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Docket No. CP80-

(DESIGN MANUAL)

Exhibit Z-9.2 Stations Design
Exhibit Z-9.3 Communications System
Exhibit Z-9.4 Oper. and Maintenance
Exhibit Z-9.5 Temp. Facil. Design

Volume VIII

ALASKA SEGMENT

ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Alaskan Northwest Natural Gas Transportation Company

OCT 6 1980
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U.S. Department of the Interior
JUL 14 1980

United States of America
Before the
Federal Energy Regulatory Commission

Docket No. CP80-

(DESIGN MANUAL)

Exhibit Z-9.2 Stations Design
Exhibit Z-9.3 Communications System
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Exhibit Z-9.5 Temp. Facil. Design

Volume VIII

Application of
ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

For a Final Certificate of Public Convenience and Necessity
Pursuant to Section 7 (C) of the Natural Gas Act, as
amended, and Section 9 of the Alaska Natural Gas
Transportation Act of 1976 to construct and
operate the Alaska Segment of the Alaska
Natural Gas Transportation System.

July 1, 1980

EXHIBIT Z-9.2

COMPRESSOR AND METERING STATION DESIGN

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

ALASKA SEGMENT OF THE
ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Docket No. CP80-
Exhibit Z-9.2
Hearing Exhibit No.

COMPRESSOR AND METERING STATION DESIGN

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1.0 INTRODUCTION

Exhibit Z-9.2 of the Design Manual provides the description and a discussion on the design of the compressor and the metering stations that will be installed in the Alaska Segment of the Alaska Natural Gas Transportation System.

Compressor Stations Configuration for both the 2000 MMSCFD and 3200 MMSCFD pipeline flow rates are based on the hydraulic criteria discussed in Exhibit Z-9.0. Additional information on the flows, temperature and pressures at each compressor station is provided in Exhibits G, GI, and GII.

Refrigeration units will be provided at every compressor station to maintain the gas temperature within the operating limits.

Pipeline gas will be used for powering the drivers for the gas compressors, the refrigeration units and the electric power generators.

Docket No. CP80-
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Hearing Exhibit No.

2.0 COMPRESSOR STATION DESIGN

2.1 DESCRIPTION AND CRITERIA

2.1.1 Location

To provide the initial capacity for the Alaska Segment of the ANGTS, seven compressor stations will be required to provide an average annual receipt gas flowrate of 2000 MMSCFD. Nine future station sites have also been designated, and with these stations the pipeline input flowrate capacity will be increased to 3200 MMSCFD. Z-9.0 shows the initial and future compressor station locations.

2.1.2 Layout and Equipment Spacing

A typical compressor station overall plot plan is shown on Figure Z-9.2-2-1 to illustrate the proposed layout arrangement of the buildings. Each station site will require approximately 20 acres to provide the necessary spacing between buildings, and the spacing between a building and outside equipment. The location of each building and the outside equipment depends on the equipment functions within the building and the distances to other buildings and equipment. The distances meet or exceed the requirements of applicable codes and standards. The equipment spacing within the buildings will be based on the operating and maintenance requirements of the equipment.

2.1.3 Access

Access roads which lead to the stations will be forty feet in width. The design gradient of access roads for station sites will be eight percent maximum. All station access roads will tie into the public road system.

Entrance to a typical compressor station site will be provided by one large gate in the perimeter fencing. The site will have two other gates as emergency exits. During construction, the site will be accessible only through the temporary camp facility area. The temporary facility will be used for construction of the station and will be removed when construction is completed. Entrance to the temporary facility will be provided by one gate in the perimeter fencing, two other gates provide emergency exits.

2.1.4 Proximity to Roads and Streams

Each compressor station will be located so that the fence-line is at least:

- o Five hundred feet from the centerline of the TAPS and the Haines Right-of-Way.
- o Five hundred feet from rivers, streams, and lakes.
- o Three hundred feet from the public highway system.

2.1.5 Environmental

The environmental considerations and review as related to compressor station site selection dealt with biological, and physical factors. In the biological field, the protection of endangered species habitat is of primary importance. It was determined that the present compressor station locations do not infringe upon boundaries of those habitats. The migrational ranges, routes, and seasonal use areas of mammals, waterbirds and raptors were taken into account based on available biological data. Data from ongoing biological investigations will be incorporated into the design process. In the physical area, the impacts of each compressor station on air quality were examined using computer techniques to estimate the atmospheric dispersion of equipment emissions. The model results indicate that the compressor stations as presently situated will not cause violations of National Ambient Air Quality Standards for the contaminants emitted. This analysis was filed March 6, 1980 with GPA Region X as part of a Prevention of Significant Deterioration (PSD) permit application for the seven compressor stations (see Section 3.1 of Exhibit Z-1.1.

A number of biological, physical and civil field investigation programs are being conducted to verify present data and supply additional information that will be incorporated in the design process.

2.1.6 Climatological and Meteorological

The climatological and meteorological criteria are based upon measured and historical data. Research of existing climatological data is continuing. The available data have been analyzed to develop the climatological and meteorological criteria used in preliminary design. These criteria will be further refined and incorporated in the final specifications and design of the compressor and metering stations.

2.1.7 Station Differences

The stations will utilize the same equipment and facility designs to the maximum extent possible. They will have similar plot plan layouts, buildings, and equipment. Primary differences between stations are as follows:

- o Stations 2 and 4 will include gas heaters. These gas heaters will be required in the winter to prevent the mainline gas temperature from dropping below 0°F when the heat generated by compression will not be adequate. Other stations will not require gas heaters because of their southerly locations and higher average ground temperatures.

- o Stations 2, 7, and 15 will include Operations and Maintenance facilities in addition to the normal station facilities. These facilities are described in Exhibit Z-9.4, Operations and Maintenance Facility Design.

