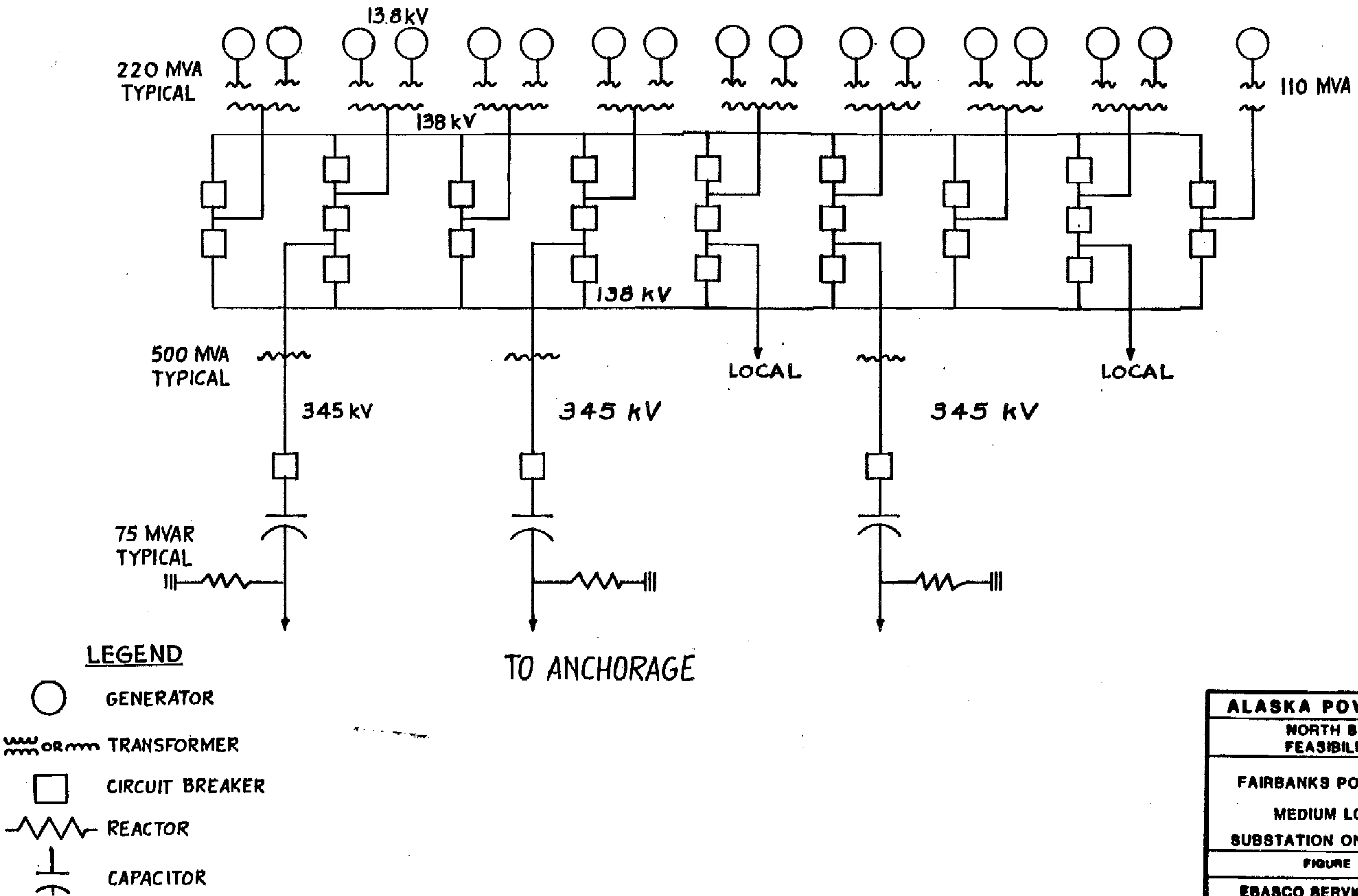
The circuit diagram of the powerplant substation is shown in Figure 4-9. It is quite similar to the North Slope substation (Figure 2-3). Two generators will be connected to the two primary windings of the 250 MVA 13.8/138 kV transformers, and the last generator to a 125 MVA two winding transformer. The bus arrangement will use a breaker and a half scheme unless reliability considerations mandate otherwise. Two 750 MVA 138/345 kV transformers will supply each of the transmission line circuits. Each of the transmission lines will have a circuit breaker. On the line side of the circuit breakers are the series capacitors and the shunt reactors. This arrangement has the advantage of being flexible as far as operation is concerned and can be expanded easily.

4.2.5 Other Systems

In addition to the potable and service water system described in Section 2.1, this plant will require make-up water for the steam cycle. To purify the make-up water a demineralizing system will be required.

Blowdown from the HRSG's and waste from the demineralizer and the condensate polisher represent additional waste handling capacity requirements over and above that previously discussed (Section 2.1). These waste streams will require treatment, in accordance with regulation, prior to discharge.

Other systems such as fire protection or lubricating oil will not change in scope or capacity to any significant degree from those presented in Section 2.1.



ALASKA POWER AUTHORITY

NORTH SLOPE GAS
FEASIBILITY STUDY

FAIRBANKS POWER GENERATION

MEDIUM LOAD FORECAST

SUBSTATION ONE LINE SCHEMATIC

FIGURE 4-9

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4.2.6 Construction and Site Support Services

The construction of this power plant in the Fairbanks area will require the following services:

1. Access Roads
2. Construction Water Supply
3. Construction Power Supply

All new roads will be of similar design to existing public roads in the Railbelt. The roads will be paved, and will meet all code design requirements for the maximum loads expected.

A complete water supply similar to that described in Section 2.1 will be provided, except the source of water will be wells. The construction power supply will be a 12.47 kV line run from existing facilities.

Since a permanent construction force will be utilized through the period of the study, it is assumed that the local area can supply living accommodations for the workforce. The number of workers necessary for construction of the power station will vary over the total period of the project from a low of 50 to a high of approximately 200. Construction facilities required are: utility services; temporary construction office; temporary and permanent access roads; temporary enclosed and open laydown storage facilities; temporary office and shop spaces for various subcontractors; settling basins to collect construction area storm runoff; and permanent perimeter fencing and security facilities.

4.2.7 Operation and Maintenance

<u>Plant Life</u>

Each unit will have a 30 year life expectancy, which is based on the life of the gas turbine units. It is expected that the gas turbine units will be overhauled a number of times throughout the life of the units during scheduled or unscheduled outages.

Heat Rate of Units

The facility's heat rate will vary, depending on the number of gas turbines and heat recovery units operating at a given time. Ideally, with only combined cycle units in operation, a heat rate of 8290 Btu/kWh (HHV, ambient conditions) can be realized.

Scheduled and Forced Outage Rate

It is expected that the forced outage rate will be about 8 percent. Operational experience on other plants indicates higher forced outages in the first few years, but this is attributed to operational adjustments required for a new plant. It is expected that a slight increase in forced outages will occur as the plant ages. Scheduled outages for annual maintenance and periodic overhaul are expected to be approximately 5 percent.

Operating Workforce

The combined cycle power plant will require a continuously increasing staff over the study period. The staff will start at approximately 10 on-duty personnel when the first gas turbine begins operation and will increase to approximately 80 on-duty personnel in the year 2010.

4.2.8 Site Opportunities and Constraints

Fairbanks represents the nearest location to which North Slope gas can be transported to and have the resulting generation of electrical energy be fed directly into an existing portion of the Railbelt electric transmission network. Transportation of heavy equipment to the site does not represent technical problems; however, the location will require expensive overland transport from the port facilities at Anchorage.

4.3 TRANSMISSION SYSTEM

The power to be transmitted from Fairbanks to Anchorage equals the power generated less the Fairbanks area load. This amount is the same as the North Slope generation scenario, except for the line losses between the North Slope and Fairbanks, which are not significant when compared to the power generated. Therefore, the conditions for the Fairbanks to Anchorage transmission line are almost exactly identical for both cases and consist of two new 345 kV lines, and an upgrade of the Willow-Anchorage and Healy-Fairbanks segments of the Intertie from 138 kV to 345 kV (Refer to Section 2.2).

4.4 FAIRBANKS GAS DISTRIBUTION SYSTEM

4.4.1 Fairbanks Residential/Commercial Gas Demand Forecasts

The following paragraphs are a summary of the study performed by Alaska Economics Incorporated to forecast residential and commercial gas demand in Fairbanks. The text of this report appears in Appendix E.

The potential residential and commercial demand for natural gas in the Fairbanks area is dependent on the price competitiveness of natural gas with respect to No. 2 distillate fuel oil and propane in heating and water heating markets, and its price competitiveness with propane and electricity in cooking applications. The potential demand of natural gas as a cooking fuel is estimated to be less than 5.0 percent of the total potential demand for natural gas even if the gas were to fully displace bottled propane in commercial cooking applications.

The forecasts of potential gas demand have been made conditional on the gas achieving discrete percentages of the total market for heating and cooking energy (10 percent, 25 percent, 40 percent, and 100 percent displacement of fuel oil and propane in heating and of propane in cooking). The size of the total market to which these percentages have been applied has, in turn, been projected to grow at a 1.43 percent annual average rate from 1981 for the low growth forecast, and at a 2.30

percent annual average rate for the medium growth forecast. These growth rates are the rates of Fairbanks population growth implied, respectively, by Battelle's (1982) low forecast of the demand for electricity in the Railbelt area, and Acres American's (1981) medium forecast of Railbelt electricity demand.

The prices at which residential and commercial users would have a minimum financial incentive to convert from fuel oil to natural gas for heating purposes have been derived. These "consumer breakeven" prices are based upon the assumption that the maximum discounted payback period for consumers is 5 years. At the 1982 price of No. 2 distillate, $1.22 per gallon, the calculated consumer breakeven prices are $9.58 per MCF for residential heating and $9.94 per MCF for commercial heating. These prices will rise annually at approximately the real (inflation free) rate of increase of fossil fuel prices in general. If this rate is the 2.0 percent real rate assumed by Battelle (1982) and Acres (1981), by the year 2010 the breakeven prices in (1982 dollars) will have reached $16.68 per MCF (residential) and $17.31 per MCF (commercial).

The presence of calculated breakeven prices is necessary for the forecasting of natural gas demand. However, breakeven price data and price elasticity data are insufficient for such a forecast in this case. These price and elasticity data are insufficient because the situation involves a new product (natural gas) competing with an existing product (e.g., distillate oil, propane). Additional factors influence consumer demand including: 1) consumer perceptions of the two products; 2) consumer inertia; 3) initial and/or unusual incentives offered by suppliers of the competing fuels based upon their calculated present worth of achieving certain market shares; and 4) other less defined factors. Because of these unquantified factors, conditional demand estimates have been forecast; and these are based upon price analysis alone.

If natural gas is priced below the consumer breakeven level, users will have an increased financial incentive to shift from fuel oil. For every 10¢ by which the price of gas falls below the breakeven level, residential users will realize approximately $81.00 (in 1982 dollars) in additional savings over the estimated cost of conversion. It might be expected that extensive inroads against fuel oil will begin to be made if gas is priced sufficiently below breakeven so as to cover conversion costs and to achieve a significant level of savings (measured as the excess of the present value of annual cash savings over conversion costs.)

It must be recognized that the producers and suppliers of fuel oil are likely to respond to the intrusion of natural gas by either lowering the price of No. 2 distillate or by offering other incentives. While the intensity of reaction by oil suppliers cannot be forecast, it can be assumed that suppliers are capable of at least offsetting the price advantage that natural gas has traditionally enjoyed based on its reputation as a "clean" fuel. Therefore, the above calculation of consumer breakeven prices correctly ignores the fact that many consumers might be willing to pay a premium for such natural gas properties.

The conditioned demand projections derived are presented in detail in Appendix E and are summarized below for the medium growth projection.

	DELIVERED GAS, BCF PER YEAR	
	1985	2010
MARKET GROWTH @ 2.30 PERCENT		
10% of Market	0.527	0.931
25% of Market	1.319	2.328
40% of Market	2.110	3.726
100% of Market	5.274	9.314

These values represent the annual demand for delivered gas conditional upon the percentage of market penetration indicated, where the total market, defined in terms of effective MMBtu's[1/] is set equal to 100

1/ Effective MMBtu's (million Btu's) are delivered MMBtu's adjusted for the fuel burning efficiency of heating units and cooking units. For example, if oil burners are 65 percent efficient, one delivered MMBtu equals 0.65 effective MMBtu's.

percent of commercial and residential heating energy requirements plus 29 percent of residential cooking energy requirements. The delivered gas demand values were calculated based upon different thermal efficiencies for oil and gas fired units.

The demand for gas would not be constantly distributed throughout the year. Based on an appraisal of normal monthly heating degree days in Fairbanks, and an assumed indoor temperature setting of 65° Fahrenheit, approximately 16.6 percent of annual Fairbanks heating energy is consumed in January, the peak month for demand.[1/] Although cooking energy requirements may be more evenly spread across the year, the relatively small size of cooking demand, less than 5.0 percent of the total, suggests rather strongly that an apportionment of total demand according to the conductive heat transfer formula will yield a good estimate of peak monthly demand. Use of this method implies the following peak monthly demand (January) for natural gas in Fairbanks for the medium growth projection.

	DELIVERED GAS, BCF PER PEAK MONTH	
	January 1985	January 2010
MARKET GROWTH @ 2.30 PERCENT		
10% of Market	0.087	0.155
25% of Market	0.219	0.386
40% of Market	0.350	0.619
100% of Market	0.875	1.546

Peak daily demand during the month of January can reasonably be estimated as 0.0322 (1/31) of the monthly demand times a factor that allows for extremes of cold. Between 1961 and 1982, the highest number of January heating degree days recorded in Fairbanks was 3002 (in January 1971). The January average was 2384. The ratio of the two

[1/] Heat loss is proportional to the indoor-outdoor temperature differential and inversely proportional to the insulation factor. At an indoor temperature setting of 65° Fahrenheit, relative monthly heating degree days is the appropriate measure of relative monthly heat loss.

(1.26) when multiplied by 0.0322 yields an appropriate measure of peak daily demand when their product is in turn multiplied by peak monthly demand. Thus, peak daily demand equals 0.0406 times peak monthly demand. The daily peaks are given in the following table for the medium growth projection:

	DELIVERED GAS, BCF, PEAK DAILY	
	January 1985	January 2010
MARKET GROWTH @ 2.30 PERCENT		
10% of Market	0.004	0.006
25% of Market	0.009	0.016
40% of Market	0.014	0.025
100% of Market	0.036	0.063

Peak hourly demand, defined as 0.0417 (1/24) times peak daily demand is quite small. For example, in the maximal case of 2.30 percent growth and 100 percent market penetration, the peak hourly demand is only 0.0026 BCF, or 2,600 MCF.

Finally, expansion of the Fairbanks steam district heating system could reduce the demand for natural gas below the estimates presented above. On the assumption that the district heating system supplies only commercial and government users, the implied reduction is at most 15.0 percent of the estimates given above, since commercial use of gas is projected to be at most 15.0 percent of total demand.

4.4.2 Fairbanks Gas Distribution System

The Fairbanks natural gas transmission and distribution system will be designed in conformance with Part 5, Alaska Public Utilities Commission, Chapter 48, Practice and Procedures; Federal Safety Standards for Transportation of Natural Gas and Other Gas by Pipeline, 49 CFR Part 293, Latest Revision; and the American National Standard Code for Gas Transmission and Distribution Piping Systems, B 31.8, Latest Edition.

The overall system network will consist of a transmission lateral from a metering station near Fox to a City Gate Station with a minimum inlet pressure to the gate station of 250 psig, a 125 psig high pressure system to distribute gas to district regulators, and a 60 psig maximum distribution system to carry gas to individual customer services. Generally, the rural facilities will be considered in Location Class 3, and those in the urban areas in Location Class 4.

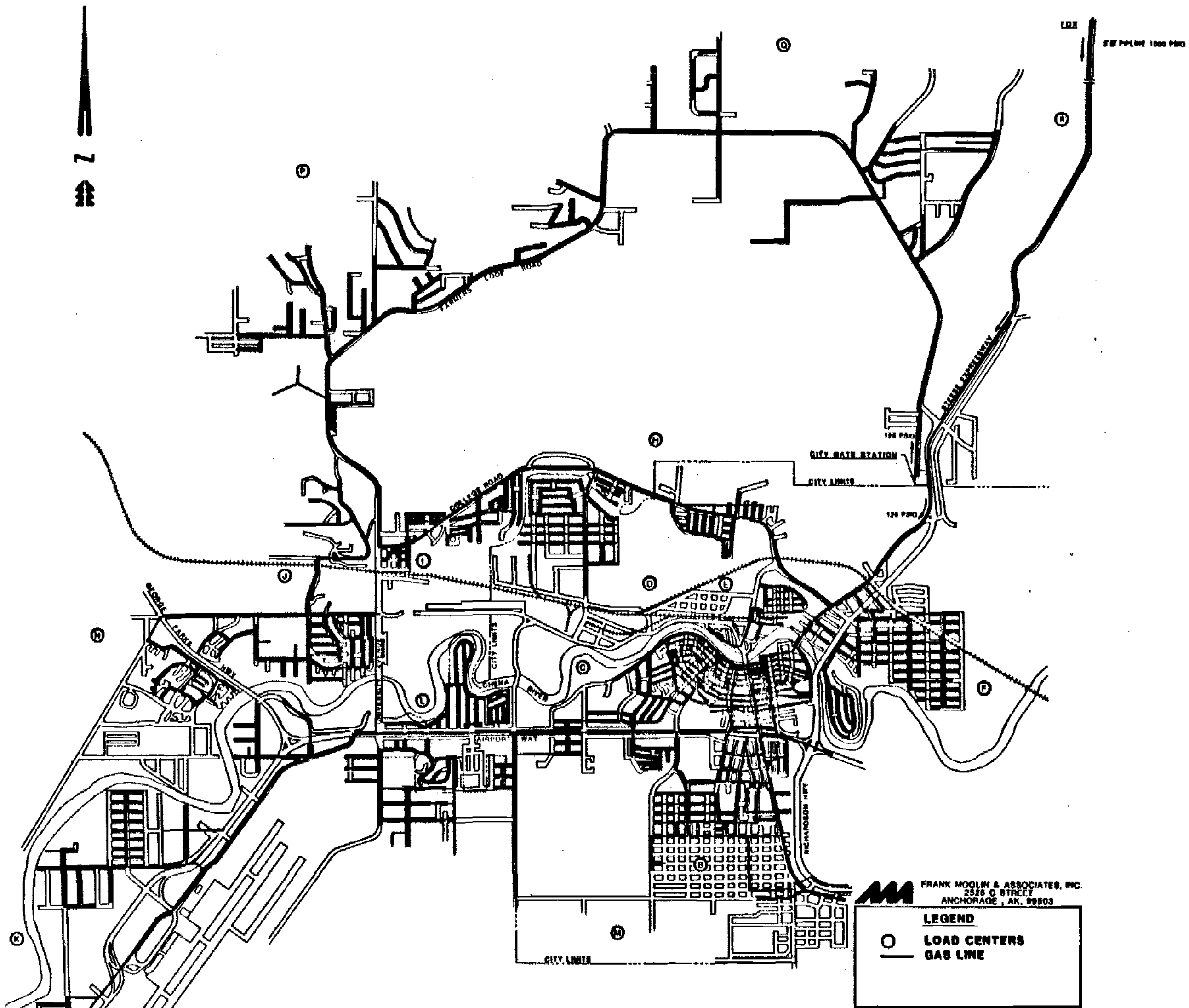
4.4.2.1 Gas Transmission Line

The gas transmission line will connect to the 22-inch pipeline near Fox (Figure 4-10). The line will be in public right-of-way, adjacent to the traveled roadway. The line will follow the Steese Highway to the intersection of Farmers Loop Road to the City Gate Station. This is approximately 12 miles of transmission line.

As load develops north of the Chena Hot Spring Road along the Steese Highway and McGrath Road, a secondary tap and gate station might be considered at the intersection of Chena Hot Spring Road and the Steese Highway for service to this northern load, and as a backfeed to the McGrath and Farmers Loop Road facilities.

The transmission line will operate at the main pipeline pressure of approximately 1,000 psig at the take-off point and have a design pressure of 1,260 psig. The gas flow will be metered at the take-off point.

The transmission line has been designed to provide peak hour coverage for commercial and residential customers in the year 2010. At this point, depending on actual growth and the location of additional supply sources, the transmission line may have to be supplemented. The 2010 peak hour projections were used to determine the range of transmission line sizes required.