2.1.8 Process

The process flow diagram of the station main gas piping is shown on Figure Z-9.2-2-2. This includes the launcher and receiver, liquid-vapor separators (scrubbers), pipeline compressor, chillers, gas heaters and blow-down drum with flare stack. The normal suction pressure at the compressor stations will be approximately 1100 psig with a gas temperature between 0 and 32°F. The discharge pressure from the station will be a maximum of 1260 psig.

2.2 DESIGN

2.2.1 Civil

The following loads, forces, and site work will be considered in the design of station structures:

Live loads will be uniformly distributed over the horizontal projection of the specified areas, and will have the following minimum values:

- o Storage Areas - 150 psf
- o Operating Areas - 75 psf
- o Access Areas - 50 psf
- o Roof Areas - UBC Section 2305
- o Stairs and Ramps - 100 psf
- o Laboratories - 100 psf

Bridges, trenches and underground installations accessible to truck loading will be designed to withstand HS 20 loading as defined by the American Association of State Highway and Transportation Officials (AASHTO) under Standard Specification for Highway Bridges, 1977 Edition.

Snow loads will be 60 psf.

Components of the stations will be designed to withstand the applicable design wind pressures as follows:

Height Zones (feet)	Design Wind Pressure - Flat Surfaces (psf)
Less than 30	30
30 to 50	40
50 to 100	50
100 to 500	60

For structures supporting live loads which induce impact, the assumed live load will be increased sufficiently to provide for the impact. If not otherwise specified the increase will be:

o Elevator Supports	100%
o Gantry and Bridge-Crane Supports	25%
o Monorail Supports	25%
o Machinery	50%
o Davits	50%

For structures which are not heated, the design temperature for the structural members will be -60°F to +80°F. For buildings which are insulated and heated with the structure entirely inside the insulation, the building design temperatures will be -60°F on the outside surface with a normal inside surface temperature of +60°F. The minimum inside operating temperature of the building will be +40°F.

The building will be designed to meet the largest of the following combinations:

	Percentage of Working Unit Stress
o Dead load plus full roof live load	100%
o Dead load plus 1/2 roof live load plus wind load	133%

2.0 FACILITY DESCRIPTIONS

2.1 ALASKAN HEADQUARTERS FACILITIES

The Alaskan operations headquarters for the project will be in the existing facilities at Fort Wainwright under lease from the U.S. Department of the Army. The headquarters will provide the point of control for construction management of the project. It will support Northwest Alaskan Pipeline Company, PMC and governmental agency personnel.

Two buildings (Nos. 1555 and 1564) available at Fort Wainwright will be developed for use as headquarters office buildings.

It is proposed that during the third quarter of 1980, an engineering firm will be engaged to conduct a detailed survey of the Fort Wainwright building facilities to prepare drawings and specifications for new construction, refurbishment and renewal of the existing facilities required to satisfy the project needs. The drawings and specifications will be utilized to award a contract for renovation of the building facilities. Construction is planned for 1981.

2.2 CONSTRUCTION CAMPS

Temporary construction camps will be constructed or camps utilized in TAPS construction will be refurbished along the route of the gas pipeline system. It is expected that most of these camps will be in service for three years.

The construction camps will accommodate construction and support personnel, such as Northwest Alaskan Pipeline Company, PMC, Execution Contractor management employees, agency representatives, craft labor, camp support personnel, and transients. Buildings used for housing will utilize factory built and equipped modules which provide comfortable living conditions in severe arctic weather.

Two types of construction camps will be developed, one for the compressor station and one for the pipeline. Camps used in the construction of the compressor stations will be located at sites immediately adjacent to the sites for the stations. Metering stations will be constructed using the camps located at the nearest compressor station. Camps used in the construction of the pipeline will be located adjacent to the pipeline route at various spacings based upon construction logistics. Access roads will be provided from the highway to the camps.

Maximum use will be made of available Alyeska construction camps. Some of these will be renovated in place, while others will be dismantled, salvaged, relocated, and re-installed and refurbished at new sites. All compressor station camps will be developed at new sites utilizing facilities currently located at Alyeska pump station camps.

Renovation and new camp construction will be in accordance with applicable codes, statutes and regulations and will incorporate features to improve and modernize the operation of the camp facilities.

Camp Facilities

Generally, the following facilities will be located at each camp:

- Living Quarters
- Food Preparation and Dining Area
- First Aid Dispensary
- Recreation Facilities
- Security Building
- Fire Fighting Equipment Building
- Life Support Systems

    Power and Light Generation Equipment
    Water Supply, Storage, Treatment and Distribution Facilities
    Sewage Collection, Treatment and Disposal Systems
    Solid Waste Collection and Disposal Facilities
    Fire Water Booster Pumps and Dispensing Equipment
    Smoke Detectors
    Building Heating and Ventilation

- o Construction Support Facilities

  Shops, Warehouses, and Vehicle Maintenance Facilities
  Laboratory
  Construction Management Offices
  Fuel Storage and Dispensing System
  Waste Oil Storage
  Equipment Laydown Areas
  Communication facilities
  Heliport

Civil Engineering Criteria

Civil engineering design criteria and standards will be developed for all temporary camp facilities. These criteria will be in terms of the existing physical conditions, new project requirements and the regulatory conditions established by governmental agencies. The work plan for developing the civil engineering criteria for the camps is as follows:

- o Collect, collate and evaluate all available civil engineering data
- o Conduct field reconnaissance of existing and proposed temporary camp facilities
- o Prepare conceptual civil designs and guideline specifications
- o Prepare a temporary facilities civil engineering report

Fencing

Perimeter fencing will be installed at all camps for security and animal control. A fence of galvanized steel chain link extending below grade will be installed to discourage burrowing by animals. The fence will be 9 feet above grade topped with a one foot section having 3 strands of barbed wire.

Site Preparation

Site preparation efforts will result in a clear, stable, well-drained, all-weather surface for the location of structures and areas for traffic, parking and storage.

The existing camp pads can be renovated by minor grading and addition of nominal amounts of borrow material to correct localized surface drainage problems. The minor grading will include recompaction of surfaces for traffic, parking, and storage areas.

Site preparation for new camps and camp expansion will be in accordance with designs based upon field surveys, and subsurface investigations. Grading designs will provide for stable, well-drained, surfaces which are subject to minimal erosion and settlement problems for the expected life of the facility. Clearing, grading, disposal, erosion control, drainage, restoration and revegetation will be in accordance with the civil design criteria provided in Exhibit Z-9.1.

2.2.1 Pipeline Construction Camps

Existing Camps Renovated in Place

In order to minimize impacts on undisturbed areas, maximum use is planned for the existing TAPS construction camps and related facilities, maintaining their present locations. Improvements which are necessary to provide support facilities for the project at these camp locations will be made in accordance with applicable statutes, regulations, standards and permit requirements. Camps to be renovated for use on this project will be:

Franklin Bluffs	Chandalar	Old Man
Happy Valley	Dietrich	Five Mile
Toolik	Coldfoot	Livengood
Galbraith	Prospect Creek	Delta
Atigun		

Several surveys have been made of these camps by various teams since 1977 to assess the condition of the camp facilities. Most of the camp buildings are in satisfactory condition due to routine surveillance and preventive maintenance action taken by Alyeska. However, some rehabilitation is required to improve the condition of the facilities for the projected three year construction period, beginning in 1983. This requirement is based on wear from the long period of use by Alyeska and also normal attrition caused by the elements since closure.

The housing units, composed primarily of factory built modules, were well built and are structurally in good condition. Typical building items requiring either replacement or repair include roofing (as evidenced by leaks), insulated ceiling panels (which have been damaged by water), worn floor covering, laundry washer and dryer units, water closets, lavatories and stall showers.

Utility systems such as power, lighting, water, heating, smoke detection and sewage will be tested and repaired or replaced as required. Shops, warehouses and utility buildings of metal panel construction are in good condition. Some repairs will be required to damaged panels and overhead door assemblies. It is anticipated that some major mechanical equipment items may be replaced such as incinerators, sewage treatment units, sewage lift stations, pumps and power generators.

One of the first activities of the reconditioning program will be the releveling of buildings. The most pronounced settlement of buildings has occurred at Toolik, where the buildings have not evidenced any major damage and can be releveled.

Fuel spillage in the pads from past breakage of buried piping is another consideration of importance at several existing Alyeska camps. NWA will work with the parties involved to estimate the extent of this residual and evaluate the need for corrective action as part of its planning for camp renovation.

An architectural and engineering firm will be engaged to conduct a detailed survey of current conditions at all the existing Alyeska pipeline camps to be renovated in place. The firm will subsequently prepare drawings and specifications defining full facility renovation and replacement requirements. These documents will be issued for contract bids to contractors for construction which is planned for 1982.

Camps at New Sites

Three new pipeline construction camps will be required along the route of the pipeline in the Delta-Leg, between Delta and the Canadian Border. These camps are identified as:

Knob Ridge
Tok
Northway

It is planned to transport camp components from the three surplus Alyeska camps south of Delta, namely, Isabel Pass, Tonsina and Sheep Creek, for installation and renovation at the new Delta-Leg campsites. Recent surveys of the Alyeska camps indicated that housing units are in fair condition at Isabel Pass and Tonsina, but substantial water damage has occurred to most units at Sheep Creek camp.

Field programs are scheduled for 1980 to conduct potable water source surveys and foundation investigations at the new sites to develop criteria required before proceeding to the definitive design phase.

In addition to the relocated facilities, it will also be required to develop the other components of a complete pipeline camp including the pad, a flow control management reservoir (or other method for wastewater disposal), five day emergency waste water holding pond, bulk fuel depot, water supply source, and utility distribution systems.

An engineering firm will be engaged to survey the surplus camps to be relocated. The new sites will also be surveyed to permit development of drawings and specifications for construction of the camps. Construction is planned for 1982.

Fort Wainwright Camp

The Fort Wainwright pipeline construction camp will be located partially in leased facilities at Fort Wainwright and partially in Fairbanks, or vicinity thereof, as arranged by the Spread 4 Execution Contractor. Two renovated barracks buildings (Nos. 1001 and 1004) at Fort Wainwright will be made available to the Execution Contractor for housing the pipeline staff and craft labor. Other facilities at Fort Wainwright will be available to the Execution Contractor for development and use. These are maintenance buildings Nos. 1594 and 1599, six acres of open ground between buildings 1001 and 1004, and an area adjacent to the north airfield runway.

From a survey conducted in December 1979, Buildings 1001 and 1004 were found to be in reasonably good condition. The two barracks (No. 1001 and 1004) will be surveyed in detail by the engineering firm selected for renovation of the Fort Wainwright office building No. 1555 and 1564. This firm will also prepare drawings and specifications defining the required renovation work for the two barracks to be issued in construction bid packages. Construction is planned for 1982.

2.2.2 Compressor Station Construction Camps

A compressor station construction camp will be constructed adjacent to each of the seven compressor stations. The usable components of eight surplus Alyeska pump station construction camps will be used to develop the compressor station camps. Facilities available are those presently located at TAPS Pump Stations 3, 4, 5, 6, 7, 9, 10 and 12. The facilities to be moved will be disassembled where necessary, transported to the new sites, erected and renovated for the construction period.

Field programs scheduled for 1980 will conduct potable water source surveys and foundation investigations at the new sites to develop site-specific criteria for design. In addition to the relocated facilities, other components required for a complete construction camp will be designed to provide an operable facility. A survey was made by the PMC in July 1978 of the TAPS pump station camps. The facilities to be salvaged are generally in good condition with modest refurbishment required for the housing units. However, it may be necessary to install several items of new equipment such as generators, pumps, incinerators and sewage treatment plants.

An architectural and engineering firm will make a detailed survey of the TAPS station construction camps. The firm will also prepare drawings and specifications for the construction bid packages. Construction is planned for 1983.