NOTES:
1. HIGH PRESSURE DISTRIBUTION FROM CITY GATE STATION AT 125 PSIG.
2. LOW PRESSURE DISTRIBUTION FROM LOAD CENTER AT 60 PSIG.
3. LOAD CENTERS (A), (Q), AND (O) FOR FUTURE USE.

ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

CITY OF FAIRBANKS GAS DISTRIBUTION

FIGURE 4-10

EBASCO SERVICES INCORPORATED

4.4.2.2 City Gate Station

The City Gate Station will be designed for an incoming gas pressure of 1,260 psig. The normal incoming operating pressure could drop as low as 250 psig during the medium forecast peak daily flowrates. The outlet pressure will be 125 psig. Gas heating equipment may be required to prevent the gas temperature from dropping below -20° F.

The vicinity of the intersection of Farmers Loop Road and the old Steese Highway appears to be a suitable location for the City Gate Station. No specific inquiries were made as to availability and cost of vacant land in the area. The station will be above ground and can be accommodated on an average city lot.

United States Geological Survey (USGS) maps indicate that this is a permafrost area. One test bore in the immediate area indicates that permafrost begins at a depth of 19 feet. Further analysis will have to be made to determine soil and foundation conditions before any land commitments are made.

Gas metering, conditioning, pressure reduction and flow control are the basic functions that will take place at the gate station. It is anticipated that the meter runs, control valves, odorization equipment and instrumentation devices will be indoors. A single story concrete block or insulated corrugated metal building approximately 20' x 50' would fulfill the requirement.

Gas purity is a major concern to distribution companies and specifications are incorporated into gas purchase contracts. The North Slope gas conditioning facility, however, will produce a pipeline gas that meets typical specifications for domestic and commercial natural gas. It is therefore assumed that the only gas processing required at the gate station will be particulate and liquids removal carried over from the North Slope to Fairbanks pipeline after primary processing has been accomplished.

Suspended solids and liquids will be removed prior to pressure reduction by means of a conventional scrubber, and liquid resulting from the condensation phenomena accompanying pressure reduction will be removed by liquid knockout drip pots.

A gas odorization system will be part of the gate station facilities. The system will be designed to maintain a relatively constant rate of odorization with varying gas volumes. A liquid injection system based upon gas volume measurement is anticipated. The odorization rate will be in the range of 0.25 to 1.00 pounds odorant per million cubic feet of gas.

Pressure reduction from 1,000 psig inlet pressure to 125 psig station outlet pressure will be accomplished at the gate station. Conventional pressure reducing valve(s) with pilots and bypasses will be used. The outlet of the gate station (inlet to high pressure system) will also be provided with overpressure protection. An atmospheric relief sized to relieve at the maximum allowable operating pressure plus 10 percent or series monitor regulation will be considered.

Metering and gas flow control will take place at parallel meter runs. Station flow will be remotely controlled by the gas dispatcher from the headquarters office. Remote control telemetering will allow the station to be normally unmanned.

4.4.2.3 High Pressure System

The high pressure system will operate at an inlet pressure of 125 psig from the City Gate Station. It is expected to traverse public rights-of-way adjacent to traveled roads as shown on the conceptual grid map (Figure 4-10). Laterals will branch off to load centers where pressure reduction and overpressure protection will be provided at district regulating stations. From these regulator stations, gas will be distributed to the individual 60 psig networks.

Individual high pressure mains are sized based upon peak hour load center estimates using the Spitzglass high pressure formula. The sizes and footages of the high pressure mains based upon the preliminary network analysis are listed below. The high pressure system will be standard wall API 5L GR.B steel pipe as required.

HIGH PRESSURE SYSTEM MAINS

Size	Length - Feet
8"	6,000
10"	15,000
12"	---
14"	27,375
18"	7,500

4.4.2.4 District Regulators

District regulator stations will be located at the inlet to 60 psig distribution networks as shown on Figure 4-10. These fifteen (15) stations will be designed to reduce the inlet pressure to 60 psig, and to provide overpressure protection for the distribution system. The method of overpressure protection (e.g., atmospheric relief, monitor regulators, etc.) will be determined during final design.

The type of construction and location of district regulator stations will also be determined during final design. The options of underground vault versus aboveground station construction must be reviewed with respect to considerations of the availability of public right-of-way, private easement, soil and groundwater characteristics, equipment operating capabilities and safety.

4.4.2.5 Distribution Systems

The distribution systems as shown on Figure 4-10 will deliver maximum 60 psig and minimum 15 psig gas to individual customer services. The lines will be polyethylene pipe, PF 3408 per ASTM D 2513. The pipe will be SDR 11 for Class 4 locations and SDR 13.5 for Class 3 locations. The smoother inside surface of plastic pipe allows the same sizes as steel pipe to handle the higher flowrates. Individual lines will be sized using the Spitzglass formula. In general, distribution lines will be 2" as standard. Larger size lines will be the exception. Distribution lines will be valved to comply with code requirements and good operating practices.

The distribution lines will be laid in public rights-of-way at a depth of three feet to the top of the main. The lines will be laid on the opposite side of the road from existing or proposed water mains. The estimated footages by size of distribution mains are tabulated below.

SCHEDULE OF DISTRIBUTION MAINS

Size	Length - Feet
2"	450,000
4"	78,000
6"	87,000
8"	2,250
12"	1,500

4.4.2.6 Residential Services

Services will be sized to deliver gas for maximum estimated demand of approximately 225 cubic feet per hour (CF/HR).

Residential temperature compensated meters sized for this demand load must also satisfy the following specifications:

Maximum pressure drop	-	0.5" W.C.
Gas temperature	-	30° F
Inlet pressure	-	7" W.C.
Ambient air temperature	-	-70° F

Residential regulators sized to deliver the demand load at an inlet pressure range 15 to 60 psig and an outlet pressure of 6" to 7" W.C. will be specified for residential customers as standard.

Residential services will be standardized as welded and wrapped steel. The meter and regulator will, when desirable, be in the basement. The service will have a curb cock where the meter and regulator is indoors.

If a service meter/regulator set cannot be placed indoors, consideration will be given to enclosing them in a metal or wooden, insulated and heated enclosure. In this case, a curb cock may not be required. The service head will be designed to allow for flexibility of movement due to frost heave and settlement.

Services will be sized for a 1.5 to 3 psig maximum allowable pressure drop for inlet pressures of 15 psig minimum to 60 psig maximum.

Assuming an average service length of 100 feet (allowing for equivalent length for fittings), and a 15 psig inlet pressure and a maximum 1.5 psig pressure drop, a 1/2" steel service has the capacity of 395 CF/HR at a specific gravity of 0.65 and a temperature of 30° F. This is in excess of the 225 CF/HR estimated maximum residential demand, and the allowable pressure drop is not exceeded. Therefore, a system standard of 1/2" service size will be used for the average residential customer.

4.4.2.7 Commercial/Industrial Services

Commercial/industrial services will be designed and constructed following the same general procedures as for residential services. However, no attempt is made to standardize on size. Rather, each service will be sized to meet its special load requirements. In addition, it is highly possible that some commercial/industrial customers may be better served from a 125 psig main. In these cases, the requirement of dual regulation or other secondary overpressure protection will be provided in the service design.

4.4.2.8 Headquarters Building

The headquarters building will contain office space for the gas dispatch and operating personnel. It will also include telemetry for controlling gas flow at the City Gas Station. Building size will be approximately 25' x 50' single story, constructed of concrete block or insulated corrugated metal suitable for climatic conditions in Fairbanks, Alaska.

4.4.2.9 Cold Temperature Design and Environmental Factors

The Fairbanks gas distribution facilities will be designed to meet or exceed the most stringent applicable minimum construction and safety standards. However, there are technical considerations which are not now specifically covered by code which must be investigated in great detail and solutions developed prior to final site selection and completion of detailed design. In addition, there are environmental considerations which must be investigated and addressed more fully during the design phase of the project. Among these are:

1. Permafrost and Frost Heave
2. Field (hydrostatic) Testing
3. Cold Temperature Operation of System Components
4. River and Stream Crossings
5. Ice Fog

<u>Permafrost and Frost Heave</u>

United States Geological Survey data for the area of the gas distribution system has been reviewed. This review indicates that the distribution system will traverse three generalized units of subsurface conditions. These are the Tanana-Chena River Flood Plain, the Upland Hills, and the Creek Valley Bottom formations.

The Tanana-Chena River Flood Plain consists of alternating layers of alluvial silt, sand and gravel. The top silt layers ranges from 1 to 15 feet thick. Permafrost is discontinuous and randomly located and ranges in depth to the top from 2 to 4 feet in older parts of the flood plain, and to 25 to 40 feet in cleared areas. Where frozen, silt has a low to moderate ice content in the form of thin seams. The silt will develop some subsidence when thawed, and may undergo intense seasonal frost heave. The portion of the distribution system "in town" is generally in the flood plain formation .

Adjacent to the flood plain are gently rolling bedrock hills covered by from 3 to 200 feet of windblown silt (loess). The Upland Hills are generally free of permafrost although perennially frozen silt does occur along the base of most hills. Portions of the transmission lateral along the Steese Highway traverse this formation, as do portions of the distribution system along Farmers Loop Road.

The valley bottoms of the upland contain this silt accumulations that are perennially frozen and have high ice content. The depth to permafrost is from 1-1/2 to 3 feet on lower slopes and valley bottoms, from 5 to 20 feet near contact with the unfrozen silt zone, and from 10 to 25 feet in cleared areas.

The seasonal frost layer is from 1-1/2 to 3 feet thick. Seasonal frost action is intense, and there is great subsidence when permafrost thaws. Sections of the transmission lateral along the Steese Highway as well as part of the distribution system along Farmers loop road cross this formation. In addition, the proposed location of the City Gate Station is within the limits of the Creek Valley Bottom formation.

The relation made between the distribution system and area geology above is based upon subsurface formation areas generally described on U.S.G.S. Quadrangle Maps. Local variations may occur, particularly near the interface between formations. Therefore, a detailed analysis of soil conditions along the proposed right-of-way will be necessary to determine where and to what extent frost susceptible soil and/or permafrost exist.

Final facilities location and design must be based upon flowing gas temperatures within the system and subsurface soil survey and analysis. Systems operating temperatures, at one extreme, may cause thermal degradation of permafrost, and at the other extreme frost heave may be the problem. In either case, specialized design may be necessary to assure that the integrity of the system and/or the environment are not jeopardized.

Field (Hydrostatic) Testing

The detailed design phase of the project will result in final determination of the pipe specifications for the project. These will be based upon the balance of service performance expectations and the economics of purchase and installation. At that time, the final code and permit requirements with respect to testing will be more exactly known.

Hydrostatic testing will require that procedures and specifications address testing at ambient air temperatures below 32° F., and dewatering and "drying" of pipe lines after testing. In addition, cold temperature testing will require a review of brittle fracture mechanics for the specified pipe material.

As generally designed now, the 60 psig distribution system would be pneumatically tested to 100 psig. The 125 psig high pressure system would be hydrostatically tested to 175 psig. The transmission lateral would be tested hydrostatically to 1.4 times the maximum operating pressure.

System Component Operation

The effects of subarctic temperatures and the temperature of flowing gas will require particular attention and perhaps specialized design to assure long, trouble free operation of the system. Among the areas where special effort may be required are:

Gas Meters:	Diaphragm materials with acceptable lower operating temperature limit to -70° F. must be provided. Potential condensate problems must be analyzed.
Shut Off Valve:	Lubricant freeze up potentials must be investigated. Valve box and operating nut accessibility in frozen snow and ice must be reviewed.

Pipe Material: Effects of stress at cold temperature must be considered. Stresses resulting from cold temperature must be considered in design.

Regulators: Effects of cold temperature and condensate freeze up on diaphragm and valve discs must be studied.

River and Stream Crossings

The conceptual system layout indicates that there are nine river and creek pipeline crossings. They are:

Jessela Creek at Farmers Loop Road
Isabella Creek at Farmers Loop Road
Pearl Creek at Farmers Loop Road
Chena River at N. Hall Street
Noyes Slough at Illinois Street
Noyes Slough at Alder Avenue
Deadman Slough at Geist Road
Deadman Slough at Loftus Road
Deadman Slough at Fairbanks Street

It is anticipated that the major crossing can be made using existing bridges. These will require close interface with highway officials and engineers. Specialized design for support, thermal movement, installation procedures, and protective coating may be necessary.

Those crossings for which a bridge crossing is not possible will require that stream flows, bed movement and scour, and potential fishery impacts be analyzed, and that appropriate design and construction procedures be developed accordingly.

Ice Fog

Ice fog is a serious and complex problem which is still being studied. Many solutions have been suggested to reduce the occurrence of ice fog. The principal focus has been on reducing water vapor emissions from the generation of heat and power. It is understood that as the quantity of water vapor released to this atmosphere is reduced, the temperature at which ice fog forms will decrease away from zero, thus decreasing the frequency of occurrence. Any design of a gas distribution system in

Fairbanks must include appropriate measures to reduce water vapor released to the atmosphere.

4.5 COST ESTIMATES

4.5.1 Capital Costs

4.5.1.1 North Slope to Fairbanks Natural Gas Pipeline

Order of magnitude, investment cost estimates have been prepared for the systems and facilities which comprise the North Slope to Fairbanks natural gas pipeline. These estimates are presented in Table 4-14.

4.5.1.2 Power Plant

To support the derivation of total systems costs which are presented in Section 4.5.4, order of magnitude investment costs were developed for the major bid lines items common to a 77 MW (ISO conditions) natural gas fired simple cycle combustion turbine and a 220 MW (ISO conditions) natural gas fired combined cycle plant. These costs are presented in Tables 4-15 and 4-16. The costs represent the total investment for the first unit to be developed at the site. Additional simple cycle units will have an estimated investment cost of $33,900,000 while additional combined cycle units will have an estimated investment cost of $127,430,000. The cost differential for additional units is due to significant reductions in line items 1 and 15, improvements to Site and Off-Site Facilities, and reductions in Indirect Construction Cost and Engineering and Construction Management.

4.5.1.3 Transmission Line Systems

Transmission line order of magnitude investment cost estimates for the Fairbanks to Anchorage connection are presented in Table 4-17. These estimates are based on two new 345 kV lines, in parallel, 1400 MW capacity, with series compensation and an intermediate switching

TABLE 4-14

ORDER OF MAGNITUDE INVESTMENT COSTS
NORTH SLOPE TO FAIRBANKS NATURAL GAS PIPELINE
(January, 1982 Dollars)

Description 1/	Materials ($1000)	Construction Labor 2/ ($1000)	Total Direct Cost ($1000)
22 in O.D. Gas Pipeline	480,000	4,100,000	4,580,000
Compressor Stations - 10 ea	96,800	83,400	180,200
Metering Stations - 2 ea	2,800	6,000	8,800
Valve Stations - 28 ea	2,500	3,800	6,300
Engineering & Construction Management	—	—	28,700
SUBTOTAL	$582,100	$4,193,200	$4,804,000
Gas Conditioning Facility 3/			780,000
TOTAL CONSTRUCTION COST			$5,584,000

1/ A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes and land and land rights expenses have not been included.

2/ Construction camp facilities and services are subsumed in the Construction Labor cost category.

3/ Factored pricing basis which includes engineering and construction management costs.

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TABLE 4-15

ORDER OF MAGNITUDE INVESTMENT COST ESTIMATES
77 MW SIMPLE CYCLE COMBUSTION TURBINE
(January, 1982 Dollars)

Description[1/]	Materials ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
1. Improvements to Site	405	1,240	1,645
2. Earthwork and Piling	195	345	540
3. Circulating Water System	0	0	0
4. Concrete	475	2,145	2,620
5. Structural Steel Lifting Equipment, Stacks	1,725	1,370	3,095
6. Buildings	750	1,440	2,190
7. Turbine Generator	11,100	650	11,750
8. Steam Generator and Accessories	0	0	0
9. Other Mechanical Equipment	460	235	695
10. Piping	205	510	715
11. Insulation and Lagging	30	110	140
12. Instrumentation	100	70	170
13. Electrical Equipment	1,510	2,590	4,100
14. Painting	70	250	320
15. Off-Site Facilities	300	1,080	1,380
SUBTOTAL	$17,325	$12,035	$29,360
Freight Increment			865
TOTAL DIRECT CONSTRUCTION COST			$30,225
Indirect Construction Costs			1,665
SUBTOTAL FOR CONTINGENCIES			31,890
Contingencies (15%)			4,790
TOTAL SPECIFIC CONSTRUCTION COST			36,680
Engineering and Construction Management			2,200
TOTAL CONSTRUCTION COST			$38,880

1/ The following items are not addressed in the plant investment pricing: laboratory equipment, switchyard and transmission facilities, spare parts, land or land rights, and sales/use taxes.

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TABLE 4-16

ORDER OF MAGNITUDE INVESTMENT COSTS
220 MW COMBINED CYCLE PLANT
(January, 1982 Dollars)

Description[1/]	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
1. Improvements to Site	425	1,295	1,720
2. Earthwork and Piling	570	1,050	1,620
3. Circulating Water System	0	0	0
4. Concrete	1,485	6,730	8,215
5. Structural Steel Lifting Equipment, Stacks	3,800	3,530	7,330
6. Buildings	1,800	3,600	5,400
7. Turbine Generator	30,100	2,520	32,620
8. Steam Generator and Accessories	9,600	4,320	13,920
9. Other Mechanical Equipment	6,735	3,425	10,160
10. Piping	1,500	2,910	4,410
11. Insulation and Lagging	290	690	980
12. Instrumentation	1,700	290	1,990
13. Electrical Equipment	4,550	8,640	13,190
14. Painting	200	720	920
15. Off-Site Facilities	300	1,080	1,380
SUBTOTAL	$63,055	$40,800	$103,855
Freight Increment			3,155
TOTAL DIRECT CONSTRUCTION COST			$107,010
Indirect Construction Costs			4,235
SUBTOTAL FOR CONTINGENCIES			111,245
Contingencies (15%)			16,685
TOTAL SPECIFIC CONSTRUCTION COST			127,930
Engineering and Construction Management			6,800
TOTAL CONSTRUCTION COST			$134,730

1/ The following items are not addressed in the plant investment pricing: laboratory equipment, switchyard and transmission facilities, spare parts, land or land rights, and sales/use taxes.

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TABLE 4-17

ORDER OF MAGNITUDE INVESTMENT COSTS
FAIRBANKS TO ANCHORAGE TRANSMISSION SYSTEM
(January, 1982 Dollars)

Description1/	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Switching Stations	14,112	12,445	26,557
Substations	62,308	41,716	104,024
Energy Management Systems	12,300	10,960	23,260
Steel Towers and Fixtures	216,495	305,085	521,580
Conductors and Devices	33,678	78,361	112,039
Clearing	---	83,144	83,144
SUBTOTAL	$388,893	$531,711	$870,604
Land and Land Rights2/			27,600
Engineering and Construction Management			60,950
TOTAL CONSTRUCTION COST			$959,154

1/ The investment costs reflect two new 345 kV lines, 1400 MW capacity, with series compensation and an intermediate switching station and upgrading of the Willow-Anchorage and Healy-Fairbanks segments of the existing grid to 345 kV.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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station. The investment cost estimates also reflect upgrading from 138 kV to 345 kV of the Willow-Anchorage and Healy-Fairbanks segments of the existing grid.

4.5.1.4 Gas Distribution System

Order of magnitude, investment cost estimates (January, 1982 dollars) have been prepared for the systems and facilities which comprise the Fairbanks gas distribution system. The results of the analyses are given below. A 15 percent contingency has been assumed for the entire project and has been distributed between each cost category. Sales/use taxes and land rights have not been included.

	Materials ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Gas Distribution System	$11,500	$48,200	$59,700
Engineering and Construction Management			3,582
TOTAL CONSTRUCTION COST			$63,282

4.5.2 Operating and Maintenance Costs

4.5.2.1 Gas Pipeline and Conditioning Facility

Annual Operating and maintenance costs (January, 1982 dollars) for the gas conditioning facilities are estimated to be as follows:

ITEM	ANNUAL COSTS ($1000)
Salaries	$2,480
Maintenance Costs (Parts and Expendables)	3,750
TOTAL	$6,230

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Annual operating and maintenance costs (January, 1982 dollars) for the gas compressor stations and pipeline maintenance activities are estimated to be as follows:

ITEM	ANNUAL COSTS ($1000)
Salaries	$ 4,400
Maintenance Costs (Parts, Expendables, Other)	5,850
TOTAL	$10,250

4.5.2.2 Power Plant

Operating and maintenance costs for the combined cycle facility at Fairbanks are estimated to be $0.0040/ kWh. These are based on discussions with operating plant personnel, history of similar units, Electric Power Research Institute data, published data and other studies performed.