2.3 AIRFIELDS

Existing permanent and temporary airfields will be used to support construction of the pipeline and compressor stations. Use of the airfields will be based upon the logistical requirements during construction, the availability of services at operational airports and the proximity or surface accessability of existing operational airfields to the pipeline or compressor station construction camps.

Existing public airports at Fairbanks, Deadhorse, Tanacross, Fort Greely (Allen Army Airfield), and Northway will be used under the existing conditions or as upgraded by the Alaska State Department of Transportation and Public Facilities. Existing private airfields built in support of TAPS construction will be evaluated and upgrading and rehabilitation measures will be initiated. The design will provide for safe and efficient air transport of project personnel, mail, and cargo during the construction period.

Facilities at the private airfields will include buildings for tower operators, crash/rescue equipment, generators, and personnel standby. Adequately insulated, lighted and heated, prefabricated modules will be used for these support functions. At some locations which are in close proximity to camps, camp electrical power will be used for airfield requirements. Airfields which are not immediately adjacent to camps will require installation of primary and standby generating systems for electrical power purposes. Aviation refueling facilities will be provided at each facility.

Detailed designs for upgrading and rehabilitation will be based upon Federal Aviation Administration (FAA) airport design standards and policies, requirements of the operating air carriers and results of detailed field surveys and investigations of the conditions of the existing airports and ancillary facilities.[1] The following is a list of the ten private airfields to be utilized:

AIRFIELD	RUNWAY LENGTH (Feet)	CURRENT STATUS	UPGRADING/ REHABILITATION
Livengood	2,500	Closed	Extend Runway, Rehab. Lighting
Five Mile	2,500	Operating	Minor
Old Man	5,000	Closed	Rehab. Runway & Lighting
Prospect Creek	5,000	Operating	Minor
Coldfoot	5,000	Closed	Runway (Minor), Rehab. Lighting
Dietrich	5,200	Closed	Rehab. Runway & Lighting
Chandalar	3,000	Operating*	Runway (Minor), Rehab. Lighting
Galbraith	5,200	Operating	Minor
Happy Valley	5,000	Closed	Runway (Minor), Rehab. Lighting
Franklin Bluffs	5,000	Operating*	Rehab. Runway & Lighting

* Intermittent Operations

1 "Airport Engineering Study," Michael Baker, Jr., Inc., May 1980.

2.4 ACCESS ROADS

Access roads for project use are shown on the civil construction alignment sheets (Exhibit Z-6.2). Project roads will be designed or evaluated for use based upon safe, proven and accepted engineering principles and practices for secondary roads in the arctic and subarctic environments.[2] Designs and evaluations of roads will give special consideration to the following:

- o Safe and efficient surface transport of personnel, materials, construction equipment, and supplies
- o Stability and integrity of the pipeline system
- o Protection of other facilities
- o Control of air and water pollution
- o Minimization of disturbance to fish and wildlife resources
- o Control of impact on visual resources
- o Control of disturbance to the thermal regime
- o Use of materials for construction of the embankments, roadways, surfaces, and erosion control structures that are available near the work site
- o Use of materials for drainage and other structures which are compatible with logistical and economic constraints
- o Optimization of the balance between initial construction and subsequent maintenance or restoration efforts

Existing roads will be evaluated for combined project and current usage in accordance with the above criteria. Those existing roads which can provide for safe and efficient transport of project personnel, materials construction equipment and supplies will be used without upgrading. Any existing roads which do not meet safe operational standards or have been "put to bed" will be upgraded or rehabilitated for project use.

[2] "Access Road Engineering Study," Michael Baker, Jr., Inc., May 1980.

New roads for project use will be designed and constructed in accordance with the above listed general criteria. Basic design standards governing horizontal alignment, grades, widths and intersections will be established from the policies of the American Association of State Highway and Transportation Officials (AASHTO) with appropriate modifications for project traffic, the arctic and subarctic environment and the regulatory requirements special to the project. Design and location of new project roads will give special attention to the following:

- Providing access to the pipeline construction zone
- Providing access to permanent pipeline facilities
- Minimizing traffic congestion
- Providing access to material storage and borrow sites
- Taking maximum advantage of locations providing competent subgrades
- Avoiding unstable soil areas, wetlands, streams and identified aufeis areas to the extent possible

2.5 OFF RIGHT-OF-WAY STORAGE

In addition to storage areas associated with the construction camps, temporary areas will be provided for storage of pipe and other manufactured materials to be used in pipeline construction. Location and design features for these storage areas include special consideration of:

- Access from the existing highway system
- Proximity and access to the pipeline right-of-way
- Use of existing facilities and disturbed areas
- Provision for a stable, well-drained, all-weather surface for storage of heavy materials and movement of materials handling equipment

To the extent possible, storage areas prepared and used during the construction of the TAPS pipeline will be used between Prudhoe Bay and Delta Junction. New storage yards will be located on a spacing of 15 to 20 miles along the Alaska Highway between Delta Junction and the Canadian Border.

2.6 BORROW (MATERIAL) AND DISPOSAL SITES

Approximately 300 potential material sites are currently under investigation as possible borrow sources for the project. A portion of these sites are included on the civil construction alignment sheets. Final selection and design of mining plans for material sites will be based on data from comprehensive surveys, investigations, and engineering studies in which both source locations and project needs are identified.[3,4] Based on availability of materials and needs of the project, optimum source locations in terms of volume, haul economics, and environmental constraints will be selected for mining plan preparation. Where materials availability allow, maximum haul distances between sites will be kept under two and one-half miles. Site location and plan preparation will assure compliance with requirements of project stipulations and to allow for sensitive aspects of the project which require special treatment in design and operation.

A detailed mining plan will be prepared for each material site in accordance with 43 CFR, Part 23. These plans, as a minimum, will contain:

- A description of the site with vicinity map
- Mineral materials information
- Plan view and representative pit section drawings showing limits of the proposed mining
- Development sequence and mining procedures
- Access road plan and profile sheet(s)
- Variations (if any) from stipulations and regulations
- Impact on nonmineral resources (environmental review)
- Hydraulic analysis (if within an active floodplain)

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[3] "Material Site Exploration Program," Michael Baker, Jr., Inc., December 1978.
[4] "Reconnaissance Plans for Material Site Exploration Program," Michael Baker Jr., Inc., May 1979.

- o Description of special problems and necessary corrective measures (fire control, soil erosion, water pollution, danger to fish and wildlife, and public health and safety hazards)

- o Restoration requirements

Disposal sites for unusable or excess excavated materials will be located near and be readily available to the work site. Location and design features of disposal sites will include special consideration of siltation and erosion control, impact on visual resources, use of existing disturbed areas, and long-term stability and restoration. Detailed plans will be prepared for each spoil disposal site. The plans will include:

- o A location description of the site and a vicinity map

- o A plan view and typical cross sections showing the working limits and proposed placement of spoil materials

- o Access road location

- o Description of any special problems and necessary corrective measures

- o Impacts on nonmineral resources

- o A restoration plan

- o Any required variances from stipulations and regulations

Spoil disposal sites will be located along the right-of-way to provide for a haul distance not to exceed approximately one-half mile. To the extent possible, excess materials from off right-of-way gradings will be disposed of at the grading site.

Spoil disposal sites will be integrated with solid waste landfill sites where site condition allow. See Section 3.3 for a description of solid waste (other than spoil) disposal.

TABLE 3-1

COMMUNICATIONS SYSTEM
CHANNEL QUANTITIES AND USAGE

FROM ↓ / TO →		CONSTRUCTION								START-UP		OPERATIONS		
		INTRA-SPREAD TELEPHONE LINES						FORT WAINWRIGHT		FBKS OCC		FBKS OCC		ALT. PIPELINE CONTROL (COMPR 11)
		PABX STA LINES	SPR. 1 HQ. HPY VALLY	SPR 2 HQ DIETRICH	SPR 3 HQ OLD MAN	SPR 5 HQ DELTA	SPR 6 HQ TOK	DATA	TELE-PHONE	DATA	TELE-PHONE	DATA	TELE-PHONE	TELE-PHONE
FR. BLUFF	CONSTRUCTION LOCATIONS (TEMPORARY)	75	6	–	–	–	–	–	–	–	–	–	–	–
FR. BLUFF		–	–	–	–	–	–	1	7	–	–	–	–	–
HAPPY VALLEY		90	–	–	–	–	–	1	11	–	–	–	–	–
TOOLIK		75	6	–	–	–	–	–	–	–	–	–	–	–
TOOLIK		–	–	–	–	–	–	1	7	–	–	–	–	–
GALBRAITH		75	–	6	–	–	–	–	–	–	–	–	–	–
GALBRAITH		–	–	–	–	–	–	1	7	–	–	–	–	–
ATIGUN		75	–	6	–	–	–	–	–	–	–	–	–	–
ATIGUN		–	–	–	–	–	–	1	7	–	–	–	–	–
CHANDALAR		75	–	6	–	–	–	–	–	–	–	–	–	–
CHANDALAR		–	–	–	–	–	–	1	7	–	–	–	–	–
DIETRICH		90	–	–	–	–	–	1	11	–	–	–	–	–
COLDFOOT		75	–	–	6	–	–	–	–	–	–	–	–	–
COLDFOOT		–	–	–	–	–	–	1	7	–	–	–	–	–
PROSPECT		75	–	–	6	–	–	–	–	–	–	–	–	–
PROSPECT		–	–	–	–	–	–	1	7	–	–	–	–	–
OLDMAN		90	–	–	–	–	–	1	11	–	–	–	–	–
FIVEMILE		75	–	–	6	–	–	–	–	–	–	–	–	–
FIVEMILE		–	–	–	–	–	–	1	7	–	–	–	–	–
LIVENGOOD		75	–	–	–	–	–	1	7	–	–	–	–	–
FORT WAINWRIGHT		2500 Max.	–	–	–	–	–	–	–	–	6	–	–	–
DELTA		90	–	–	–	–	–	1	11	–	–	–	–	–
SEARS CREEK		75	–	–	–	6	–	–	–	–	–	–	–	–
SEARS CREEK		–	–	–	–	–	–	1	7	–	–	–	–	–
TOK		90	–	–	–	–	–	1	11	–	–	–	–	–
NORTHWAY		75	–	–	–	–	6	–	–	–	–	–	–	–
NORTHWAY		–	–	–	–	–	–	1	7	–	–	–	–	–
FBKS TOLL		–	–	–	–	–	–	–	100	–	–	–	–	–
COMPR 2	PERMANENT LOCATIONS	40	–	–	–	–	–	1	5	1	2	2	4	1
COMPR 4		40	–	–	–	–	–	1	5	1	2	2	4	1
COMPR 7		40	–	–	–	–	–	1	5	1	2	2	4	1
COMPR 9		40	–	–	–	–	–	1	5	1	2	2	4	1
COMPR 11		40	–	–	–	–	–	1	5	1	2	2	4	–
COMPR 13		40	–	–	–	–	–	1	5	1	2	2	4	1
COMPR 15		40	–	–	–	–	–	1	5	1	2	2	4	1
Prudhoe Meter Sta.		0	–	–	–	–	–	1	2	1	2	2	2	0
Border Meter Sta.		0	–	–	–	–	–	1	2	1	2	2	2	0

4.0 OUTLINE SPECIFICATIONS

4.1 MICROWAVE LINKS

4.1.1 Frequencies, RF and MUX

The RF equipment will operate at microwave frequencies not to exceed 7 GHz. Frequency modulation will be employed.

The multiplex (MUX) frequencies will conform to CCITT standards as to group, supergroup and organization.