4.5.2.3 Transmission Line Systems

Annual operating and maintenance costs (January 1982 dollars) have been developed for the scenario's required transmission line facilities and total $12 million per year. These costs should be viewed as an annual average over the life of the system. Actual O&M costs should be less initially, and will increase with time.

4.5.2.4 Gas Distribution System

Annual operating and maintenance costs (January 1982 dollars) for the Fairbanks gas distribution system are estimated to be as follows:

Item	ANNUAL COSTS ($1000)
Salaries	$1,290
Maintenance Costs (Parts, Consumables, Other)	500
TOTAL	$1,790

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4.5.3 Fuel Costs

For the economic analyses which follow fuel costs were treated as zero. This approach permits fuel cost and fuel price escalation to be treated separately; and makes possible subsequent sensitivity analyses of the Present Worth of Costs for this scenario based upon a range of fuel cost and cost escalation assumptions.

4.5.4 Total System Costs

4.5.4.1 Cost Allocation Methodology

For purposes of total system cost comparisons, natural gas pipeline conditioning plant and pipeline costs from the North Slope to Fairbanks must be allocated between electricity generation applications and residential/commercial customer applications. In this way the non-electric system costs can be removed from the total cost comparison associated with electricity supply. Two types of costs must be allocated: (1) capital investment costs; and (2) annual costs, including operating and maintenance (O&M) costs and fuel costs (e.g., for pipeline compressor stations).

Capital cost allocation is based upon the peak demand for natural gas, and consequently the capacity requirements of the line. In this allocation it is useful to make the conservative assumption that both peak loads may occur simultaneously. Given that assumption, the following formulas can be used to allocate capital costs:

$$P_E/(P_E + P_R) = O_I \qquad (1)$$

$$O_I\ (I_{GC} + I_p) = ESCC \qquad (2)$$

Where

- P_E = peak natural gas demand for electricity generation
- P_R = peak natural gas demand for residential and commercial uses
- O_I = the proportion of investment costs charged to electricity generation
- I_{GC} = capital investment in the conditioning plant
- I_p = capital investment in the pipeline
- ESCC = electric service related capital charges

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The second formula arrives at the specific dollar value for allocation purposes. It can be applied either to I_{GC} or I_p separately when capital costs must be disaggregated by component, or as shown for the total capital burden. Neither formula is applied to investments that are specific to one user community (e.g. the residential gas distribution system), as those investment costs must be borne totally by the appropriate users.

Annual costs are allocated on an energy basis rather than on a capacity basis. Those costs are allocated by the following formula:

$$SC_A = SC_{O+M} + SC_F \qquad (3)$$
$$EC_E \ (EC_E + EC_R) = O_A \qquad (4)$$
$$O_A \times SC_A = ESAC \qquad (5)$$

Where:

SC_A =	total shared annual charges
SC_{O+M} =	shared O & M costs
SC_F =	shared fuel costs
EC_E =	annual natural gas consumption for electricity generation
EC_R =	annual natural gas consumption by residential and commercial users
O_A =	the proportion of annual costs charged to electricity generation
ESAC =	electrical service related annual costs

Again, disaggregation may be accomplished for O&M or fuel costs; and this is accomplished by multiplying the O_A term by either SC_{O+M} or SC_F. Again, only shared costs are considered, and user community-specific costs are not considered.

Given these formulae, costs may be disaggregated. Costs may be allocated to residential and commercial users by substituting $(1-O_I)$ for O_I and $(1-O_A)$ for O_A. Precise comparison of the electrical generation options can now be accomplished.

4.5.4.2 Power Generation System Costs

The Fairbanks medium load growth scenario is far more complex than the Prudhoe Bay medium load growth scenario in that it includes: (1) a gas conditioning facility, (2) a natural gas pipeline, (3) power generation facilities, and (4) transmission line facilities.

Further, the conditioning plant and pipeline facilities serve both electricity and residential/commercial markets. As a consequence, the capital, operating and maintenance, and fuel costs associated with the conditioning facility and pipeline must be apportioned to the respective user communities.

The method for apportionment has been previously described (see Section 4.5.4.1). On this basis 0_I and 0_A values are calculated (0 refers to the fraction of costs apportioned to the electricity segment of the natural gas market). 0_I, the capital cost apportionment term, is calculated as follows for the medium load forecast:

Residential/Commercial Peak Daily Flow (2010)	=	63 MMSCFD
Electricity Generation Peak Daily Flow (2010)	=	271 MMSCFD
Total Peak Daily Flow	=	334 MMSCFD
0_I	=	0.82

0_A, the annual costs apportionment term, varies over time for the medium load forecast. Values for 0_A are presented in Table 4-18.

Given the apportionment terms, the annual systems costs for the electricity generation system can be presented. The annual capital expenditures are shown in Table 4-19. The annual non-fuel O&M costs are shown in Table 4-20. The annual fuel costs, based upon a wellhead price and escalated at 2 percent per year (above inflation) are shown in Table 4-21. The summary of total systems costs is presented in Table 4-22.

TABLE 4-18

0_A VALUES[1/]

FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST

Calendar Year	Residential Demand (BCFY)	Electrical Demand (BCFY)	Total Demand (BCFY)	0_A
1982	0.	0.	0.	NA[2/]
1983	0.	0.	0.	NA
1984	0.	0.	0.	NA
1985	0.	0.	0.	NA
1986	0.	0.	0.	NA
1987	0.	0.	0.	NA
1988	0.	0.	0.	NA
1989	0.	0.	0.	NA
1990	0.	0.	0.	NA
1991	0.	0.	0.	NA
1992	0.	0.	0.	NA
1993	1.219	6.266	7.485	0.84
1994	2.494	6.266	8.760	0.72
1995	3.827	12.532	16.359	0.77
1996	5.220	12.633	17.853	0.71
1997	6.676	25.133	31.809	0.79
1998	6.829	25.203	32.032	0.79
1999	6.986	25.203	32.189	0.78
2000	7.147	31.551	38.698	0.82
2001	7.311	31.467	38.778	0.81
2002	7.479	37.804	45.283	0.83
2003	7.651	37.804	45.455	0.83
2004	7.827	44.188	52.015	0.85
2005	8.008	45.809	53.817	0.85
2006	8.192	49.535	57.727	0.86
2007	8.380	53.146	61.526	0.86
2008	8.573	52.292	60.865	0.86
2009	8.770	55.893	64.663	0.86
2010	8.971	59.425	68.396	0.87

1/ Values as calculated are shown for purposes of reproducibility only, and do not imply accuracy beyond 100 MMSCFD.

2/ NA - Not applicable

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TABLE 4-19

TOTAL ANNUAL CAPITAL EXPENDITURES
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated[1/] Unit A	Unit B	Transmission Line	Pipeline	Gas Conditioning Plant	Total
1982	0.	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.	0.
1988	0.	0.	514.2	0.	0.	514.2
1989	0.	0.	118.1	1,313.1	0.	1,431.2
1990	0.	0.	232.4	1,313.1	319.8	1,865.3
1991	9.91[2/]	0.	94.5	1,313.1	319.8	1,737.3
1992	33.90	0.	0.	0.	0.	33.9
1993	0.	0.	0.	0.	0.	0.
1994	33.90	0.	0.	0.	0.	33.9
1995	56.97	0.	0.	0.	0.	57.0
1996	33.90	33.90	0.	0.	0.	67.8
1997	56.97	0.	0.	0.	0.	57.0
1998	0.	0.	0.	0.	0.	0.
1999	33.90	0.	0.	0.	0.	33.9
2000	0.	0.	0.	0.	0.	0.
2001	33.90	56.97	0.	0.	0.	90.0
2002	0.	0.	0.	0.	0.	0.
2003	33.90	0.	0.	0.	0.	33.9
2004	33.90	56.97	0.	0.	0.	90.9
2005	33.90	0.	0.	0.	0.	33.9
2006	33.90	0.	0.	0.	0.	33.9
2007	56.97	0.	0.	0.	0.	57.0
2008	33.90	0.	0.	0.	0.	33.9
2009	33.90	0.	0.	0.	0.	33.9
2010	0.	0.	0.	0.	0.	0.
Total	$554.	$148.	$959.	$3,939.	$640.	$6,240.

1/ Unit B denotes a second unit erected in any give year.

2/ Includes all site preparation activities for multiple unit site.

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TABLE 4-20

TOTAL ANNUAL NON-FUEL OPERATING AND MAINTENANCE COSTS
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated	Transmission Line	Pipeline	Gas Conditioning Plant	Total
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.
1991	0.	0.	0.	0.	0.
1992	0.	0.	0.	0.	0.
1993	2.260	12.0	8.61	5.23	28.1
1994	2.260	12.0	7.38	4.49	26.1
1995	4.520	12.0	7.89	4.80	29.2
1996	6.376	12.0	7.28	4.42	30.1
1997	10.880	12.0	8.10	4.92	35.9
1998	12.720	12.0	8.10	4.92	37.7
1999	12.720	12.0	8.00	4.86	37.6
2000	15.020	12.0	8.41	5.11	40.5
2001	14.980	12.0	8.30	5.05	40.3
2002	19.080	12.0	8.51	5.17	44.8
2003	19.080	12.0	8.51	5.17	44.8
2004	21.396	12.0	8.71	5.30	47.4
2005	23.120	12.0	8.71	5.30	49.1
2006	24.212	12.0	8.82	5.36	50.4
2007	25.300	12.0	8.82	5.36	51.5
2008	26.392	12.0	8.82	5.36	52.6
2009	27.480	12.0	8.82	5.36	53.7
2010	28.572	12.0	8.92	5.42	54.9
Total	$296.	$216.	$151.	$92.	$755.

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TABLE 4-21

TOTAL ANNUAL COSTS
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Capital Expenditures	O & M Costs	Total Expenditures
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	499.8	0.	499.88
1989	1,431.2	0.	1,431.22
1990	1,865.3	0.	1,865.33
1991	1,737.3	0.	1,737.33
1992	33.9	0.	33.99
1993	0.	28.1	28.14
1994	33.9	26.1	60.04
1995	57.0	29.2	86.29
1996	67.8	30.1	97.94
1997	57.0	35.9	92.94
1998	0.	37.7	37.77
1999	33.9	37.6	71.57
2000	0.	40.5	40.54
2001	90.9	40.3	131.24
2002	0.	44.8	44.81
2003	33.9	44.8	78.72
2004	90.9	47.4	138.30
2005	33.9	49.1	83.03
2006	33.9	50.4	84.39
2007	33.9	51.5	85.43
2008	33.9	52.6	86.54
2009	33.9	53.7	87.63
2010	0.	54.9	54.90
Total	$6,240.	$755.	$6,994.
Present Worth @ 3%	$4,787.	$415.	$5,202.

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For comparison purposes, the 1982 present worth of power generating costs has been calculated, assuming a real discount rate of 3 percent and excluding fuel costs. The present worth of costs, expressed in 1982 dollars, is $5.2 billion. The present worth of costs for the Fairbanks gas distribution system is $0.9 billion.

4.5.4.3 Gas Distribution System Costs

The costs attributable to the gas distribution system are those costs not associated with electricity generation. The capital costs include a portion of the gas conditioning plant, a portion of the pipeline, and the Fairbanks residential/commercial gas distribution itself. Operating and maintenance costs, and internal fuel requirements, must be treated in a like manner.

In Section 4.5.4.2 the values for 0_I and 0_A were presented. Allocation of costs to the gas distribution system require the presentation of $(1-0)_I$ and $(1-0)_A$ values; and these are presented in Table 4-22. These are required because, by definition, 1-0 defines the portion of costs associated with joint investments attributed to non-electric purposes.

Given such values, the annualized expenditures associated with the natural gas distribution system can be calculated. These are summarized in Tables 4-23 through 4-25. The present worth of all costs associated with the distribution system, as of 1982, is $891 million (January, 1982 dollars), excluding fuel costs.

4.6 ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATIONS

Environmental effects associated with the Fairbanks power generation scenario will be similar in many respects to those of the North Slope scenario. Because the pipeline from the North Slope to Fairbanks will be buried and chilled, it will result in different environmental effects and will require different types of mitigation than would a

TABLE 4-22

APPORTIONMENT VALUES FOR THE GAS DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - MEDIUM LOAD SCENARIO

Term	Year	Value
$(1-0)_I$	NA[1/]	0.18
$(1-0)_A$	1982-1992	NA
	1993	0.16
	1994	0.28
	1995	0.23
	1996	0.29
	1997	0.21
	1998	0.21
	1999	0.22
	2000	0.18
	2001	0.19
	2002	0.17
	2003	0.17
	2004	0.15
	2005	0.15
	2006	0.14
	2007	0.14
	2008	0.14
	2009	0.14
	2010	0.13

1/ NA - Not applicable

TABLE 4-23

TOTAL ANNUAL CAPITAL EXPENDITURES FOR THE GAS DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Gas Distribution System	Pipeline	Gas Conditioning Plant	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	0.	0.
1986	0.	0.	0.	0.
1987	0.	0.	0.	0.
1988	0.	0.	0.	0.
1989	12.66	288.2	0.	300.9
1990	12.66	288.2	70.2	371.1
1991	12.66	288.2	70.2	371.1
1992	12.66	0.	0.	12.7
1993	12.66	0.	0.	12.7
1994	0.	0.	0.	0.
1995	0.	0.	0.	0.
1996	0.	0.	0.	0.
1997	0.	0.	0.	0.
1998	0.	0.	0.	0.
1999	0.	0.	0.	0.
2000	0.	0.	0.	0.
2001	0.	0.	0.	0.
2002	0.	0.	0.	0.
2003	0.	0.	0.	0.
2004	0.	0.	0.	0.
2005	0.	0.	0.	0.
2006	0.	0.	0.	0.
2007	0.	0.	0.	0.
2008	0.	0.	0.	0.
2009	0.	0.	0.	0.
2010	0.	0.	0.	0.
Total	$63.	$865.	$140.	$1,068.

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TABLE 4-24

TOTAL ANNUAL NON-FUEL OPERATING AND MAINTENANCE COSTS
FOR THE GAS DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Gas Distribution System	Pipeline	Gas Conditioning Plant	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	0.	0.
1986	0.	0.	0.	0.
1987	0.	0.	0.	0.
1988	0.	0.	0.	0.
1989	0.	0.	0.	0.
1990	0.	0.	0.	0.
1991	0.	0.	0.	0.
1992	0.	0.	0.	0.
1993	1.8	1.7	1.0	4.5
1994	1.8	3.0	1.7	6.5
1995	1.8	2.4	1.4	5.6
1996	1.8	3.0	1.8	6.6
1997	1.8	2.2	1.3	5.3
1998	1.8	2.2	1.3	5.3
1999	1.8	2.3	1.4	5.5
2000	1.8	1.8	1.1	4.7
2001	1.8	1.9	1.2	4.9
2002	1.8	1.7	1.1	4.6
2003	1.8	1.7	1.1	4.6
2004	1.8	1.5	0.9	4.2
2005	1.8	1.5	0.9	4.2
2006	1.8	1.4	0.9	4.2
2007	1.8	1.4	0.9	4.2
2008	1.8	1.4	0.9	4.2
2009	1.8	1.4	0.9	4.2
2010	1.8	1.3	0.8	3.9
Total	$32.	$34.	$20.	$86.

TABLE 4-25

ANNUAL SYSTEMS COST SUMMARY, GAS DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Capital Expenditures	O&M Costs	Total Expenditures
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	300.9	0.	300.9
1990	371.1	0.	371.1
1991	371.1	0.	371.1
1992	12.7	0.	12.7
1993	12.7	4.5	17.2
1994	0.	6.5	6.5
1995	0.	5.6	5.6
1996	0.	6.6	6.6
1997	0.	5.3	5.3
1998	0.	5.3	5.3
1999	0.	5.5	5.5
2000	0.	4.7	4.7
2001	0.	4.9	4.9
2002	0.	4.6	4.6
2003	0.	4.6	4.6
2004	0.	4.2	4.2
2005	0.	4.2	4.2
2006	0.	4.2	4.2
2007	0.	4.2	4.2
2008	0.	4.2	4.2
2009	0.	4.2	4.2
2010	0.	3.9	3.9
Total	$1,068.	$86.	$1,154.
Present Worth @ 3%	$841.	$51.	$891.

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transmission line through the same area. As in the North Slope scenario, power plant emissions will be a significant consideration because of existing air quality problems in the Fairbanks area. Environmental impacts caused by the transmission line from Fairbanks to Anchorage will be identical to those discussed for the North Slope scenario, Sections 2.5 and 3.5, and are not repeated here. Power plant characteristics related to environmental effects are summarized in Table 4-26.

4.6.1 Air Resource Effects

Meteorological conditions in the Fairbanks area play a very important role in determining the ambient air quality levels in the area. Analyses of the Fairbanks urban "heat island" have shown that winds are generally light in the winter and that wind directions change dramatically in the vertical direction during the wintertime. During the winter months, the air near the ground is relatively cold, compared to the air aloft. This reduces mixing of the air in the vertical direction, and when combined with relatively light winds, often leads to periods of air stagnation.

In large part due to the winter stagnation conditions, the Fairbanks area is currently designated as a non-attainment area for carbon monoxide (CO). Emissions of CO are largely due to automobiles. The State Department of Environmental Conservation and the Fairbanks North Star Borough Air Pollution Control Agency are implementing a plan to reduce the ambient CO mainly through the use of vehicle emission or traffic control techniques. In addition, relatively high levels of nitrogen oxides have recently been monitored in the Fairbanks area. Only an annual average nitrogen dioxide standard exists, but the short term measurements of nitrogen oxides are as high as in major urban areas such as Los Angeles.

The installation and permitting of a major fuel-burning facility, such as a power plant, will require a careful analysis of the impact of its

TABLE 4-26

ENVIRONMENT RELATED POWER PLANT CHARACTERISTICS
FAIRBANKS POWER GENERATION - MEDIUM LOAD FORECAST
COMBINED CYCLE POWER PLANT

Air Environment	
Emissions	
Particulate Matter	Below Standards
Sulfur Dioxide	Below Standards
Nitrogen Oxides	Emissions variable within standards - dry control techniques would be used to meet calculated NO_x standard of 0.014 percent of total volume of gaseous emissions. This value calculated based upon new source performance standards, facility heat rate, and unit size.
Physical Effects	Maximum structure height of 50 feet
Water Environment	
Plant Water Requirements	200 GPM
Plant Discharge Quantity including treated sanitary waste, floor drains, boiler blowdown and demineralizer wastes	Less than 200 GPM
Land Environment	
Land Requirements	
Plant	140 acres
Socioeconomic Environment	
Construction Workforce	Approximately 200 personnel at peak construction
Operating Workforce	Approximately 150 employed personnel

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emissions on ambient air quality. Because Fairbanks is a non-attainment area, the operators of such a facility must demonstrate that they will reduce, or offset, impacts of the power plant by reducing emission levels of CO at other sources. Emissions of CO from a natural gas-fired power plant are relatively low, and any displacement of the burning of other fuels, such as coal or oil, will likely lead to improved air quality. This arises from the clean-burning nature of natural gas and from the fact that emissions from a major facility will be injected higher in the atmosphere (due to plume buoyancy) than the displaced emissions. During the very stagnant conditions in midwinter, the plume from a power plant will likely remain well aloft with little mixing to the surface layers. The complex urban heat island and associated wind pattern will require a great deal of in-depth modeling and analysis to determine air quality impacts in terms that will withstand regulatory scrutiny.

A large combustion turbine power plant must meet the existing New Source Performance Standards and Best Available Control Technology. The nitrogen oxides limits will be the most constraining atmospheric pollutant. The operation of the power plant will also consume a portion of the allowable deterioration in air quality for nitrogen oxides. While it is possible that the power plant could be sited near Fairbanks, its installation would constrain other development efforts which also might consume a portion of the air quality increment. The nature, magnitude, and duration of emission plumes must be studied as well as the potential for beneficial impacts due to reduced combustion at other sources within the area.

The Fairbanks area is also subjected to extended periods of wintertime ice fog, and the Alaska Department of Environmental Conservation will require the impact of any water vapor plumes to be carefully assessed. A combustion turbine power plant which uses water or steam injection techniques would have an adverse impact on the ice fog and icing deposition nearby. For the purposes of this study, it is assumed that Best Available Control Technology would be defined to not include water or steam injection.

Construction of the gas pipeline from the North Slope to Fairbanks will result in fugitive dust and exhaust emissions from construction vehicles. These air quality impacts will be temporary and located in very sparsely populated areas, and will therefore be insignificant.

Ten compressor stations will be located along the pipeline route, each producing relatively low levels of emissions. The impacts of these facilities will most likely not cause exceedances of the Alaska Ambient Air Quality Standards and will not be required to meet the Prevention of Significant Deterioration Increments. The emissions will not impact any air quality sensitive areas.

4.6.2 Water Resource Effects

The gas-fired combined cycle power plant described in Section 4.2 will use approximately 200 gpm of fresh water for boiler make-up, potable supplies, and miscellaneous uses such as equipment wash-down. Because ample groundwater exists in the Fairbanks area and because the water requirements are not particularly large, impacts on water supplies in the area will not be significant.

Power plant wastes will consist of wash-down water (for cleaning of equipment), sanitary wastes, boiler blowdown, and demineralizer regenerant wastes. The wash-down water will be treated for oil and suspended solids removal. Sanitary wastes will be passed through a sanitary wastewater treatment facility, and demineralizer wastes will be treated for pH control. No treatment should be required for boiler blowdown. The resultant wastewater stream, up to 200 gpm, will meet all applicable effluent guidelines and will be discharged to a local water body with sufficient assimilating capacity.

The gas pipeline from the North Slope to Fairbanks will cross 15 major streams and rivers, including the Yukon River, and could potentially impact numerous additional small streams and drainages. The pipeline will be buried for its entire length; vegetation will be disturbed within a 50 ft wide strip. Without careful siting and construction practices, erosion from exposed areas could cause sedimentation problems in nearby water bodies.

To control soil-loss and subsequent sedimentation effects, several mitigation practices should be used during pipeline construction. Existing work pads, highways, access roads, airports, material sites, and disposal sites should be used whenever possible to minimize vegetation disturbance. Pipeline rights-of-way and access roads should avoid steep slopes and unstable soils. Hand clearing could be used in areas where the use of heavy equipment would cause unacceptable levels of soil erosion. A 50-foot buffer strip of undisturbed land could be maintained between the pipeline and streams, lakes, and wetlands wherever possible. Construction equipment should not be operated in water bodies except where necessary. Where high levels of sediment are expected from construction activity, settling basins should be constructed and maintained. All disturbed areas should be left in a stabilized condition through the use of revegetation and water bars; culverts and bridges should be removed, and slopes should be restored to approximately their original contour.

A significant problem with the operation of a chilled, buried pipeline is the formation of aufeis. Aufeis is an ice structure formed by water overflowing onto a surface and freezing, with subsequent layers formed by repeated overflow. Chilled pipe in streams can cause the stream to freeze to the bottom in the vicinity of the pipe, creating aufeis over the blockage. A chilled pipe through unfrozen ground can also form a frost bulb several times larger than the pipe diameter. This frozen area can block subsurface flow, forcing water to the surface and causing aufeis. Road cuts can also expose subsurface flow channels, causing aufeis build-up over the roadway. The potential for aufeis and possible effects will require detailed considerations for all construction areas.

All stream crossing facilities should be designed to withstand the Pipeline Design Flood as defined for the ANGTS system. Streams should be stabilized and returned to their original configuration, gradient, substrate, velocity, and surface flow. Water supplies for compressor or meter stations should not be taken from fish spawning beds, fish rearing areas, overwintering areas or waters that directly replenish those areas during critical periods.

The Yukon River crossing will utilize an existing bridge. The Yukon River will therefore not be significantly affected by the pipeline.

4.6.3 Aquatic Ecosystem Effects

The Fairbanks power plant will not cause significant impacts to the aquatic resources. The water supply for the power plant will be obtained from groundwater, and therefore will not affect surface waterbodies. Discharges from the plant will be treated to meet effluent guidelines before being released, so that fish habitat should not be significantly affected. Discharge quantities will be relatively low, less than 200 gpm.

The pipeline from the North Slope to Fairbanks will cross numerous rivers and creeks, including the Yukon River. Aquatic resource impacts will include all those discussed for the North Slope scenario (Section 2.5.3), and additional impacts caused by the chilled pipeline crossing waterbodies. Several mitigation measures, in addition to those already discussed, should be implemented to protect the fish habitat affected by pipeline construction and operation. Stream crossings should be constructed such that fish passage is not blocked and flow velocity does not exceed the maximum allowable flow velocity for the fish species in a given stream. If these criteria cannot be met, a bridge should be installed.

Chilled pipes in streams should not cause: a) lower stream temperatures so as to alter biological regime of stream; b) slow spring breakup and delay of fish migration; or c) early fall freeze-up which would affect fish migration. In addition, the temperature of surface or subsurface water should not be changed significantly by the pipeline system or by any construction-related activities.

All mitigation measures designed to reduce sedimentation of water bodies (discussed in the water resources section) will protect fish spawning, rearing and overwintering areas.

For the purpose of making recommendations regarding timing of ANGTS construction activities, the pipeline corridor was divided into three large geographical regions: Region I, Beaufort Sea to the Continental Divide of the Brooks Range; Region II, Continental Divide of the Brooks Range to the Yukon River; and Region III, Yukon River to Fairbanks. In association with the ANGTS development, the following broad temporal guidelines were developed for recommendation for each gasline corridor region based on fish use habitat (Schmidt et al 1981). These would also be applicable to a smaller diameter pipeline.

Region I Region II Region III	1 May-20 July 15 April-15 July 1 April-15 July (early breakup streams) 15 April-15 July (late breakup streams)	A critical period for most streams due to the occurrence of major spring migrations and spring spawning (primarily grayling).
Region I Region II Region III	20 July-25 August 15 July-25 August 15 July-1 September	A sensitive period. Fry of spring spawning species have emerged and major fall emigrations have not yet begun. Fish are mobile at this time and can move to avoid or reduce effects of disturbance.
Region I Region II Region III	25 August-1 October (small streams) 25 August-15 October (large streams) 25 August-1 October (small streams) 25 August-15 October (large streams) 1 September-1 November	A critical period for all streams. Fish must emigrate from streams that do not provide winter habitat prior to freeze-up. Major upstream migrations and spawning of fall spawning species occurs in streams that provide over-wintering habitat.

Region I	1 October-1 May (small streams) 15 October-1 May (large streams)	A preferred period for construction in many streams that do not provide winter habitat. These streams generally are dry or freeze to the bottom during winter. This is a critical period for fish overwintering in springs, large rivers, and lakes.
Region II	15 October-15 April (small streams) 1 November-15 April (large streams)	
Region III	1 November-1 April (early breakup streams) 1 November-15 April (late breakup streams)	

4.6.4 Terrestrial Ecosystem Effects

The Fairbanks power plant will affect terrestrial resources primarily through habitat disturbance. As discussed in the Report on Facility Siting and Corridor Selection (Appendix C), potential power plant sites in the Fairbanks area are located in developed or previously disturbed areas. The potential for adversely affecting terrestrial habitats is therefore not considered to be significant.

Construction of the gas pipeline from the North Slope to Fairbanks will require total clearing of a 50-foot right-of-way for the length of the gasline. In addition, ten 10-acre compressor stations, two 1.5 acre metering stations and a gas conditioning facility (15 acres) will be constructed. Construction activities will disrupt terrestrial animals near the corridor during the 3-year construction period. The pipeline alignment will avoid the peregrine falcon nest sites near the Franklin and Sagwon Bluffs, but other raptors may restrict construction schedules (refer to Appendix C). Special construction measures may be necessary in the areas delineated by the BLM land use plan, as discussed for the North Slope scenario. Construction activities, especially aircraft traffic, could disturb Dall sheep habitat in critical wintering, lambing and movement areas. These construction-related impacts would be less than 3 years in duration.

Long term terrestrial impacts will result primarily from habitat elimination. Important moose browsing habitat, such as the willow stand along Oksrukuyik Creek, should be preserved. The treeline white spruce stand at the head of Dietrich Valley, which has been nominated for Ecology Reserve status, should be avoided. The pipeline design should allow for free passage of caribou and other large animals.

4.6.5 Socioeconomic and Land Use Effects

The potential socioeconomic and land use effects of locating an electrical generating facility in the vicinity of Fairbanks includes the temporary impacts related to the influx of workers and permanent land use impacts.

The size of the construction work force for the generating facility is expected to be approximately 200 persons. These generation units will be constructed during the summer for about 4-5 months.

Since the project could draw on the large labor pool of Fairbanks, it can be expected that the majority of workers will be hired locally. Economic benefits to the region will not be significant as employment on the project will be temporary. Any in-migrating work force will have to seek temporary housing on their own since housing will not be provided at the project site. The extent of the impacts on the local housing supply will depend on the vacancy rate for the summer of each year of construction.

As discussed in the Report on Facility Siting and Corridor Selection (Appendix C), development of a generating facility on the outskirts of the Fairbanks area should not engender significant land use conflicts, since the focus of the final site selection activities will be on areas which are presently used for industrial development. However, the long-term staged development of a major electric generating complex will certainly be a determinant of future land uses in the local area.

Construction activities at the generating plant site will generate additional worker and construction vehicle traffic loads on the local road system. However, disruptions to existing traffic patterns can be minimized through site selection by utilizing major highways and arterials to the maximum extent possible and by developing a local access plan and schedule. Depending on the site selected, new access requirements will be planned in recognition of local traffic requirements.

For construction of the gas pipeline in the North Slope-Fairbanks corridor, employees will be housed either at the pump stations or the permanent camp facilities that were constructed for the trans-Alaska oil pipeline. Construction activities will be consistent with the BLM land use criteria as discussed in Section 2.5.5.

The potential socioeconomic and land use impacts of the transmission facilities between Fairbanks and Anchorage included in this scenario are identical to those discussed in Section 2.5.5 for the North Slope scenario, with the addition of transmission facilities from the Fairbanks generating site to the power grid. Again, assuming the site is located on the outskirts of Fairbanks to the southeast, transmission interconnections can probably expand on existing GVEA rights-of-way with minimal additional impacts to existing land uses. However, future land use patterns will be signficantly affected by the presence of the three parallel 500 kV transmission lines.

SCENARIO II
FAIRBANKS POWER GENERATION
LOW LOAD

5.0 FAIRBANKS POWER GENERATION

LOW LOAD FORECAST

The Fairbanks generation scenario, under the low load forecast, requires all of the major systems of the medium growth forecast except that fewer compression stations are required to transport the gas and fewer units are required to generate electricity. The Fairbanks area electrical generating station will require 3 combined cycle plants, each consisting of two gas fired combustion turbines paired with two waste heat recovery boilers, and a steam turbine generator for a station capacity of 726 MW in 2010. Units will be phased-in by bringing each combustion turbine on-line individually, followed by the waste heat recovery boilers and steam turbine generator. Between Fairbanks and Anchorage, one new 345 kV transmission line and upgrading of the Healy-Fairbanks and Willow-Anchorage segments of the existing line will be required. The Fairbanks residential/commercial, gas system peak demand at 100 percent penetration of potential market is 49 MMSCFD.

Construction of the gas conditioning facilities, gas pipeline, power generating facilities and transmission systems, is estimated to cost $4.7 billion. Total annual operation and maintenance costs are estimated to be $0.4 billion. The present worth of costs excluding fuel costs is $3.4 billion. Construction costs of the Fairbanks gas distribution system total $1.5 billion, with total annual operating and maintenance costs totalling $41 million. The present worth of costs for this system is $1.0 billion.

5.1 NORTH SLOPE TO FAIRBANKS NATURAL GAS PIPELINE

As explained in Section 4.1, pipeline design proceeded on the basis of preliminary gas demand calculations. Because the refined demand values did not warrant design changes, certain of the gas demand calculations differ in the low load forecast as follows:

Pipeline Design (Preliminary Demand)	Low Load Forecast (MMSCFD)
Power Generation	
Annual Average Demand	108
Peak Daily Demand	179
Residential/Commercial	
Annual Average Demand	14
Peak Daily Demand	40
Total	
Annual Average Demand	122
Peak Daily Demand	219

After refined demand values were available, the results were:

Utility System Design (Refined Demand)	Low Load Forecast (millions of standard cubic feet per day)
Power Generation	
Peak Daily Demand	130
Residential/Commercial	
Peak Daily Demand	49
Total	
Peak Daily Demand	179

For the low load forecast, the refined demand was 40 MMSCFD less than the preliminary calculation.

5.1.1 Gas Conditioning Plant

The gas conditioning facility required for the low growth scenario will utilize the SELEXOL physical solvent process, as described in Section 4.1.1. The design flowrate will be 230 MMSCFD based on the daily peak load anticipated for this growth forecast, a pipeline availability of 96.5 percent and compressor station demands. All other details and specifications will be as described in Section 4.1.1.

5.1.2 Pipeline

Similar to the medium forecast design, the pipeline will have an outside diameter of 22 inches and will follow the same route, the ANGTS right-of-way. Details regarding pipeline design and route are presented in section 4.1.2.

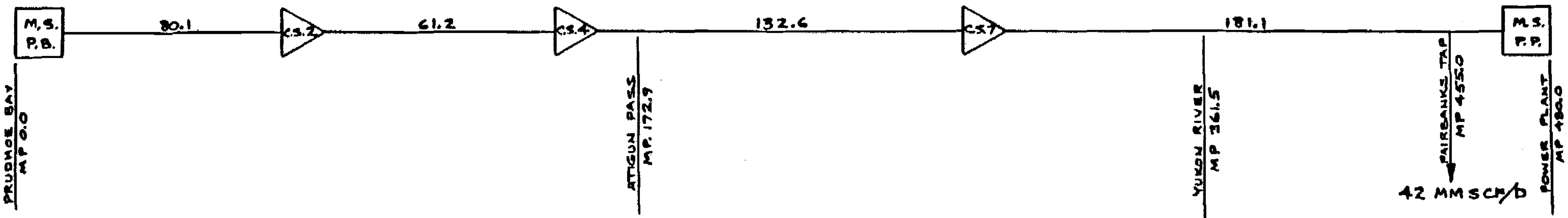
The peak daily flowrate, however, requires only three compressor stations, which will be located at Stations 2, 4 and 7 when using the ANGTS numbering system. The flow conditions anticipated for the demand scenario are presented in Figure 5-1. The design of the compressor stations is indentical to that presented for the medium load forecast. All other required systems, facilities and support services will also be the same as those presented in Section 4.1.2.

5.2 POWER PLANT

The scenario for power generation at a Fairbanks site, under the low load forecast requires three combined cycle plants to satisfy the anticipated demand in the year 2010. The schedule for unit addition which resulted from the analyses presented in the Report on System Planning Studies (Appendix B) is shown in Table 5-1.

The details of plant design and operation are identical to those described for the medium load case in Section 4.2. Only where there are variances due to the decreased number of units are specific items addressed below.

Total operations and maintenance personnel will be less for this scenario than the medium load case. Ten on duty operations and maintenance personnel will be required per shift in 1996 when the first gas turbine begins operation. In the year 2010 when three complete units are operating, 60 on duty personnel will be required per shift. The plant site will be approximately 90 acres in size and will include all three units, two switchyards, and a 300 foot buffer zone around the plant.



TOTAL 480 MILES, 22" O.D. PIPELINE, WALL THICKNESS = 0.275 INCH MINIMUM

	STATION DESIGNATION	M.S. PRUDHOE BAY	C.S. 1	C.S. 2	C.S. 3	C.S. 4	C.S. 5	C.S. 6	C.S. 7	C.S. 8	C.S. 9	C.S. 10	M.S. POWER PLANT
STATION	MILEPOST (MILES)	0.0		80.1		141.3			273.7				480.0
	ELEVATION (FEET)	21		825		3050			1315				500
	STATION INLET VOLUME (MMSCF/D)	230		230		229			228				185
	TOTAL FUEL (MMSCF/D)	—		1		1			1				—
	STATION OUTLET VOLUME (MMSCF/D)	230		229		228			227				185
	STATION SUCTION PRESSURE (PSIG)	1260		1101		1036			1114				1041
	STATION DISCHARGE PRESSURE (PSIG)	1260		1260		1185			1260				—
COMPRESSION	COMPRESSOR SUCTION PRESSURE (PSIG)	—		1097		1032			1110				—
	COMPRESSOR DISCHARGE PRESSURE (PSIG)	—		1264		1189			1264				—
	COMPRESSION RATIO	—		1.150		1.150			1.137				—
	HORSEPOWER REQUIRED	—		1450		1470			1320				—

ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

HYDRAULIC SUMMARY
LOW FORECAST
PEAK DAILY FLOW

FIGURE 5-1

EBASCO SERVICES INCORPORATED

TABLE 5-1

NEW CAPACITY ADDITIONS AND FUEL REQUIREMENTS
FAIRBANKS POWER GENERATION SCENARIO - LOW LOAD FORECAST[1/]

Year	Combined Cycle (MW) (Increment/Total)	Gas Required (MMSCFD)
1990	0/0	0.
1991	0/0	0.
1992	0/0	0.
1993	0/0	0.
1994	0/0	0.
1995	0/0	0.
1996	86/86	5,957.6
1997	86/172	11,873.2
1998	0/172	11,873.2
1999	0/172	11,873.2
2000	0/172	11,904.7
2001	70/242	11,939.4
2002	86/328	17,876.4
2003	0/328	17,876.4
2004	86/414	23,873.6
2005	70/484	23,873.8
2006	86/570	29,814.1
2007	0/570	29,814.1
2008	86/656	33,413.4
2009	0/656	34,508.4
2010	70/726	32,228.9

1/ Values as calculated are shown for purposes of reproducibility only, and do not imply accuracy beyond the 100 MMSCFD level.

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Annual fuel requirements for power generation will grow from 5.96 BCFY in 1996 to 32.23 BCFY in 2010. The maximum potential firing rate in the year 2010, based on a heat rate of 8280 Btu/kWh, will be approximately 9×10^4 SCFM. Annual fuel requirements for the study period are also shown in Table 5-1.

5.3 TRANSMISSION SYSTEM

5.3.1 Fairbanks to Anchorage

This transmission system uses two 345 kV lines as described in Section 3.2. Other details are similar, including series compensation.

5.4 FAIRBANKS GAS DISTRIBUTION SYSTEM

5.4.1 Fairbanks Residential/Commercial Gas Demand Forecasts

A study has been performed by Alaska Economics Incorporated to forecast residential and commercial gas demand in Fairbanks. A summary of the study's methodology and the results of the medium growth projection appear in Section 4.4.1. The text of the study appears in Appendix E. Table 5-2 presents the study's results for the low growth forecast. These forecasts have been made conditional on the gas achieving the discrete percentages of the total market for heating and cooking energy applications shown in Table 5-2. The size of the total market to which these percentages have been applied has been projected to grow at a 1.43 percent annual average rate, the low growth forecast, beginning in 1981. This rate is the implied population growth rate for Fairbanks as derived in Battelle's (1982) low forecast of the demand for electricity in the Railbelt area.

5.4.2 Fairbanks Gas Distribution System.

The gas distribution system has been designed to supply Fairbanks a low growth demand value of 5.2 BCFY . The differences in flowrates and service areas between the medium and low growth scenarios affect the

TABLE 5-2

FAIRBANKS RESIDENTIAL/COMMERCIAL GAS DEMAND
LOW GROWTH FORECAST[1/]

	Delivered Gas, BCF Per Year	
	1985	2010
Market growth at 1.43 Percent		
10% of Market	0.510	0.727
20% of Market	1.275	1.818
40% of Market	2.039	2.908
100% of Market	5.098	7.720
	Delivered Gas, BCF Per Peak Month	
	1985	2010
10% of Market	0.085	0.121
20% of Market	0.212	0.302
40% of Market	0.338	0.483
100% of Market	0.846	1.207
	Delivered Gas, BCF Peak Daily	
	1985	2010
10% of Market	0.003	0.005
20% of Market	0.009	0.012
40% of Market	0.014	0.020
100% of Market	0.034	0.049

[1/]Refer to Appendix E for details

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size and lengths of the high pressure and distribution system mains. The sizes and footages of the high pressure mains and the distribution mains required for the low growth forecast are presented below. All other system and piping details are the same as the medium growth forecast which is described in Section 4.4.2.

High Pressure System Mains

Size (Inches)	Length (Feet)
8	6,000
10	15,000
12	27,375
14	7,500

Schedule of Distribution Mains

Size (Inches)	Length (Feet)
2	450,000
4	78,000
6	90,750

5.5 COST ESTIMATES

5.5.1 Capital Costs

5.5.1.1 North Slope to Fairbanks Gas Pipeline

Order of magnitude, investment cost estimates have been prepared for the systems and facilities which comprise the North Slope to Fairbanks natural gas pipeline. These estimates are presented in Table 5-3.

5.5.1.2 Power Plant

The capital cost of simple cycle combustion turbines and combined cycle facilities are the same as that presented in Section 4.5 for the medium load forecast.