4.1.2 Channel Performance

Noise	50 dBrn
Crosstalk	-50 dBm0, transmit to receive in same channel at 4-wire point or from adjacent channels
Delay, Absolute	Maximum one-way delay between any two interconnected nodes, 300 milliseconds
Delay, Envelope	Envelope delay within limits of C2 conditioning per Bell specifications
Response	+1 to -3dB, 300-3400 Hz, reference 1 kHz
Test Tone	4-wire, 0 dBm transmit and receive at interface 2-wire, +7 dBm to -16 dBm, adjustable output to PABX or other termination equipment. Input from PABX or other termination equipment, 0 dBm.
Impulse Noise	Less than 30 impulses greater than 68 dBrn in any 30-minute period
Harmonic Distortion	1.5% maximum at 0 dBm0, 300-3400 Hz
Phase Jitter	6% or less at 1004 Hz
Synchronization	Zero frequency error, end-to-end
Return Loss	Nominally 30 dB at 1004 Hz, 2-wire circuits

Data Loading	Modem signals to data channel will be applied at -13 dBm0 rms.
Drop Impedance	4-wire, 600 ohms balanced 2-wire, 600 or 900 ohms, depending on termination equipment

4.1.3 Alarms

Communication system alarms will be provided with indicators at the equipment. Remote signals will be transmitted as switch closures isolated from ground, over MUX to the Fairbanks facilities. Alarms will be included for all circuits necessary to effectively monitor the operation of the microwave and UHF repeater sites.

4.1.4 Redundancy

Radio frequency and multiplex subcarrier equipment for the operations phase will be redundant, with automatic changeover capability in the event of failure. This does not apply to antennas, feedlines, or towers. The construction phase will not have the same redundancy features since minimal communications outages can be tolerated.

4.1.5 Towers

Towers will be designed to withstand the wind and ice loading with all antennas attached and will not twist or sway more than one-half beam width of the highest gain antenna mounted thereon. Painting and lighting will be as per FAA/FCC requirements if tower height requires this safety treatment.

4.1.6 Antennas

Antennas will be high-performance types having minimum side lobes. They will be equipped with shrouds capable of shedding ice and snow in the presence of even light winds. Anchoring to tower will be designed to withstand the highest specified wind and ice load for each site.

4.1.7 Feedline

The antenna feedline may be waveguide or low-loss coax, with line loss not to exceed 2 dB/100 feet. The feedline will be regularly supported by hangers on the tower and be within the bend radius specified by the manufacturer. The number of reducers, bends, splices and connectors will be minimized.

4.1.8 Communication System Power

Communication system power will be provided with standby power to operate the system (together with UHF repeater, if colocated, at reduced power permitted during such operation) for a minimum of 24 hours.

4.1.9 Shelters and Sites

Shelters will be insulated and heated to keep interior temperature at 40°F in coldest winter temperature. Shelters will withstand specification winds. Shelters will be securely locked, and will include fire, smoke, water and intrusion alarms. A room will be provided of sufficient size and width to house the electric generating system and ancillary equipment.

The sites will be fenced with locked gates. The fencing will be located at least 8 feet away from any point on the tower or shelter. A buried fuel supply will be provided with underground lines to the shelter for the electrical generating equipment.

4.1.10 Spur Links

Microwave spur links from the transmission facilities to the remote facilities channels will include redundant equipment for RF and MUX. Spur links will have the same channel performance requirements as previously listed under channel performance. At least 40 dB fade margins will be included. Minimum side lobes (high performance antennas) will be provided.

4.2 UHF MOBILE SYSTEM

Mobile repeaters will be strategically located to provide 95/95 area/time radio coverage to mobiles along the pipeline route. Two UHF frequency pairs are to be alternated between adjacent repeaters. A continous tone-coded squelch system (CTCSS) will be provided, using the same tones throughout, for unwanted signal control.

Mobile repeaters are to be 100 watts with 10 dB antennas as required to provide the coverage specified. Each mobile radio unit will be 100 watts with 6 dB omni antennas. Multiple frequency equipment (repeater pairs plus simplex on repeater output frequencies) will be used. Weatherproof cases of rugged design will be provided. MIL-type mobile microphones will be included. Automatic time-outs will be provided on mobiles and repeaters. Equipment will have a provision for repeater disable by (1) maintenance section dispatch or (2) OCC dispatcher.

The repeaters will have VSWR monitor with go/no-go limits sending an alarm when operating out of band. Low loss coax cable and Teflon fittings will be used throughout. Antenna cables will be in conduit through the point of shelter penetration. Watertight fittings, drain and breather holes in conduit at drip loops and ice protection will be included. Repeater antennas will be installed near top of tower, preferably on top consistent with lighting requirements. Antenna tower lightning protection will be provided.

Repeaters will be colocated with microwave stations where feasible. Where colocation is not feasible, 960 mHz low-density links are to be used.

Monitors and alarms will be included, with switch contacts isolated from ground, which will pass over the microwave MUX. Alarms will be provided to indicate low transmitter power, noisy receiver, or off frequency operation.

Repeaters and mobiles are to be of solid state design.

Operational portable units are to be 2 watts, of intrinsically safe design for explosive environments. The units will include vehicular battery charger and multiple charger at each maintenance center and carrying cases. Flexible "rubber duck" antennas and a CTCSS will be provided. Rechargeable batteries of the longest possible life will be included.

Some repeaters may require down-tilt antennas, depending on coverage situation.

EXHIBIT Z-9.4

OPERATIONS AND MAINTENANCE
FACILITY DESIGN

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

ALASKA SEGMENT OF THE
ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Docket No. CP80-
Exhibit Z-9.4
Hearing Exhibit No.

OPERATIONS AND MAINTENANCE FACILITY DESIGN

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1.0 OPERATIONS AND MAINTENANCE FACILITY DESCRIPTION

1.1 OPERATIONS FACILITY

The Operations Control Center and the operations personnel will be located in the Operations and Maintenance facility in Fairbanks, Alaska, and pipeline operating functions will emanate from this facility.

The Fairbanks Operations and Maintenance facility layout is shown in Figure Z-9.4-1-1. The Operations facility will be located in the OCC and office areas of this building.

The OCC and office will be situated so that the Director of Operations will have easy access to the control room for day-to-day supervision and immediate access in the event of an emergency.

A communications tower will be located adjacent to the facilities which will receive and transmit communications between the OCC and facilities along the system.

The primary function of the Fairbanks Operations and Maintenance facility will be to provide an efficient working environment for personnel and equipment. The extreme climatic conditions at Fairbanks and the availability of leased buildings are important design considerations. It is planned to lease the Fairbanks Operations and Maintenance facility and make modifications to the facility as required. The size of this Operations facility is planned to be 100 feet wide by 75 feet long.

The facility will house the following operations equipment:

- o The Supervisory Control Computer
- o The Dispatcher Console
- o The Programmer Console
- o The Uninterruptible Power Supply and Generator Equipment

- The Computer File and Record Storage Equipment
- The Communications Equipment
- The Heating and Ventilating Equipment
- The Office Equipment Necessary to Support the Operations Personnel

1.2 MAINTENANCE FACILITIES

Maintenance of the system will be performed out of four District Maintenance Facilities under the direction of the Fairbanks Operations. Each district will cover approximately one-fourth of the pipeline route. Figure Z-9.4-1-2 shows the District Maintenance Facilities locations. A description of the coverage of each district is shown in Table 1-1.

With the exception of the Fairbanks District, district headquarters will be centrally located at one of the Compressor Stations to allow immediate attention to that station and minimize access time to other locations within the district.

The compressor station building design features previously described in Exhibit Z-9.2, are applicable to the Operations and Maintenance District Headquarters buildings. Reference Exhibit Z-9.2, Buildings, for more detailed information. Table 1-2 contains a list of the buildings and their sizes. Note that the building sizes are column to column dimensions (where applicable).

In addition to the vehicles listed in Table 1-3, provisions will be made for air travel to the various Compressor Stations. Helicopter pads will be built outside the station fence, adjacent to the living quarters at each station. Also, use of existing nearby airfields will provide the ability to ferry personnel and equipment to each station as required.

Each District Headquarters will accommodate company vehicle storage and service requirements and be available to contractors for vehicle storage when required.

- Table 1-3 shows the proposed transportation equipment to be provided at each District Headquarters.

- Maintenance equipment will be permanently stationed at each Compressor Station including the equipment necessary for handling large items such as valves, pipe, drums, pumps and other miscellaneous items. A list of equipment required for station and pipeline maintenance is shown in Table 1-4.

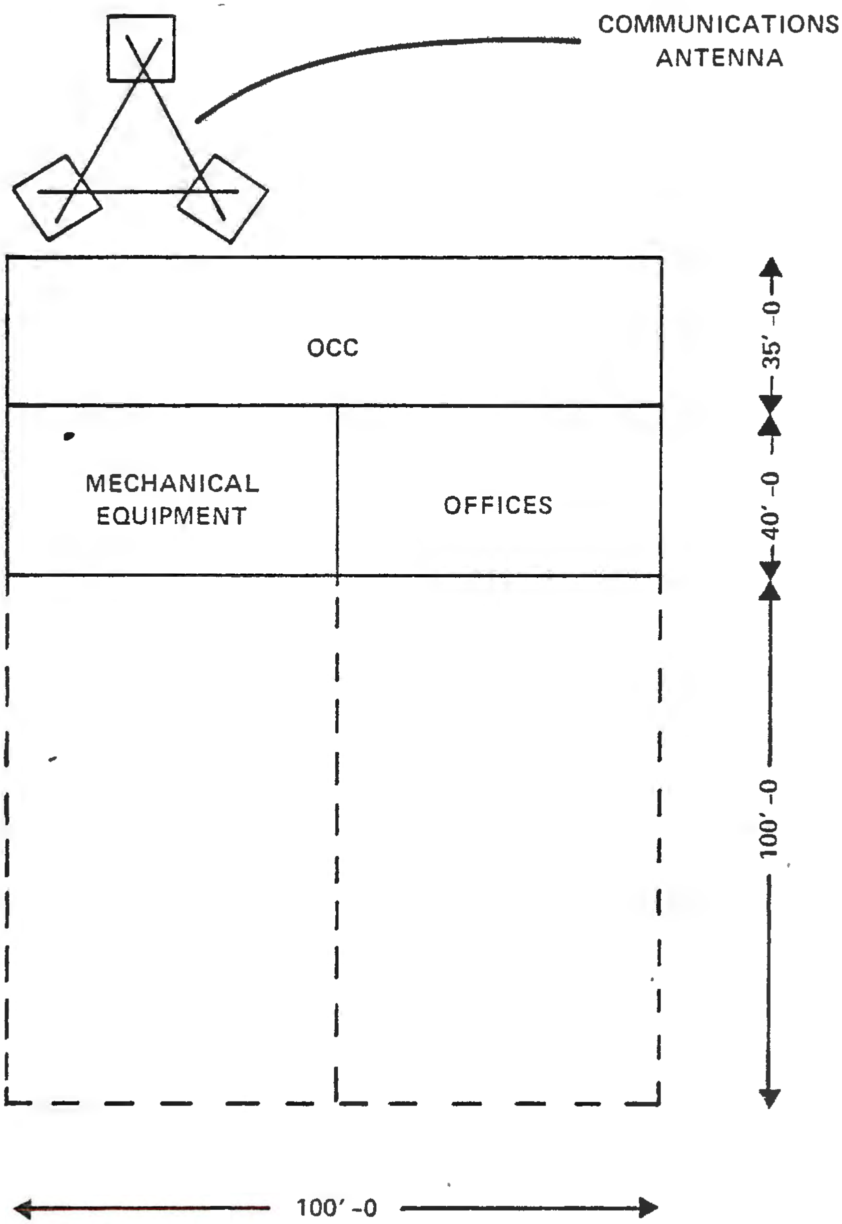
- Shop equipment will consist of a hoist, an engine analyzer for vehicles, a lathe, grinder, drill press, electric hacksaw, arc and acetylene welders, air compressor, crane and handtools. At compressor stations where there is not a District Headquarters, a lathe, grinder, hacksaw, crane, welder, and handtools will be stored in the utilities building where shop space will be provided. Test stands will be provided at each compressor and metering station for checking instruments, gauges, relief valves and electronic components comprising the control systems. Each compressor station will have a full complement of tools for repairing or replacing installed equipment.