TABLE 5-3

ORDER OF MAGNITUDE INVESTMENT COSTS
NORTH SLOPE TO FAIRBANKS NATURAL GAS PIPELINE
(Millions of January, 1982 Dollars)

Description[1/]	Materials ($1000)	Construction Labor[2/] ($1000)	Total Direct Costs ($1000)
22 in O.D. Gas Pipeline	480,000	4,100,000	4,580,000
Compressor Stations - 3 ea	30,300	25,300	55,600
Metering Stations - 2 ea	2,800	6,000	8,800
Valve Stations - 28 ea	2,500	3,800	6,300
Engineering & Construction Management			27,900
SUBTOTAL	$515,600	$4,135,100	$4,678,600
Gas Conditioning Facility[3/]			538,300
TOTAL			$5,216,900

1/ A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes and land and land rights expenses have not been included.

2/ Construction camp facilities and services are subsumed in the Construction Labor cost category.

3/ Factored pricing basis which includes engineering and construction management.

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5.5.1.3 Transmission Line Systems

Order of Magnitude investment cost estimates have been prepared for all required transmission line systems. The results of this analysis are presented in Table 5-4. The estimate is of one new 345 kV line, 700 MW capacity, with series compensation and an intermediate switching station, and the required upgrading of the Willow-Anchorage and Healy-Fairbanks segments of the existing grid.

5.5.1.4 Gas Distribution System

Order of magnitude and investment cost estimates (January 1982 dollars) have been prepared for the systems and facilities which comprise the Fairbanks gas distribution system. The results of the analysis are presented below. A 15 percent contingency has been assumed for the entire project and has been distributed between each cost category. Sales/use taxes and land and land rights have not been included.

	Materials ($1000)	Construction Labor ($1000)	Total Direct Costs ($1000)
Gas Distribution System	$11,300	$45,200	$56,500
Engineering and Construction Management			3,390
TOTAL CONSTRUCTION COSTS			$59,890

5.5.2 Operating and Maintenance Costs

5.5.2.1 Gas Pipeline and Conditioning Facility

Annual operating and maintenance costs (January, 1982 dollars) for the gas conditioning facilities are estimated to be as follows:

Item	Annual Costs ($1000)
Salaries	$1,390
Maintenance Costs (Parts and Expendables)	2,100
TOTAL	$3,490

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TABLE 5-4

ORDER OF MAGNITUDE INVESTMENT COSTS
FAIRBANKS TO ANCHORAGE TRANSMISSION SYSTEM
(Millions of January, 1982 Dollars)

Description[1/]	Materials ($1000)	Construction Labor ($1000)	Total Direct Costs ($1000)
Switching Stations	8,857	8,414	17,271
Substations	32,958	30,872	63,830
Energy Management Systems	12,300	10,960	23,260
Steel Towers and Fixtures	129,214	182,083	311,291
Conductors and Devices	20,049	53,183	73,232
Clearing	--	41,572	41,572
SUBTOTAL	$203,378	$327,084	$530,456
Land and Land Rights[2/]			14,400
Engineering and Construction Management			37,130
TOTAL			$581,986

1/ The investment costs one new 345 kV line, 700 MW capacity with series compensation and an intermediate switching station, and reflect upgrading of the Willow-Anchorage and Healy-Fairbanks segments of the existing grid to 345 kV.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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Annual operating and maintenance cost (January 1982 dollars) for the gas compressor stations and pipeline maintenance activities are estimated to be as follows:

Item	Annual Costs ($1000)
Salaries	$2,090
Maintenance Costs (Parts and Expendables)	1,750
TOTAL	$3,840

5.5.2.2 Power Plant

Operating and Maintenance Costs for the combined cycle facility at Fairbanks are estimated to be $0.0040/kWh. These are based on discussions with operating plant personnel, history of similar units, EPRI published data and other studies.

5.5.2.3 Transmission Line Systems

Annual operating and maintenance costs (January 1982 dollars) have been developed for the scenario's required transmission line facilities and total $8 million per year. These costs should be viewed as an annual average over the life of the system. Actual O&M costs should be less initially, and increase with time.

5.5.2.4 Gas Distribution System

Annual operating and maintenance costs (January 1982 dollars) for the Fairbanks gas distribution system are estimated to be as follows:

Item	Annual Costs ($1000)
Salaries	$680
Maintenance Costs (Parts and Expendables)	270
TOTAL	$950

5.5.3 Fuel Costs

For the economic analyses which follow fuel costs were treated as zero. This approach permits fuel cost and fuel price escalation to be treated separately; and makes possible subsequent sensitivity analyses of the Present Worth of Costs for this scenario based upon a range of fuel cost and cost escalation assumptions.

5.5.4 Total System Costs

5.5.4.1 Cost Allocation Methodology

The methodology that was developed and presented in Section 4.4.4.1 is equally applicable to the low growth scenario.

5.5.4.2 Total System Costs

Like the Fairbanks medium load growth scenario, the Fairbanks low load growth scenario involves a complex series of investments in a gas conditioning facility, a natural gas pipeline, power generation facilities, and transmission lines. Also, like the previous Fairbanks scenario, the costs of the the gas conditioning facility and pipeline must be apportioned according to the formulae presented in Section 4.5.4.1. After that apportionment, total annual system costs can be calculated.

The formulae for conditioning facility and pipeline cost apportionment are the same regardless of growth; however, the resulting O_I and O_A values are quite different between the low and medium growth scenarios. For the low load forecast the O_I value is as follows:

Residential/Commercial Peak Daily Flow (2010)	=	49 MMSCFD
Electrical Generation Peak Daily Flow (2010)	=	130 MMSCFD
Total Peak Daily Flow (2010)	=	179 MMSCFD
O_I	=	0.73

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The O_A values for the Fairbanks low load forecast are presented in Table 5-5. Significant to note is the fact that in the low load forecast case, the residential/commercial customers must assume a higher share of the capital and annual cost burdens of the gas conditioning and pipeline facilities.

Given the joint systems cost apportionment, the total annual electrical systems costs can be calculated. Total annual capital costs are presented in Table 5-6. Total annual O&M costs are presented in Table 5-7. Total annual costs are then summarized in Table 5-8.

The present worth of costs has been calculated for comparison purposes. The present worth of costs as of 1982, assuming a discount rate of 3 percent, is $3.4 billion (1982 $) exclusive of fuel costs.

5.5.4.3 Gas Distribution System Costs

The costs attributable to the gas distribution system serving residential and commercial customers include a portion of the gas conditioning plant, a portion of the pipeline, and all of those costs associated with the distribution system within Fairbanks. Again, the apportionment method discussed in Section 4.5.4.1 is an essential precursor to the calculation of final total system costs.

Gas distribution costs depend upon calculating $1-O_I$ and $1-O_A$ values. These are presented in Table 5-9. Again, it is clear that the non-electric customers must assume a larger portion of the capital and operating expenses in the low load growth scenario as compared to the medium load growth scenario.

Given those apportionment values, the total systems costs for the gas distribution system can be calculated. Capital and O&M are presented in Tables 5-10 through 5-11. Total annual systems costs are summarized in Table 5-12. The present worth of these costs of 1982, assuming a real discount rate of 3 percent, is $1.05 billion, exclusive of any fuel costs.

TABLE 5-5

O_A VALUES
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST

Calendar Year	Residential Demand (BCFY)	Electrical Demand (BCFY)	Total Demand (BCFY)	O_A
1982	0.	0.	0.	NA[1/]
1983	0.	0.	0.	NA
1984	0.	0.	0.	NA
1985	0.	0.	0.	NA
1986	0.	0.	0.	NA
1987	0.	0.	0.	NA
1988	0.	0.	0.	NA
1989	0.	0.	0.	NA
1990	0.	0.	0.	NA
1991	0.	0.	0.	NA
1992	0.	0.	0.	NA
1993	0.	0.	0.	NA
1994	0.	0.	0.	NA
1995	0.	0.	0.	N/A
1996	1.266	5.958	7.224	0.82
1997	2.568	11.873	14.441	0.82
1998	3.906	11.873	15.779	0.75
1999	5.283	11.873	17.156	0.69
2000	6.698	11.905	18.603	0.64
2001	6.794	11.939	18.913	0.63
2002	6.891	17.876	24.767	0.72
2003	6.990	17.876	24.866	0.72
2004	7.090	23.874	30.964	0.77
2005	7.191	23.874	31.065	0.77
2006	7.294	29.814	37.108	0.80
2007	7.398	29.814	37.212	0.80
2008	7.504	33.413	40.917	0.82
2009	7.611	34.508	42.119	0.82
2010	7.720	32.229	39.949	0.81

1/ NA - Not applicable

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TABLE 5-6

ANNUAL CAPITAL EXPENDITURES
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated[1/] Unit A	Unit B	Transmission Line	Pipeline	Gas Conditioning Plant	Total
1982	0.	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.	0.
1991	0.	0.	0.	0.	0.	0.
1992	0.	0.	311.3	0.	0.	311.3
1993	0.	0.	71.8	1,138.5	0.	1,210.3
1994	9.96[2/]	0.	141.4	1,138.5	196.5	1,476.4
1995	33.90	0.	57.5	1,138.5	196.5	1,392.5
1996	33.90	0.	0.	0.	0.	33.9
1997	0.	0.	0.	0.	0.	0.
1998	0.	0.	0.	0.	0.	0.
1999	0.	0.	0.	0.	0.	0.
2000	56.97	0.	0.	0.	0.	57.0
2001	33.90	0.	0.	0.	0.	33.9
2002	0.	0.	0.	0.	0.	0.
2003	33.90	0.	0.	0.	0.	33.9
2004	56.97	0.	0.	0.	0.	57.0
2005	33.90	0.	0.	0.	0.	33.9
2006	0.	0.	0.	0.	0.	0.
2007	33.90	0.	0.	0.	0.	33.9
2008	0.	0.	0.	0.	0.	0.
2009	0.	0.	0.	0.	0.	0.
2010	0.	0.	0.	0.	0.	0.
Total	$327.	0.	$582.	$3,416.	$393.	$4,718.

1/ Unit A refers to first unit built in a given year and Unit B to second unit built.

2/ Includes site preparation activities for multiple unit site.

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TABLE 5-7

ANNUAL NON-FUEL OPERATING AND MAINTENANCE COSTS
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated	Transmission Line	Pipeline	Gas Conditioning Plant	Total
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.
1991	0.	0.	0.	0.	0.
1992	0.	0.	0.	0.	0.
1993	0.	0.	0.	0.	0.
1994	0.	0.	0.	0.	0.
1995	0.	0.	0.	0.	0.
1996	2.268	8.00	3.15	2.86	16.3
1997	4.520	8.00	3.15	2.86	18.5
1998	4.520	8.00	2.88	2.62	18.0
1999	4.520	8.00	2.65	2.41	17.6
2000	4.520	8.00	2.46	2.23	17.2
2001	6.360	8.00	2.42	2.20	19.0
2002	8.620	8.00	2.76	2.51	21.9
2003	8.620	8.00	2.76	2.51	21.9
2004	10.908	8.00	3.00	2.69	24.6
2005	12.720	8.00	3.00	2.69	26.4
2006	14.980	8.00	3.07	2.79	28.8
2007	14.980	8.00	3.07	2.79	28.8
2008	16.112	8.00	3.15	2.86	30.1
2009	16.640	8.00	3.15	2.86	30.7
2010	17.168	8.00	3.11	2.83	31.1
Total	$147.	$120.	$44.	$40.	$351.

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TABLE 5-8

TOTAL ANNUAL COSTS
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Capital Expenditures	O & M Costs	Total Expenditures
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	0.	0.	0.
1990	0.	0.	0.
1991	0.	0.	0.
1992	311.3	0.	311.3
1993	1,210.3	0.	1,210.3
1994	1,476.4	0.	1,476.4
1995	1,392.5	0.	1,392.5
1996	33.9	16.3	50.2
1997	0.	18.5	18.5
1998	0.	18.0	18.0
1999	0.	17.6	17.6
2000	57.0	17.2	74.2
2001	33.9	19.0	52.9
2002	0.	21.9	21.9
2003	33.9	21.9	55.8
2004	57.0	24.6	81.6
2005	33.9	26.4	60.3
2006	0.	28.8	28.8
2007	33.9	28.8	62.7
2008	0.	30.1	30.1
2009	0.	30.7	30.7
2010	0.	31.1	31.1
Total	$4,718.	$351.	$5,069.
Present Worth @ 3%	$3,246.	$185.	$3,431.

TABLE 5-9

APPORTIONMENT VALUES FOR THE GAS DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST

Term	Year	Value
$(1-0)_I$	NA	0.27
$(1-0)_A$	1983-1995	NA
	1996	0.18
	1997	0.18
	1998	0.25
	1999	0.31
	2000	0.36
	2001	0.37
	2002	0.28
	2003	0.28
	2004	0.23
	2005	0.23
	2006	0.20
	2007	0.20
	2008	0.18
	2009	0.18
	2010	0.19

TABLE 5-10

CAPITAL COSTS ASSOCIATED WITH THE DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Gas Conditioning Plant	Pipeline	Distribution System	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	0.	0.
1986	0.	0.	0.	0.
1987	0.	0.	0.	0.
1988	0.	0.	0.	0.
1989	0.	0.	0.	0.
1990	0.	0.	0.	0.
1991	0.	0.	0.	0.
1992	0.	0.	0.	0.
1993	0.	421.0	12.0	433.0
1994	72.6	421.0	12.0	505.6
1995	72.6	421.0	12.0	505.6
1996	0.	0.	12.0	12.0
1997	0.	0.	12.0	12.0
1998	0.	0.	0.	0.
1999	0.	0.	0.	0.
2000	0.	0.	0.	0.
2001	0.	0.	0.	0.
2002	0.	0.	0.	0.
2003	0.	0.	0.	0.
2004	0.	0.	0.	0.
2005	0.	0.	0.	0.
2006	0.	0.	0.	0.
2007	0.	0.	0.	0.
2008	0.	0.	0.	0.
2009	0.	0.	0.	0.
2010	0.	0.	0.	0.
Total	$145.	$1,263.	$60.	$1,468.

TABLE 5-11

OPERATION AND MAINTENANCE COSTS
ASSOCIATED WITH THE DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Gas Conditioning Plant	Pipeline	Distribution System	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	0.	0.
1986	0.	0.	0.	0.
1987	0.	0.	0.	0.
1988	0.	0.	0.	0.
1989	0.	0.	0.	0.
1990	0.	0.	0.	0.
1991	0.	0.	0.	0.
1992	0.	0.	0.	0.
1993	0.	0.	0.	0.
1994	0.	0.	0.	0.
1995	0.	0.	0.	0.
1996	0.63	0.69	0.95	2.3
1997	0.63	0.69	0.95	2.3
1998	0.87	0.96	0.95	2.8
1999	1.08	1.19	0.95	3.2
2000	1.26	1.38	0.95	3.6
2001	1.29	1.42	0.95	3.7
2002	0.98	1.08	0.95	3.0
2003	0.98	1.08	0.95	3.0
2004	0.80	0.88	0.95	2.6
2005	0.80	0.88	0.95	2.6
2006	0.70	0.77	0.95	2.4
2007	0.70	0.77	0.95	2.4
2008	0.63	0.69	0.95	2.3
2009	0.63	0.69	0.95	2.3
2010	0.66	0.73	0.95	2.3
Total	$13.	$14.	$14.	$41.

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TABLE 5-12

ANNUAL SYSTEMS COST SUMMARY FOR THE GAS DISTRIBUTION SYSTEM
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Capital Cost	O & M Cost	Total Cost
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	0.	0.	0.
1990	0.	0.	0.
1991	0.	0.	0.
1992	0.	0.	0.
1993	433.0	0.	433.0
1994	505.6	0.	505.6
1995	505.6	0.	505.6
1996	12.0	2.3	14.3
1997	12.0	2.3	14.3
1998	0.	2.8	2.8
1999	0.	3.2	3.2
2000	0.	3.6	3.6
2001	0.	3.7	3.7
2002	0.	3.0	3.0
2003	0.	3.0	3.0
2004	0.	2.6	2.6
2005	0.	2.6	2.6
2006	0.	2.4	2.4
2007	0.	2.4	2.4
2008	0.	2.3	2.3
2009	0.	2.3	2.3
2010	0.	2.3	2.3
Total	$1,468.	$41.	$1,509.
Present Worth at 3%	$1,027.	$22.	$1,050.

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5.6 ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATIONS

The Fairbanks power plant for the low load forecast will consist of three combined cycle units in contrast to five combined cycle and two simple cycle units for the medium load forecast. Power plant characteristics are summarized in Table 5-13.

It is assumed that water or steam injection would not be required for NO_x control because of associated ice fog problems. Air emissions will be reduced by approximately one-half from the medium load forecast, and will meet all applicable air quality standards. Groundwater will provide approximately 100 gpm for equipment wash-down, potable supplies, and boiler make-up water. This relatively small amount of water will not affect ground water supplies in the area. Wastewater discharges will be less than 100 gpm and will be treated to meet effluent guidelines.

Aquatic resources, as for the medium load forecast, will not be significantly affected. Plant acreage will be approximately 90 acres, as compared to 140 acres for the medium load forecast. Terrestrial impacts on vegetation and habitat elimination are correspondingly reduced.

Pipeline-related impacts are identical to those discussed for the Fairbanks scenario medium load forecast, Section 4.5. Impacts associated with the transmission line from Fairbanks to Anchorage are identical to those discussed in Section 3.5 for the North Slope scenario, low load forecast. Socioeconomic impacts are expected to be similar to those for the medium demand scenario.

Socioeconomic impacts, as for the medium load forecast, are not expected to be significant. The majority of workers will be hired locally. Any in-migrating workforce will have to seek temporary housing on their own but this number is expected to be low.

TABLE 5-13

ENVIRONMENT RELATED POWER PLANT CHARACTERISTICS
FAIRBANKS POWER GENERATION - LOW LOAD FORECAST
COMBINED CYCLE POWER PLANT

Air Environment	
Emissions	
Particulate Matter	Below standards
Sulfur Dioxide	Below standards
Nitrogen Oxides	Emissions variable within standards - dry control techniques would be used to meet calculated NO_x standard of 0.014 percent of total volume of gaseous emissions. This value calculated based upon new source performance standards, facility heat rate, and unit size.
Physical Effects	Maximum structure height of 50 feet
Water Environment	
Plant Water Requirements	100 GPM
Plant Discharge Quantity, including treated sanitary waste, floor drains, boiler blow-down and demineralizer wastes	Less than 100 GPM
Land Environment	
Land Requirements	
Plant and Switchyard	90 acres
Socioeconomic Environment	
Construction Workforce	Approximately 100 personnel at peak construction
Operating Workforce	Approximately 50 personnel

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SCENARIO III
KENAI POWER GENERATION
MEDIUM LOAD

6.0 KENAI AREA POWER GENERATION

MEDIUM LOAD FORECAST

The development of power generation facilities in the Kenai area which will utilize North Slope natural gas is dependent on the construction of a major, high pressure gas pipeline from the North Slope to a tidewater location near Kenai. The details concerning this pipeline and the attendant tidewater gas conditioning and liquefaction facilities are presented in The Governor's Economic Committee (1983) report entitled "Trans Alaska Gas System: Economics of an Alternative for North Slope Natural Gas."

The gas conditioning and liquefaction facilities associated with the Trans Alaska Gas System (TAGS) will have numerous power loads, many of which can not be satisfied by any source except electricity. These loads will include lighting, certain types of heating, ventilation and air conditioning systems, pumps, various process coolers and compressors, controls, tools, and any shaft horsepower requirements that are intermittant, such as some refrigeration applications, or too small to be economical for a combustion turbine. Based on the electrical demand values required for the ANGTS gas conditioning facility and discussions with gas liquefaction process equipment vendors, the total peak electrical demand of these tidewater processing facilities has been estimated to be approximately 300 MW. This value is only an approximation, the actual demand requirements will be dependent upon the type of liquefaction facility selected for design (e.g. compressor/expander system, Cascade refrigerant system), and specific design decisions regarding various process power sources made during detailed engineering. To ensure that the Kenai power generation scenario presents a realistic development approach and that the entire Railbelt utility system can support such a major contingency of demand, the anticipated electrical requirements of these processing facilities have been included in the electrical demand analysis. As TAGS will be developed in phases, the total electrical demand of the facilities has been proportioned, based on the flow rates anticipated during each phase.

This scenario, then, centers on a major electric generating station in the Kenai area near the terminus of the TAGS pipeline. By the year 2010, the station would consist of 7 combined cycle units and 1 simple cycle gas turbine to satisfy the medium energy demand forecast for the Railbelt and the additional power requirements of the TAGS gas conditioning and liquefaction facilities, a total of 1743 MW. The fuel for the power plant will be a blend of waste gas from the TAGS gas conditioning facilities and TAGS sales gas. A major electrical transmission system from the Kenai generating station to Anchorage is required. The Kenai to Anchorage lines would be operated at 500 kV and employ an underwater crossing of Turnagain Arm. To ensure system reliability, both the 500 kV lines from Kenai to Anchorage and the 345 kV lines from Anchorage to Fairbanks would consist of two parallel lines. A residential/commercial gas distribution for Fairbanks is not an integral part of this scenario, although it is not precluded as an adjunct to TAGS. The total construction cost of this scenario is $2.1 billion, with total operation and maintenance costs of $0.8 billion per year. The present worth of these costs excluding fuel costs is $2.0 billion.

6.1 POWER PLANT

6.1.1 General

The power generation technology selected for the Kenai locale is combined cycle utilizing 237 MW baseloaded plants (refer to Appendix B). The plants are identical in configuration with those described in Section 4.2. The difference in capacity rating is due to the slightly higher average annual temperature encountered in the Kenai locale.

Facilities required for the site and the site arrangement will be the same as that described in Section 4.2. Equipment arrangement will be as previously shown in Figures 4-1 and 4-2 and the site arrangement as shown in Figure 4-3. A total of 7 complete combined cycle plants plus 1 simple cycle gas turbine will be required to satisfy the demand for energy in the year 2010. The land area required for this development will be approximately 175 acres. The schedule for addition of these facilities is shown on Table 6-1 along with the total of new capacity on a yearly basis.

The functional parts of the power plant will include all the systems described in Section 4.2. Additionally, a system for gas quality monitoring will be necessary. The fuel to be utilized will be a blend of waste gas and sales gas from the gas conditioning plant (see Section 6.1.4 Fuel Supply).

6.1.2 Combustion Turbine Equipment

The combustion turbines will be identical to those described previously except for one operating detail. The gas burner nozzle in the combustion chamber is typically designed to operate at a specific fuel heat value plus or minus 10 percent. A nozzle purchased to burn 400 Btu/ft^3 fuel will be useful to 440 Btu/ft^3. In order to burn higher Btu content gas, a different nozzle would need to be installed. Several nozzles for a range of potential fuels should be inventoried for each turbine.

6.1.3 Steam Plant

The effect of burning a low Btu content fuel on the heat recovery steam generator (HRSG) will be negligible. Since the gas turbines are controlled at a constant gas temperature, the response of the system to a higher flow of noncombustibles in the waste stream will be to reduce the amount of excess air while maintaining gas temperature and mass flow constant. Therefore, no changes to the HRSG or the balance of the steam cycle from that described in Section 4.2 is expected.

TABLE 6-1

NEW CAPACITY ADDITIONS AND FUEL REQUIREMENTS
MEDIUM LOAD FORECAST

KENAI POWER GENERATION

Year	New Capacity (MW) (Increment/Total)	Gas Required (MMSCFY)[1/] Waste Gas	Sales Gas
1989	84/84	12,451.6	3,625.4
1990	84/168	24,903.3	7,250.7
1991	0/168	24,903.3	7,250.7
1992	237/405	49,864.6	14,518.3
1993	0/405	49,864.6	14,518.3
1994	69/474	49,924.1	14,535.7
1995	84/558	62,372.7	18,160.2
1996	84/642	74,827.0	21,689.7
1997	153/795	87,336.2	25,428.4
1998	84/879	99,786.8	29,053.5
1999	0/879	99,786.8	29,053.5
2000	69/948	99,848.2	29,071.4
2001	0/948	99,848.2	29,071.4
2002	168/1116	124,745.6	36,320.0
2003	0/1116	124,745.6	36,320.0
2004	69/1185	124,810.1	36,339.3
2005	168/1353	141,620.7	41,234.4
2006	69/1422	139,175.5	40,522.0
2007	84/1506	146,795.8	42,740.2
2008	153/1659	147,913.1	43,066.1
2009	84/1743	155,253.6	45,203.9
2010	0/1743	156,950.0	46,994.3

1/ Values as calculated are shown for reproducibility only, and do not imply accuracy beyond a 100 MMSCFD level.

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6.1.4 Fuel Supply

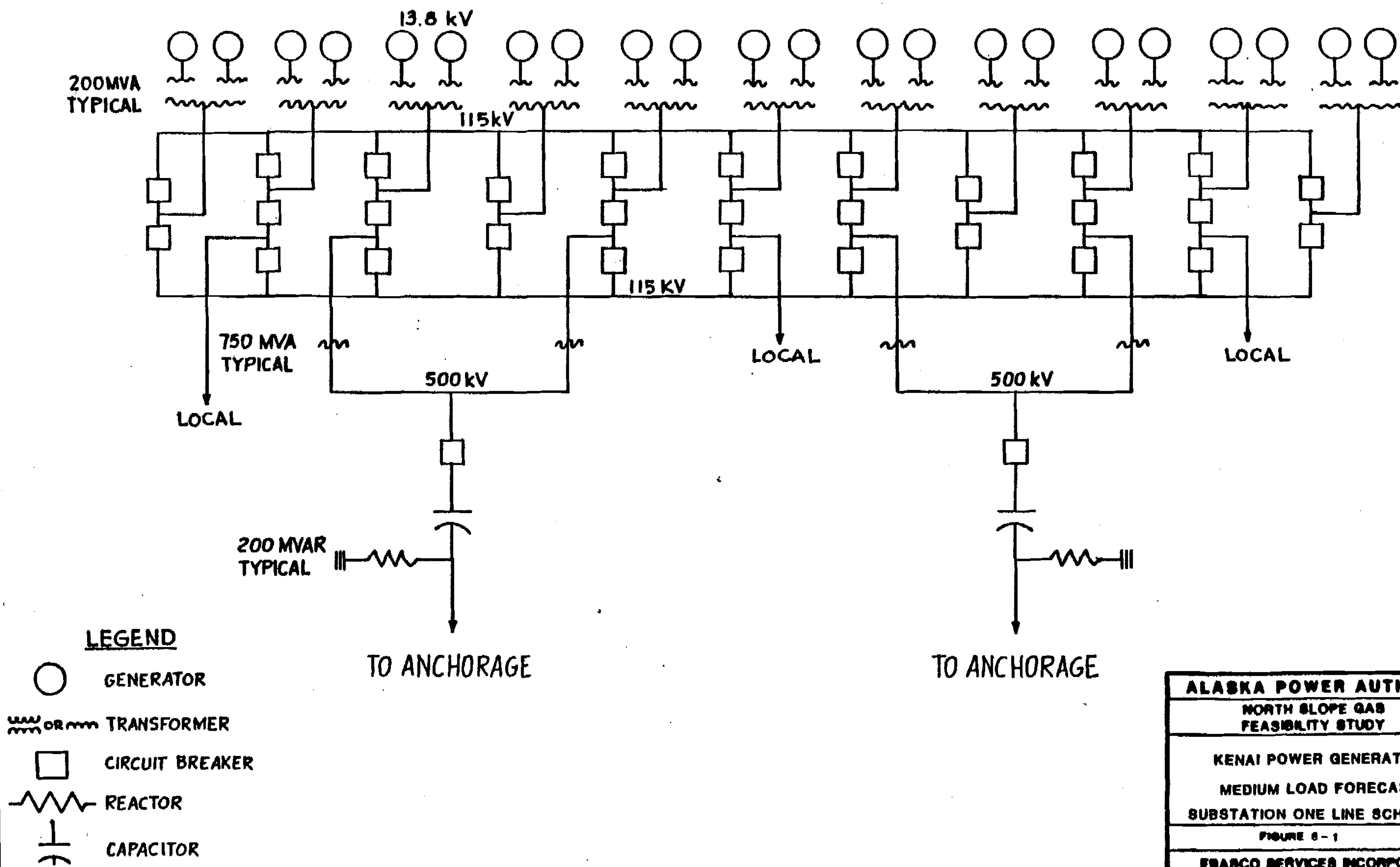
Depending upon the gas conditioning facility design chosen, a waste gas stream comprised mainly of carbon dioxide and heavier hydrocarbons may be generated. It has been previously estimated (refer to Appendices A and B) that a waste gas stream of approximately 430 MMSCFD with a higher heating value of 195 Btu/ft^3 could result. While it is possible to directly burn this waste gas in combustion turbines, it will require expensive redesign of the turbines, and increased equipment supply costs. Since the waste stream alone could not supply enough energy to satisfy demand through the year 2010, it was decided to blend the waste gas with sales gas to achieve a minimum heating value of 400 Btu/ft^3 (HHV). This resultant heating value does not require combustion turbine modifications. The required amounts of both waste and sales gas are shown in Table 6-1.

6.1.5 Electrical Equipment and Substation

The electrical equipment, including the generators, will essentially be the same as that described for the North Slope and Fairbanks medium forecast scenarios (Sections 2.1 and 4.2). Major differences involve the number of units installed, their actual ratings, and the bus voltage. Figure 6-1 presents a simplified one line diagram of the substation. There will be 22 generators feeding the 11 transformers, each rated 200 MVA 13.8/115 kV. For this alternative 115 kV bus voltage was chosen to be compatible with the existing 115 kV Chugach Electric Association line in the area. Three circuits will provide power for local area loads. The outgoing voltage will be 500 kV, with the two lines, each supplied by two 750 MVA transformers, terminating in Anchorage. Whenever possible, a breaker and a half configuration will be used.

6.1.6 Other Systems

Depending on interpretation of regulations governing the application of Best Available Control Technology (BACT), it may be necessary to add an



ALASKA POWER AUTHORITY

NORTH SLOPE GAS
FEASIBILITY STUDY

KENAI POWER GENERATION

MEDIUM LOAD FORECAST

SUBSTATION ONE LINE SCHEMATIC

FIGURE 6 - 1

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NO_x control system to the gas turbines at the Kenai location. All other systems will be identical to those described for the Fairbanks medium load growth forecast (Section 4.2).

The NO_x control system will consist of either steam or water injection directly into the combustion chamber. This is used to control the gas temperature, keeping it below the range of high NO_x formation.

6.2 TRANSMISSION SYSTEMS

6.2.1 Kenai to Anchorage Line

6.2.1.1 Overview of the System

To transmit medium forecast power from Kenai to Anchorage, a 500 kV transmission alternative was developed and found to be a cost effective voltage. Two routes were investigated in detail: a 150 mile long land based route around Turnagain Arm, crossing the mountains west of Girwood to Anchorage; and an underwater cable crossing of Turnagain Arm. The latter route was chosen as the better alternative. A brief description of the line is presented below.

The line, with its two circuits on separate towers, will originate at the Kenai generating plant substation and will run eastward to approximately Sterling. The two circuits will then run towards the northeast and follow an existing pipeline right-of-way. The overland route on the Kenai peninsula will be 65 miles in length and will terminate at Gull Rock. From this point 4 mile-long cables will carry the power underwater to the north shore of Turnagain Arm to a location marked Isle 29, which is less than a half-mile northwest of McHugh Creek. The remaining overhead line segment will parallel the Seward-Anchorage highway for about 25 miles before reaching the substation at Anchorage.

This routing is made possible by recent advancements in cable technology developed by Pirelli of Italy and Standard Telefon O.G. Kabel Fabrik A/S of Norway, which are about to install, for the British Columbia Hydro and Power Authority, two 500 kV circuits, each consisting of three single phase cables between the British Columbia mainland and Vancouver Island. The Turnagain Arm crossing will consist of 7 cables: 3 for each circuit and 1 spare.

The system is similar to the one presented for the North Slope to Fairbanks connection, except there will be no intermediate switching stations and there will be a cable crossing. The design of the overhead section of the line will be identical to the North Slope-Fairbanks connection described in Section 2.3 and Appendix D, except that guyed type transmission towers will be used for this line and only 3 repeater stations will be required for communication purposes.

6.2.1.2 Alternatives

Several alternative transmission corridors between Kenai and Anchorage were considered in order to select a reasonable route for cost estimating purposes. Factors considered were general engineering and environmental constraints. Of the many potential routes, two were investigated in detail. A land based route was assumed to follow the existing Chugach Electric Association (CEA) right-of-way, which generally follows the Sterling and Seward Highways, and which traverses the eastern end of Turnagain Arm. However, closer examination of that route in light of the major transmission facility requirements disclosed the following severe constraints:

(1) The existing transmission lines between Portage and Indian Creek are co-located with the Seward Highway and the Alaska Railroad on a narrow bench between Turnagain Arm and the Chugach Mountains. The bench is at the base of a uniformly steep slope which rises to above 3500 feet in elevation. The proposed transmission facilities could not reasonably be accommodated within or adjacent to the

existing rights-of-way. One option for avoiding this area would be to traverse the Chugach Mountains between Portage and Anchorage. This would, however, involve crossing difficult terrain, much of which is included in the Chugach State Park.

(2) The existing CEA right-of-way parallels the Sterling Highway for most of its length. In the vicinity of Bear Mountain, designated wilderness areas within the Kenai National Wildlife Refuge are within close proximity of the highway. Development of transmission facilities of the magnitude required by this scenario would engender severe aesthetic impacts to travelers along this scenic highway, and possibly infringe on wilderness land use values.

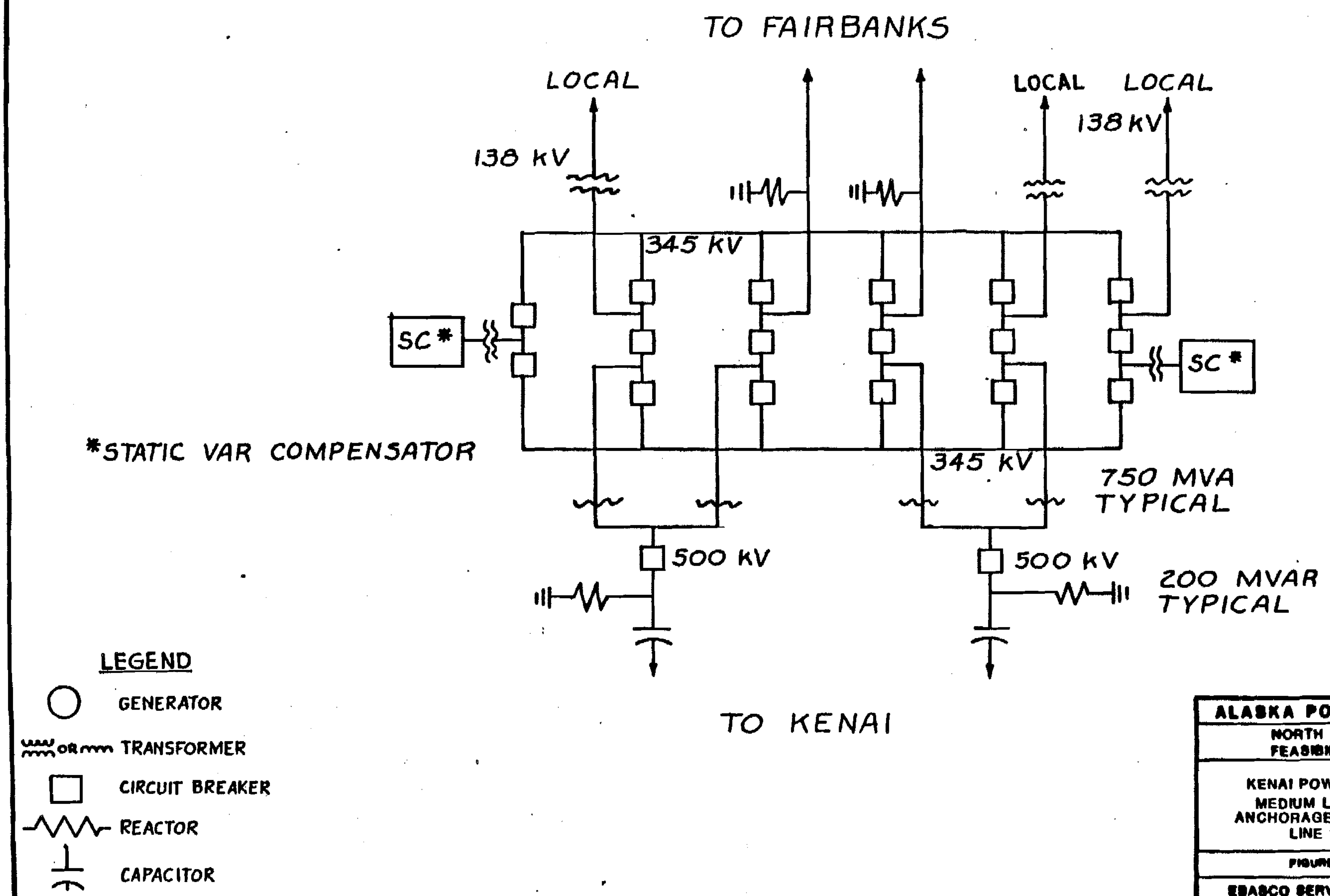
As a consequence of these severe routing constraints, this study focused on a transmission line corridor which utilizes a Turnagain Arm crossing from Gull Rock to McHugh Creek. The total length of this preferred corridor route is 94 miles, as compared to the 150 mile route which would be required for a completely overland route around the eastern end of Turnagain Arm.

6.2.2 Anchorage Substation

The planned Anchorage substation is shown in Figure 6-2. The two 500 kV lines will terminate in two 750 MVA 345/525 kV transformers. The bus will feed the area transmission system using 138/345 kV transformers. From the bus two 345 kV lines will connect to Fairbanks. These lines will have shunt reactors but no series capacitors connected to them.

6.2.3 Anchorage to Fairbanks Line

This line must carry about half the amount of power that the Fairbanks to Anchorage lines have to carry under previously discussed low growth forecast conditions (Section 3.2). Therefore, one 345 kV line would be adequate as far as power carrying capability and system performance is concerned. However, the reliability of electric power transmission



ALASKA POWER AUTHORITY

NORTH SLOPE GAS
FEASIBILITY STUDY

KENAI POWER GENERATION
MEDIUM LOAD FORECAST
ANCHORAGE SUBSTATION ONE
LINE SCHEMATIC

FIGURE 6-2

EBASCO SERVICES INCORPORATED

over a single line is very poor, making two lines in parallel a minimum requirement. With two lines, neither series compensation nor an intermediate switching station is required at 345 kV. Therefore, in this scenario, the 345 kV intertie will be fully extended and a second line will be built between Anchorage and Fairbanks using the Gilbert Commonwealth (1981) design.

6.2.4 Fairbanks Substation

The Fairbanks substation will be the terminus of the two 345 kV lines. It will be a conventionally designed 345/138 kV substation using a breaker and a half scheme to supply the two 138/345 kV transformers that will provide power locally.

6.3 COST ESTIMATES

6.3.1 Construction Costs

6.3.1.1 Power Plant

To support the derivation of total systems costs which is presented in Section 6.3.4, order of magnitude investment costs were developed for the major bid lines items common to a 77 MW (ISO conditions) natural gas fired simple cycle combustion turbine and a 220 MW (ISO conditions) natural gas fired combined cycle plant. These costs are presented in Tables 6-2 and 6-3. The costs represent the total investment for the first unit to be developed at the site. Additional simple cycle units will have an estimated investment cost of $35,680,000 while additional combined cycle units will have an estimated investment cost of $128,060,000. The unit cost differential for addition units is due to significant reductions in line items 1 and 15, improvements to Site and Off-Site Facilities, and reductions in Indirect Construction Cost and Engineering and Construction Management.

TABLE 6-2
ORDER OF MAGNITUDE INVESTMENT COSTS
77 MW SIMPLE CYCLE PLANT
KENAI AREA POWER GENERATION - MEDIUM LOAD FORECAST
(January, 1982 Dollars)

	Description[1/]	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
1.	Improvements to Site	475	1,410	1,885
2.	Earthwork and Piling	75	500	575
3.	Circulating Water System	0	0	0
4.	Concrete	475	2,145	4,505
5.	Structural Steel Lifting Equipment, Stacks	1,725	1,370	3,095
6.	Buildings	750	1,440	2,190
7.	Turbine Generator	11,400	685	12,085
8.	Steam Generator and Accessories	0	0	0
9.	Other Mechanical Equipment	955	530	1,485
10.	Piping	265	590	855
11.	Insulation and Lagging	35	135	170
12.	Instrumentation	100	70	170
13.	Electrical Equipment	1,535	2,665	4,200
14.	Painting	70	250	320
15.	Off-Site Facilities	300	1,080	1,380
	SUBTOTAL	$18,160	$12,870	$31,030
	Freight Increment			910
	TOTAL DIRECT CONSTRUCTION COST			$31,940
	Indirect Construction Costs			1,780
	SUBTOTAL FOR CONTINGENCIES			33,720
	Contingencies (15%)			5,060
	TOTAL SPECIFIC CONSTRUCTION COST			38,780
	Engineering and Construction Management			2,200
	TOTAL CONSTRUCTION COST			$40,980

[1/] The following items are not addressed in the plant investment pricing: laboratory equipment, switchyard and transmission facilities, spare parts, land or land rights, and sales/use taxes.

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TABLE 6-3
ORDER OF MAGNITUDE INVESTMENT COSTS
220 MW COMBINED CYCLE PLANT
KENAI AREA POWER GENERATION - MEDIUM LOAD FORECAST
(January, 1982 Dollars)

Description[1]	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
1. Improvements to Site	490	1,440	1,930
2. Earthwork and Piling	220	1,520	1,740
3. Circulating Water System	0	0	0
4. Concrete	1,485	6,730	8,215
5. Structural Steel Lifting Equipment, Stacks	3,800	3,530	7,330
6. Buildings	1,800	3,600	5,400
7. Turbine Generator	30,700	2,590	33,290
8. Steam Generator and Accessories	9,600	4,320	13,920
9. Other Mechanical Equipment	6,230	3,120	9,350
10. Piping	1,630	3,055	4,685
11. Insulation and Lagging	295	720	1,015
12. Instrumentation	1,700	290	1,990
13. Electrical Equipment	4,600	8,785	13,385
14. Painting	200	720	920
15. Off-Site Facilities	300	1,080	1,380
SUBTOTAL	$63,050	$41,500	$104,550
Freight Increment			3,150
TOTAL DIRECT CONSTRUCTION COST			$107,700
Indirect Construction Costs			4,310
SUBTOTAL FOR CONTINGENCIES			112,010
Contingencies (15%)			16,800
TOTAL SPECIFIC CONSTRUCTION COST			128,810
Engineering and Construction Management			6,800
TOTAL CONSTRUCTION COST			$135,610

1/ The following items are not addressed in the plant investment pricing: laboratory equipment, switchyard and transmission facilities, spare parts, land or land rights, and sales/use taxes.

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6.3.1.2 Kenai to Anchorage Transmission Line

Transmission line order-of-magnitude investment cost estimates for the submarine cable crossing alternative are presented in Table 6-4. These estimates are based on two 500 kV lines of 1400 MW capacity with series compensation. An order of magnitude investment cost estimate has also been prepared for the land based route which traverses the eastern end of Turnagain Arm. These estimates are presented in Table 6-5. As the submarine cable crossing alternative is preferred, only this estimate has been used in the derivation of total systems costs (Section 6.3.4).

6.3.1.3 Anchorage to Fairbanks Transmission Line

Order of magnitude investment cost estimates have been prepared for the Anchorage-Fairbanks connection. These estimates which are presented in Table 6-6 are based on one new 345 kV line without series compensation and an intermediate switching station. The estimates also reflect upgrading of the Willow-Anchorage and Healy-Fairbanks segments of the present Intertie.

6.3.2 Operation and Maintenance Costs

6.3.2.1 Power Plant

The power plant operating and maintenance (O&M) costs were derived to support the system planning studies (Appendix B). They reflect a review of figures from previous Railbelt studies, operation of other utilities, and salary requirements and expendable materials. The O&M costs for this scenario are estimated to be $0.0040/kWh.

6.3.2.2 Transmission Line Systems

Annual operating and maintenance costs (January 1982 dollars) have been developed for the scenario's required transmission line facilities and total $12 million per year. These costs should be viewed as an annual

TABLE 6-4

ORDER OF MAGNITUDE INVESTMENT COSTS
KENAI TO ANCHORAGE TRANSMISSION SYSTEM
SUBMARINE CABLE CROSSING ALTERNATIVE
(January 1982 Dollars)

Description 1/	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Switching Stations	--	--	--
Substations	63,073	43,729	106,802
Energy Management System	11,400	9,400	20,800
Steel Towers and Fixtures	112,370	130,909	243,279
O.H. Conductors and Devices	12,726	29,919	42,645
Submarine Cable and Devices	77,900	52,200	130,100
Clearing	--	4,164	4,164
SUBTOTAL	277,469	270,321	547,790
Land and Land Rights 2/			7,200
Engineering and Construction Management			38,290
TOTAL CONSTRUCTION COST			$593,280

1/ The investment costs reflect two 500 kV lines, 1400 MW capacity with series compensation. A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes have not been included.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

TABLE 6-5

ORDER OF MAGNITUDE INVESTMENT COSTS
KENAI TO ANCHORAGE TRANSMISSION SYSTEM
LAND BASED ROUTE ALTERNATIVE
(January 1982 Dollars)

Description[1]	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Switching Stations	0	0	0
Substations	51,262	35,540	86,802
Energy Management System	11,400	9,400	20,800
Steel Towers and Fixtures	265,066	281,477	546,543
Conductors and Devices	20,522	48,248	68,770
Clearing	0	6,720	6,720
SUBTOTAL	348,250	381,385	729,635
Land and Land Rights[2]			11,600
Engineering and Construction Management			51,100
TOTAL CONSTRUCTION COST			$792,335

1/ The investment costs reflect two 500 kV lines, 1400 MW capacity with series compensation. A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes have not been included.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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TABLE 6-6

ORDER OF MAGNITUDE INVESTMENT COSTS
ANCHORAGE TO FAIRBANKS TRANSMISSION SYSTEM
(January 1982 Dollars)

Description 1/	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Switching Stations	--	--	--
Substations	38,531	32,100	70,631
Energy Management System	12,300	10,960	23,260
Steel Towers and Fixtures	129,214	182,091	311,305
Conductors and Devices	20,049	53,183	73,232
Clearing	--	41,572	41,572
SUBTOTAL	200,094	319,906	520,000
Land and Land Rights 2/			14,400
Engineering and Construction Management			36,400
TOTAL CONSTRUCTION COST			$570,800

1/ The investment costs reflect one new 345 kV line without series compensation or an intermediate switching station, and the upgrading of the Willow-Anchorage and Healy-Fairbanks segments of the Intertie to 345 kV.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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average over the life of the system. Actual O&M costs should be less initially, and will increase with time.

6.3.3 Fuel Costs

For the economic analyses which follow fuel costs werre treated as zero. This approach permits fuel cost and fuel price escalation to be treated separately; and makes possible subsequent sensitivity analyses of the Present Worth of Costs for this scenario based upon a range of fuel cost and cost escalation assumptions.

6.3.4 Total Systems Costs

Total systems costs for Kenai reflect a very different situation than the North Slope or Fairbanks scenarios. The Kenai medium growth scenario recognizes that a pipeline and gas conditioning facility are required; however, these capital investments are external to the electricity generation system per se. The costs of the pipeline and the gas conditioning facility should be reflected in the purchase price of the natural gas rather than in the capital or O&M outlays.

The methodology and assumptions utilized to derive the systems' costs which are presented below have been previously described in the Report on Systems Planning Studies (Appendix B). This methodology is consistent with previous studies of electric generating scenarios for the Railbelt, specifically Acres American, Inc. (1981), Susitna Hydroelectric Project Feasibility Report and Battelle (1982), Railbelt Electric Power Alternative Study.

The total systems costs for the Kenai medium growth scenario have been calculated. Annual capital outlays are presented in Table 6-7. Annual O&M costs are presented in Table 6-8. Total annual costs are summarized in Table 6-9. The present worth of these costs, exclusive of fuel costs, is $2.0 billion as of 1982, assuming a discount rate of 3 percent and a value base of 1982 dollars.

TABLE 6-7

ANNUAL CAPITAL EXPENDITURES
KENAI AREA POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated[1/] Unit A	Electricity Generated[1/] Unit B	Transmission Line	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	621.2	621.2
1986	0. [2/]	0.	142.8	142.8
1987	10.6	0.	282.2	292.8
1988	35.68	0.	114.9	150.6
1989	35.68	0.	0.	35.7
1990	0.	0.	0.	0.
1991	53.65	71.36	0.	125.0
1992	0.	0.	0.	0.
1993	53.65	0.	0.	53.7
1994	35.68	0.	0.	35.7
1995	35.68	0.	0.	35.7
1996	53.65	35.68	0.	89.3
1997	35.68	0.	0.	35.7
1998	0.	0.	0.	0.
1999	53.65	0.	0.	53.7
2000	0.	0.	0.	0.
2001	35.68	35.68	0.	71.4
2002	0.	0.	0.	0.
2003	53.65	0.	0.	53.7
2004	35.68	35.68	0.	71.4
2005	53.65	0.	0.	53.7
2006	35.68	0.	0.	35.7
2007	35.68	53.65	0.	89.3
2008	35.68	0.	0.	35.7
2009	0.	0.	0.	0.
2010	0.	0.	0.	0.
Total	$689.	$232.	$1,161.	$2,083.

1/ Unit A refers to first unit built in a given year and Unit B to second unit built.

2/ Includes site preparation activities for multiple unit site.

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TABLE 6-8

ANNUAL NON-FUEL OPERATING AND MAINTENANCE COSTS
KENAI AREA POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated	Transmission Line	Total
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	2.21	12.0	14.21
1990	4.42	12.0	16.42
1991	4.42	12.0	16.42
1992	10.64	12.0	22.64
1993	10.64	12.0	22.64
1994	12.46	12.0	24.46
1995	14.66	12.0	26.66
1996	16.87	12.0	28.87
1997	20.89	12.0	32.89
1998	23.10	12.0	35.10
1999	23.10	12.0	35.10
2000	24.91	12.0	36.91
2001	24.91	12.0	36.91
2002	29.33	12.0	41.33
2003	29.33	12.0	41.33
2004	31.14	12.0	43.14
2005	33.64	12.0	45.64
2006	34.72	12.0	46.72
2007	35.81	12.0	47.81
2008	36.90	12.0	48.90
2009	37.99	12.0	49.99
2010	39.08	12.0	51.08
Total	$501.	$264.	$765.

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TABLE 6-9

TOTAL ANNUAL COSTS
KENAI AREA POWER GENERATION - MEDIUM LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Capital Expenditures	O & M Costs	Total Expenditures
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	621.2	0.	621.2
1986	142.8	0.	142.8
1987	292.8	0.	292.8
1988	150.6	0.	150.6
1989	35.7	14.21	49.91
1990	0.	16.42	16.42
1991	125.0	16.42	141.42
1992	0.	22.64	22.64
1993	53.7	22.64	76.34
1994	35.7	24.46	60.16
1995	35.7	26.66	62.36
1996	89.3	28.87	118.17
1997	35.7	32.89	68.59
1998	0.	35.10	35.10
1999	53.7	35.10	88.80
2000	0.	36.91	36.91
2001	71.4	36.91	108.31
2002	0.	41.33	41.33
2003	53.7	41.33	95.03
2004	71.4	43.14	114.54
2005	53.7	45.64	99.34
2006	35.7	46.72	82.42
2007	89.3	47.81	137.11
2008	35.7	48.90	84.60
2009	0.	49.99	49.99
2010	0.	51.08	51.08
Total	$2,083.	$765.	$2,848.
Present Worth @ 3%	$1,612.	$436.	$2,048.

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TABLE 6-10

ENVIRONMENT RELATED POWER PLANT CHARACTERISTICS
NATURAL GAS COMBINED CYCLE
KENAI AREA POWER GENERATION - MEDIUM LOAD FORECAST

Air Environment	
Emissions	
Particulate Matter	Below standards
Sulfur Dioxide	Below standards
Nitrogen Oxides	Emissions variable within standards - dry control techniques would be used to meet calculated NO_x standard of 0.014 percent of total volume of gaseous emissions. This value calculated based upon new source performance standards, facility heat rate, and unit size.
Physical Effects	maximum structure height of 50 feet
Water Environment	
Plant Water Requirements	
Water Injection	800 GPM
Other Requirements	200 GPM
Plant Discharge Requirements	
Demineralizer	40 GPM
Steam Generators	70 GPM
Treated Sanitary Waste	15 GPM
Floor Drains	25 GPM
Land Environment	
Land Requirements	175 acres
Socioeconomic Environment	
Construction Workforce	Approximately 200 personnel at peak construction
Operating Workforce	Approximately 150 employed personnel

6.4 ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATIONS

The Kenai power plant and transmission line to Anchorage and Fairbanks will have many environmental effects similar to those discussed for the North Slope and Fairbanks scenarios. The environmental and socioeconomic considerations associated with the transmission line from Anchorage to Fairbanks will be identical to those discussed in Section 3.5, the North Slope Scenario (low load forecast), and therefore will not be repeated here. Power plant characteristics related to environmental impacts are summarized in Table 6-10.

6.4.1 Air Resource Effects

As is typical of many exposed coastal locations, the air quality and meteorological conditions are generally favorable to the development of facilities such as power plants. It is not likely that an intense "marine layer", which may restrict dispersion of pollutants, develops in this area. The air quality attains the applicable ambient standards, but the locale is burdened with several existing petroleum refinery emissions. A new natural gas-fired power plant could probably be sited in the area with the use of appropriate emissions controls including water or steam injection to reduce nitrogen oxides emissions. The impact of water vapor emissions on the formation of fog must also be considered. The power plant must be carefully sited in order to avoid adding to the air quality impacts of the existing facilities.

Construction of the transmission line from Kenai to Anchorage will result in temporary air quality impacts. Heavy equipment and construction vehicles will cause fugitive dust and exhaust emissions, and slash burning will cause particulate emissions. As discussed in Section 2.5, these emissions would occur rarely and would be widely dispersed, generally in unpopulated areas. Long term impacts would be negligible.

6.4.2 Water Resource Effects

As in the Fairbanks scenario, water resource effects will be minimal. Groundwater will supply up to 1000 gpm for water or steam injection (for control of nitrogen oxides emissions), boiler make-up, potable supplies and miscellaneous uses. Wastewater discharges will consist of boiler blowdown, demineralizer regenerant wastes and sanitary wastes, each treated within the plant to meet the appropriate effluent guidelines. Because water used for water or steam injection is consumed rather than recycled, wastewater quantities will be less than 200 gpm.

The transmission line from Kenai to Anchorage would cross the streams and creeks listed below.

Soldatna Creek	Moose River
Mystery Creek	Chickaloon River
Big Indian Creek	Little Indian Creek
Potter Creek	Furrow Creek
Campbell Creek	Chester Creek
Ship Creek	

The water quality of these streams should not be directly affected if towers will be set back from the streambank at least 200 feet, and construction activities stay out of stream channels. Indirect impacts on the waterbodies, however, will result from construction activity in the small drainageways that feed the main channel, primarily from removal of vegetation (causing higher erosion rates), equipment crossings of small drainages, and access roads construction. Because helicopter construction will be used along most of the route, the use of heavy equipment, vegetation removal, and access road construction should be minimal.

The transmission line will cross Turnagain Arm from Gull Rock to the mouth of McHugh Creek via seven buried submarine cables. Construction phase impacts will consist of increased turbidity from the cable installation, and construction activity near the shore on both shorelines. Operation phase impacts will primarily be the potential for cable rupture and subsequent cable oil contamination of Turnagain Arm. The cable will be designed to have a very low probability of rupture over the life of the project. A synthetic cable oil, Dodeco Benzene, should be used for cable insulation. If this oil accidentally leaks, it will rise to the surface and quickly evaporate when exposed to air. This oil is used specifically to minimize environmental effects associated with a cable rupture.

6.4.3 Aquatic Ecosystem Effects

Because groundwater will provide the power plant's water supply, and wastewater discharges will be low, the power plant in Kenai will not significantly affect aquatic resources.

Soldatna Creek and Moose River flow into the Kenai River System, a major river for anadromous fish habitat. Sodatna Creek provides spawning and rearing habitat for Silver Salmon, and Moose River contains King, Silver, and Sockeye Salmon (U.S. Army Corps of Engineers 1978). Sedimentation of these water bodies, as discussed in the previous section, could affect spawning and rearing habitat in these streams. Because helicopter construction will be used for most of the route, however, sedimentation effects would be relatively minor.

Impacts to freshwater aquatic resources will be mitigated primarily through the control of sedimentation of waterbodies, keeping construction equipment out of streambeds and wetlands, and avoiding areas of high biological value. These mitigation measures are discussed in greater detail in Section 2.5.3 for the North Slope scenario.

Crossing Turnagain Arm with underwater cables poses additional environmental hazards. Turnagain Arm is an environmentally sensitive area in the general vicinity of the project that contains marine mammals, including Harbor Seals, sea lions and Beluga whales (U.S.

Department of Commerce 1979). Salmon are present in some of the small streams that enter this area (Alaska Department of Fish and Game 1978).

Installation of buried, submarine cables will temporarily disrupt the sea floor along the cable route and increase turbidity and suspended solids in the vicinity of the crossing. Tidal currents could carry suspended sediment beyond the immediate crossing site. Special construction techniques should be used to minimize disturbance of the substrate. Installation should take place when biological activity is at its lowest point in the yearly cycle.

An accidental rupture of a cable would leak cable oil into the aquatic environment. As discussed in the previous section, the cable oil used, Dodeco Benzene, was chosen because it evaporates when exposed to air, thereby minimizing environmental impacts.

The cables may operate at a temperature level above ambient conditions. Because the cables will be buried six to ten feet, only the substrate temperature and not water temperature would be elevated (Bonneville Power Administration 1981).

6.4.4 Terrestrial Ecosystem Effects

Because the Kenai power plant will be located in an area already extensively developed, little habitat degradation will occur. The area disturbed for power plant construction, approximately 140 acres, will not significantly affect terrestrial resources in the area.

The transmission route passes through an area of caribou habitat northeast of Kenai (University of Alaska 1974). Little alteration of caribou habitat will result from construction of the transmission line because the animal utilizes cover types that require little if any clearing.

Much of the route between Kenai and Anchorage is within moose rangeland. However, because moose utilize many different habitat types, they will be the least adversely affected by habitat alterations (Spencer and Chatelain 1953). Where the proposed route crosses heavily forested areas, moose will benefit from additional clearing of the right-of-way and the subsequent establishment of a subclimax community (Leopold and Darling 1953). The route does not cross Dall sheep or mountain goat habitat.

The transmission line corridor passes near Chickaloon Flats and Potter Marsh on Turnagain Arm, both key waterfowl areas. Various puddle ducks, geese and sandhill cranes feed and rest during seasonal migration periods in these areas. The shoreline of Turnagain Arm is also used by seals and sea lions. The transmission line would not directly affect this wildlife habitat.

Construction of the submarine cable could slightly affect terrestrial habitat indirectly by increasing turbidity of Turnagain Arm and thereby affecting food sources. This would be a temporary effect during the construction phase only.

The transmission corridor passes through several vegetation types. Between Kenai and Sterling, the vegetation is primarily bottomland spruce-poplar forest. As the corridor extends northeasterly towards Turnagain Arm, the vegetation becomes upland spruce-hardwood forest and, on the foothills of the Kenai Mountains, coastal western hemlock-Sitka spruce forest. North of Turnagain Arm, the vegetation is primarily bottomland spruce-poplar forest (University of Alaska 1974).

Transmission line construction will necessitate clearing a 220-foot wide corridor in all forested areas. Over the length of the corridor, it is assumed that a total of 550 acres would be cleared within the right-of-way.

6.4.5 Socioeconomic and Land Use Effects

The socioeconomic effects of locating a gas conditioning facility and electrical generating plant depends primarily on the size of the in-migrating work force. Land use impacts are not expected to occur as these facilities are compatible with the heavily industrialized development that dominates the Kenai-Nikiski area.

The size of the construction work force for the generating facility is expected to be approximately 175 persons. The construction schedule would require that a unit be constructed every year during the period 1993-2010, with the exception of 1994 and 1999, when no new units would be required. The duration and time of the construction period would be 4 to 5 months in the summer.

The extent to which local people would be hired would depend on the match of skills required for the project to those skills of the available labor force. Labor union policies would also influence the extent of local hires on the project. The in-migrating work force would have to seek temporary housing on their own since housing would not be provided at the project site. The magnitude of the impacts on the local housing supply would depend on the vacancy rate for the summer of each year a unit was constructed.

The project is expected to have little effect on the unemployment rate since employment on the project would be seasonal. In addition, these job openings would be competitive with other employment opportunities in seasonal industries such as construction and fisheries.

The operations work force is expected to be approximately 100. The magnitude of potential impacts depends on the availability of local labor to meet the work force requirements. If the majority of the employees migrate to the Kenai-Nikiski region, the demand for housing could exceed the supply.

Construction of the transmission lines between Kenai and Anchorage is expected to take 22 months. The peak work force is estimated at 221 persons during the last 6 months and average construction work force is expected to be approximately 163 workers. It is assumed that workers would be hired from the labor pools of Kenai and Anchorage.

SCENARIO III
KENAI POWER GENERATION
LOW LOAD

7.0 KENAI AREA POWER GENERATION

LOW LOAD FORECAST

The Kenai area power generation scenario, under the low load forecast, is also depedent upon the development of TAGS. The anticipated electrical requirements associated with TAGS gas conditioning and liquefaction facilities have also been included in the electrical demand analysis. The development scheme will consist of 4 combined cycle plants and 2 simple cycle combustion turbines conditioning facility. Fuel for the power plant will be a blend of waste gas and sales gas. A reliable electrical transmission system will require parallel lines from the Kenai area to Anchorage (at 500 kV and underwater across Turnagain Arm) and from Anchorage to Fairbanks (at 345 kV). A residential/commercial gas distribution system is not a part of the scenario. Construction costs for this scenario are $1.7 billion, with total operation and maintenance costs of $0.6 billion. The present worth of these costs excluding fuel costs is $1.7 billion.

The information in this section is intended to include only those conditions which are significantly different from those for the medium load forecast presented in Section 6.0.

7.1 POWER PLANT

This scenario will require four complete combined cycle plants, each capable of generating 237 MW and two simple cycle combustion turbines, to satisfy the low load forecast demand for energy in the year 2010. The first gas turbine unit will go on line in 1990. The scheduled additions are summarized in Table 7-1 and details are addressed in Appendix B. Fuel requirements for this scenario are also shown in Table 7-1.

TABLE 7-1

NEW CAPACITY ADDITIONS AND FUEL REQUIREMENTS
KENAI AREA POWER GENERATION - LOW LOAD FORECAST

Year	New Capacity (MW) (Increment/Total)	Gas Requirements (MMSCFD)1/ Waste Gas	Sales Gas
1990	84/84	12,451.6	3,625.4
1991	0/84	12,451.6	3,625.4
1992	153/237	24,962.1	7,267.8
1993	0/237	24,962.1	7,267.8
1994	84/321	37,413.5	10,893.2
1995	84/405	49,864.6	14,518.3
1996	0/405	49,864.6	14,518.3
1997	153/558	62,372.7	18,160.2
1998	0/558	62,372.7	18,160.2
1999	0/558	62,372.7	18,160.2
2000	0/558	62,372.7	18,160.2
2001	84/642	74,827.0	21,689.7
2002	69/711	74,886.2	21,803.5
2003	0/711	74,886.2	21,803.5
2004	84/795	87,336.2	25,428.4
2005	84/879	99,786.8	29,053.5
2006	69/948	99,848.2	29,071.4
2007	0/948	99,848.2	29,071.4
2008	84/1032	110,241.2	32,097.3
2009	0/1032	95,864.8	27,911.6
2010	84/1116	117,735.7	34,279.4

1/ Values as calculated are shown for reproducibility only, and do not imply accuracy beyond a 100 MMSCFD level.

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Facilities required for the site and the site arrangement will be the same as that described in Section 4.2. Equipment arrangement will be as previously shown in Figures 4-1 and 4-2 and the site arrangement as shown in Figure 4-3. The land area required for this development will be approximately 120 acres.

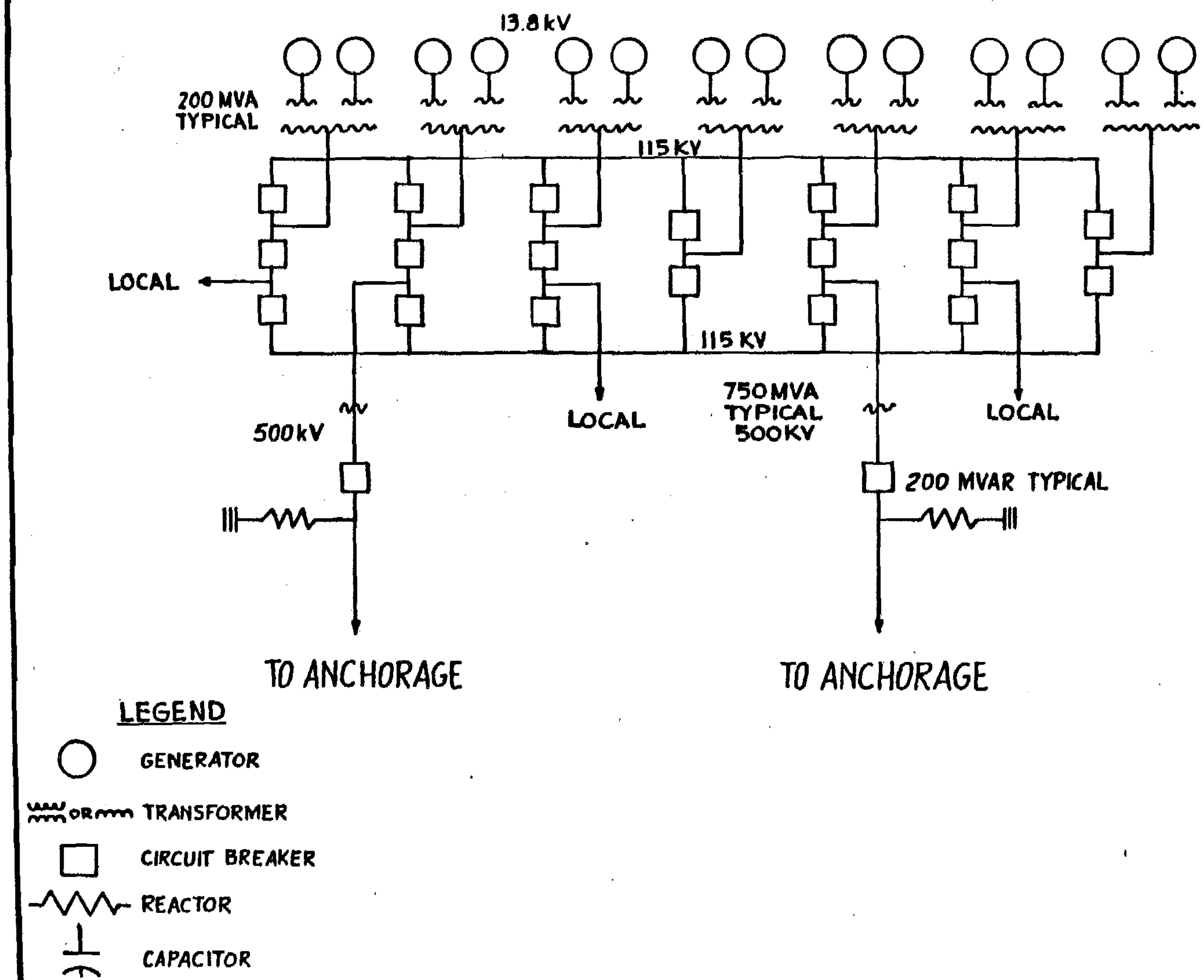
The one line schematic of the low forecast generation plant substation is shown in Figure 7-1. It is essentially a scaled down version of Figure 6-1. The number of generators is reduced to 14 and only one transformer will supply each of the 500 kV lines, which will be without series compensation.

7.2 TRANSMISSION SYSTEM

The Kenai-Anchorage transmission system will be similar to the medium forecast design including the utilization of 7 cables: 3 for each circuit and 1 spare (Section 6.2). Series compensation is not required, however, because the power transmitted to Anchorage in this low forecast case will be much reduced from that of the medium forecast.

Installing a reduced number of cables under Turnagain Arm was investigated but was not considered feasible because it is unlikely that the required switchyards could be located at the two terminations due to the lack of suitable land. During the system studies performed for this project, the possibility of transmitting the power on two 230 kV circuits, with one intermediate switching station, was also considered. Complete investigation of this system would have required detailed studies far beyond the scope of this project. However, such an alternative should be investigated during detailed engineering.

At the substation in Anchorage the 500 kV voltage will be transformed to 345 kV for transmittal to Fairbanks and to supply local Anchorage loads. The one line diagram would be similar to that presented in Figure 6-1, except that there will only be two 750 kVA transformers at the substation and the 500 kV lines will not be series compensated. The Fairbanks substation will terminate the two 345 kV circuits and supply, via transformers, the local area load at 138 kV.



ALASKA POWER AUTHORITY

NORTH SLOPE GAS FEASIBILITY STUDY

KENAI POWER GENERATION

LOW LOAD FORECAST SUBSTATION ONE LINE SCHEMATIC

FIGURE 7 - 1

EBASCO SERVICES INCORPORATED

7.3 COST ESTIMATES

7.3.1 Construction Costs

7.3.1.1 Power Plant

The capital cost of simple cycle combustion turbines and combined cycle facilities are the same as that presented in Section 6.3 for the medium load forecast.

7.3.1.2 Transmission Line Systems

Order-of-magnitude investment cost estimates for the submarine cable crossing alternative for the Kenai-Anchorage line are presented in Table 7-2. These estimates are based on two 500 kV lines of 700 MW capacity without series compensation. An order-of-magnitude investment cost estimate has also been prepared for the land based route which traverses the eastern end of Turnagain Arm. These estimates are presented in Table 7-3. As the submarine cable crossing alternative is preferred, only this estimate has been used in the derivation of total systems costs (Section 7.3.4).

The construction costs associated with the Anchorage-Fairbanks line are the same for both the medium and low growth forecasts. These costs were previously presented in Table 6-6.

7.3.2 Operation and Maintenance Costs

Power plant operating and maintenance (O&M) costs are the same for both the medium and low load forecasts, \$0.0040/kWh. Transmission line O&M costs are estimated to be \$12 million per year. These costs should be viewed as an annual average over the life of the system. Actual O&M costs should be less initially and will increase with time.

TABLE 7-2

ORDER OF MAGNITUDE INVESTMENT COSTS
KENAI TO ANCHORAGE TRANSMISSION SYSTEM
SUBMARINE CABLE CROSSING ALTERNATIVE
(January 1982 Dollars)

Description1/	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Switching Stations	--	--	--
Substations	41,620	30,885	72,505
Energy Management System	11,400	9,400	20,800
Steel Towers and Fixtures	112,370	130,909	243,279
O.H. Conductors and Devices	12,726	29,919	42,645
Submarine Cable and Devices	77,900	52,200	130,100
Clearing	--	4,164	4,164
SUBTOTAL	256,016	257,477	513,493
Land and Land Rights2/			7,200
Engineering and Construction Management			35,950
TOTAL CONSTRUCTION COST			$556,643

1/ The investment costs reflect two 500 kV lines, 700 MW capacity with no series compensation. A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes have not been included.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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TABLE 7-3

ORDER OF MAGNITUDE INVESTMENT COSTS
KENAI TO ANCHORAGE TRANSMISSION SYSTEM
LAND BASED ROUTE ALTERNATIVE
(January 1982 Dollars)

Description 1/	Material ($1000)	Construction Labor ($1000)	Total Direct Cost ($1000)
Switching Stations	--	--	--
Substations	30,140	22,366	52,506
Energy Management System	11,400	9,400	20,800
Steel Towers and Fixtures	265,066	281,477	546,543
Conductors and Devices	20,522	48,248	68,770
Clearing	--	6,720	6,720
SUBTOTAL	327,128	368,211	695,339
Land and Land Rights 2/			11,600
Engineering and Construction Management			48,700
TOTAL CONSTRUCTION COST			$755,639

1/ The investment costs reflect two 500 kV lines, 700 MW capacity with no series compensation. A 15 percent contingency has been assumed for the entire project and has been distributed among each of the cost categories shown. Sales/use taxes have not been included.

2/ Assumes a cost of $40,000 per mile (Acres American Inc. 1981).

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7.3.3 Fuel Costs

For the economic analyses which follow fuel costs were treated as zero. This approach permits fuel cost and fuel price escalation to be treated separately; and makes possible subsequent sensitivity analyses of the Present Worth of Costs for this scenario based upon a range of fuel cost and cost escalation assumptions.

7.3.4 Total Systems Costs

Total systems costs for the Kenai low load growth scenario are constructed in a manner identical to that used for the Kenai medium load growth scenario, except for the number of power plants installed and operated.

The methodology and assumptions utilized to derive the systems' costs which are presented below have been previously described in the Report on Systems Planning Studies (Appendix B). This methodology is consistent with previous studies of electric generating scenarios for the Railbelt, specifically Acres American, Inc. (1981), Susitna Hydroelectric Project Feasibilty Report and Battelle (1982), Railbelt Electric Power Alternatives Study.

Annual capital expenditures are presented in Table 7-4. Annual O&M costs are presented in Table 7-5. The summary of all annual costs is presented in Table 7-6. For comparison purposes the 1982 present worth of costs, assuming a discount rate of 3 percent and excluding fuel costs, is $1.7 billion (1982 dollars).

7.4 ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATIONS

The Kenai power plant for the low load forecast will consist of three combined cycle units, in contrast to the five combined cycle and two simple cycle units for the medium load forecast. Power plant characteristics realted to environmental resources are summarized in Table 7-7.

TABLE 7-4

ANNUAL CAPITAL EXPENDITURES
KENAI AREA POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated Unit A	Unit B	Transmission Line	Total
1982	0.	0.	0.	0.
1983	0.	0.	0.	0.
1984	0.	0.	0.	0.
1985	0.	0.	0.	0.
1986	0.	0.	603.2	603.2
1987	0.	0.	138.6	138.6
1988	10.60	0.	274.0	284.6
1989	35.68	0.	111.6	147.3
1990	0.	0.	0.	0.
1991	35.68	53.65	0.	89.33
1992	0.	0.	0.	0.
1993	35.68	0.	0.	35.7
1994	35.68	0.	0.	35.7
1995	0.	0.	0.	0.
1996	53.65	35.68	0.	89.3
1997	0.	0.	0.	0.
1998	0.	0.	0.	0.
1999	0.	0.	0.	0.
2000	35.68	0.	0.	35.7
2001	53.65	0.	0.	53.7
2002	0.	0.	0.	0.
2003	35.68	0.	0.	35.7
2004	35.68	0.	0.	35.7
2005	53.65	0.	0.	53.7
2006	0.	0.	0.	0.
2007	35.68	0.	0.	35.7
2008	0.	0.	0.	0.
2009	35.68	0.	0.	35.7
2010	0.	0.	0.	0.
Total	$405.	$89.	$1,128.	$1,710.

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TABLE 7-5

ANNUAL NON-FUEL OPERATING AND MAINTENANCE COSTS
KENAI AREA POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Electricity Generated	Transmission Line	Total
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	0.	0.	0.
1987	0.	0.	0.
1988	0.	0.	0.
1989	0.	0.	0.
1990	2.21	12.0	14.21
1991	2.21	12.0	14.21
1992	6.23	12.0	18.23
1993	6.23	12.0	18.23
1994	8.44	12.0	20.44
1995	10.64	12.0	22.64
1996	10.64	12.0	22.64
1997	14.66	12.0	26.66
1998	14.66	12.0	26.66
1999	14.66	12.0	26.66
2000	14.66	12.0	26.66
2001	16.87	12.0	28.87
2002	18.68	12.0	30.68
2003	18.68	12.0	30.68
2004	20.89	12.0	32.89
2005	23.10	12.0	35.10
2006	24.91	12.0	36.91
2007	24.91	12.0	36.91
2008	26.62	12.0	38.62
2009	23.15	12.0	35.15
2010	27.68	12.0	39.68
Total	$331.	$252.	$583.

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TABLE 7-6

TOTAL ANNUAL COSTS
KENAI AREA POWER GENERATION - LOW LOAD FORECAST
(Millions of January, 1982 Dollars)

Calendar Year	Capital Expenditures	O & M Costs	Total Expenditures
1982	0.	0.	0.
1983	0.	0.	0.
1984	0.	0.	0.
1985	0.	0.	0.
1986	603.2	0.	603.2
1987	138.6	0.	138.6
1988	284.6	0.	284.6
1989	147.3	0.	147.3
1990	0.	14.21	14.21
1991	89.3	14.21	103.51
1992	0.	18.23	18.23
1993	35.7	18.23	53.93
1994	35.7	20.44	56.14
1995	0.	22.64	22.64
1996	89.3	22.64	111.92
1997	0.	26.66	26.66
1998	0.	26.66	26.66
1999	0.	26.66	26.66
2000	35.7	26.66	62.36
2001	53.7	28.87	82.57
2002	0.	30.68	30.68
2003	35.7	30.68	66.38
2004	35.7	32.89	68.59
2005	53.7	35.10	88.80
2006	0.	36.91	36.91
2007	35.7	36.91	72.61
2008	0.	38.62	38.62
2009	35.7	35.15	70.85
2010	0.	39.68	39.68
Total	$1,710.	$583.	$2,292.
Present Worth @ 3%	$1,342.	$331.	$1,673.

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TABLE 7-7

ENVIRONMENT RELATED POWER PLANT CHARACTERISTICS
COMBINED CYCLE POWER PLANT
KENAI AREA POWER GENERATION - LOW LOAD FORECAST

Air Environment	
Emissions	
Particulate Matter	Below standards
Sulfur Dioxide	Below standards
Nitrogen Oxides	Emissions variable without standards - dry control techniques would be used to meet calculated NO_x standard of 0.014 percent of total volume of gaseous emissions. This value calculated based upon new source performance standards, facility heat rate, and unit size.
Physical Effects	Maximum structure height of 50 feet
Water Environment	
Plant Water Requirements	500 GPM
Plant Discharge Quantities	100 GPM
Wastewater Holding Basin including treated sanitary waste, floor drains, boiler blow-down, and demineralizer wastes	
Land Environment	
Land Requirements	
Plant and Switchyard	120 acres
Socioeconomic Environment	
Construction Workforce	Approximately 200 personnel at peak construction
Operating Workforce	Approximately 130 personnel

Approximately 500 gpm of fresh water will be supplied by groundwater for water or steam injection (for NO_x control), equipment wash-down, boiler make-up water, and potable supplies. This amount of water will not significantly affect groundwater supplies in the area. Wastewater discharges will be less than 100 gpm and will be treated to meet effluent guidelines.

Aquatic resources, as for the medium load forecast, will not be significantly affected. Plant acreage will be approximately 120 acres as compared to 175 acres for the medium load forecast. Terrestrial impacts are correspondingly reduced.

Impacts associated with the transmission line from Kenai to Anchorage and on to Fairbanks are identical to those discussed in Section 6.4 for the medium load forecast.

Socioeconomic impacts are expected to be similar to those for the medium load forecast. They would be less significant for the low load forecast. The in-migrating workforce, which would have to seek temporary housing on their own, would be smaller than for the medium growth forecast, and thus would cause fewer demands on local housing and public services.

COMPARISON OF SCENARIOS

8.0 COMPARISON OF SCENARIOS

The three development scenarios have a common purpose of meeting the electrical generating needs of the Railbelt Region using North Slope gas as a fuel source. However, the electric generating schemes and auxiliary systems vary widely among the scenarios making comparison of their relative merits complex. Table 8-1 is a side-by-side comparison of some of the important features of the three scenarios for both medium and low load forecasts. Each power plant meets the respective electricity demand forecast for the Railbelt. The Kenai plants also include the anticipated electrical requirements of the TAGS gas conditioning and liquefaction facilities. Simple cycle units are the recommended technology for electric generators on the North Slope, but combined cycle is more appropriate for the other two scenarios. The environmental and socioeconomic effects of all development scenarios are substantial, but how have been identified which would preclude any project. All scenarios are technically feasible from an engineering point of view.

none(?)

The ultimate feasibility of each development scenario described herein will depend upon a comparison of power costs between these scenarios and alternative electric generating technologies. Such comparisons are outside Ebasco's scope of work, but can be considered as a logical extension of these studies which may be performed by the Alaska Power Authority.

TABLE 8-1

COMPARISON OF SCENARIOS

Factor	Power Plant Location: North Slope Medium	North Slope Low	Fairbanks Medium	Fairbanks Low	Kenai Medium	Kenai Low
Power Plant Capacity (MW)	1365	728	1383	726	1743	1116
Required Units (Simple Cycle/Combined Cycle)	15/0	8/0	2/5	0/3	1/7	2/4
Plant Site Acreage	90	60	140	90	175	120
North Slope to Fairbanks Transmission Lines (500 kV)	2	2	NA1/	NA	NA	NA
Fairbanks to Anchorage Transmission Lines (345 kV)	3	2	3	2	2	2
Kenai to Anchorage Transmission Lines (500 kV)	NA	NA	NA	NA	2	2
North Slope to Fairbanks Pipeline Compressor Stations	NA	NA	10	3	NA	NA
POWER GENERATION (1982 $ Billion)						
Capital Investment	4.2	3.3	6.2	4.7	2.1	1.7
Total O&M	1.1	0.7	0.8	0.3	0.8	0.6
Present Worth	3.8	2.7	5.2	3.4	2.0	1.7
DISTRIBUTION SYSTEM (1982 $ Billion)						
Capital Investment	NA	NA	1.1	1.5	NA	NA
Total O&M	NA	NA	0.09	0.04	NA	NA
Present Worth	NA	NA	0.9	1.1	NA	NA

1/ NA - Not applicable

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9.0 REFERENCES

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