- Spare parts and operating supplies will be stocked at each operating location and the Fairbanks warehouse. The Fairbanks warehouse will be the principal receiving and distribution center. Major spare parts and assembled replacement components will be stored at both District 1 and at the Fairbanks warehouse.

The major items which are presently planned to be included in the spare parts inventory are presented in Table 1-5. Mainline pipe will be stored at each District Headquarters and one mainline valve will be stored at Fairbanks. Operating supplies such as filter cartridges, lube oils, and chemicals will be stored at each compressor station. Procedures for handling, storage and disposal of the latter, lube oils and chemicals, will be prescribed by criteria, manuals, and plans now in preparation. These include Criteria for Fuel Storage and Distribution Systems, the Petroleum Handling Procedures Manual, the Pesticides, Herbicides and Chemicals Plan, the Hazardous Wastes Disposal Plan, and the Hazardous Substances Plans. Descriptions of these documents are provided in Section 3.0 of Exhibit Z-1.1.

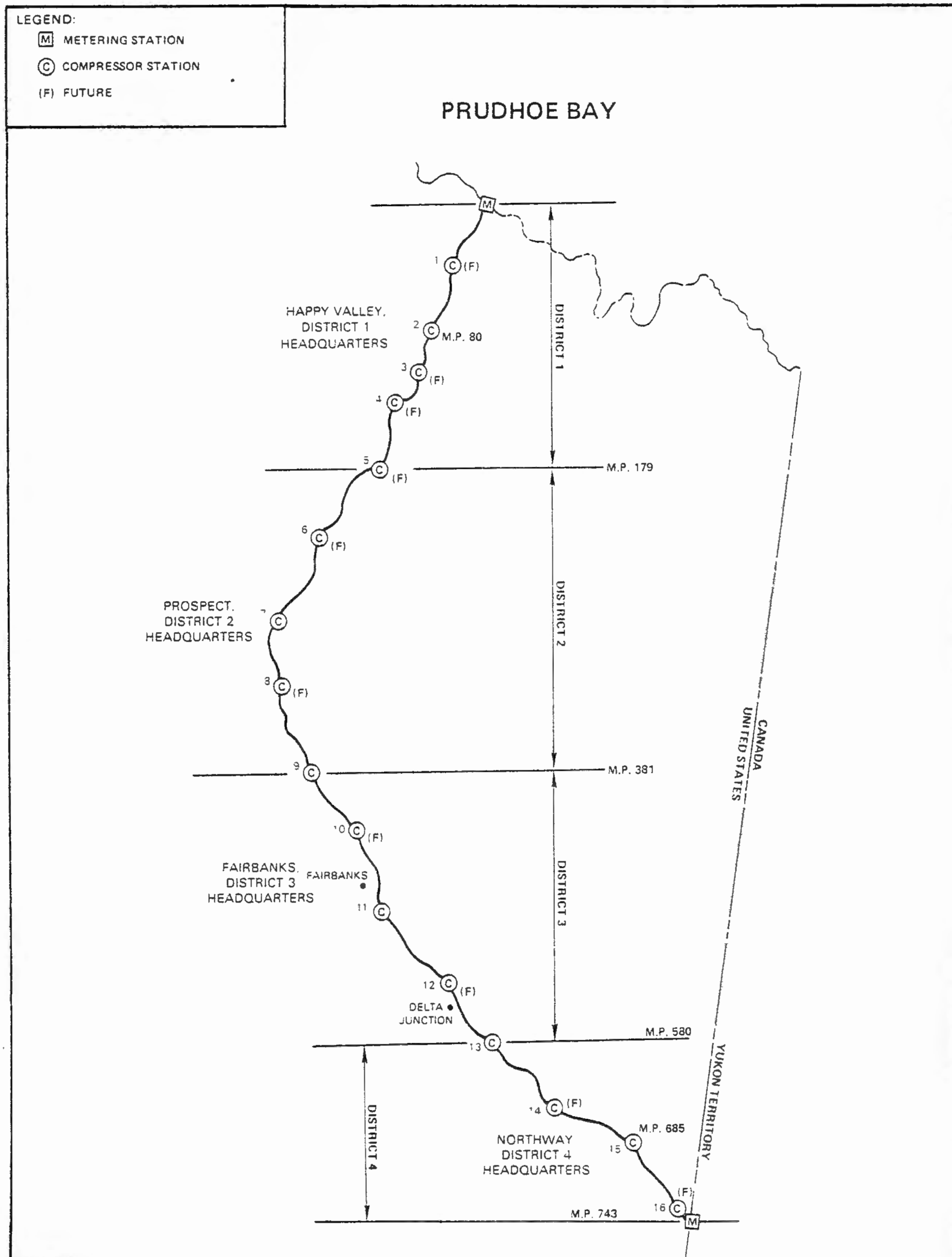
1.0 feet

FAIRBANKS
OPERATIONS AND MAINTENANCE FACILITY LAYOUT



FIGURE–Z–9.4–1–1

MAY, 1980



ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

MAY, 1980

O&M FACILITIES LOCATIONS AND DISTRICT COVERAGE

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

DOCKET NO. CP80 ________

EXHIBIT Z - 9.4

HEARING EXHIBIT NO. ________

FIGURE Z - 9.4-1-2

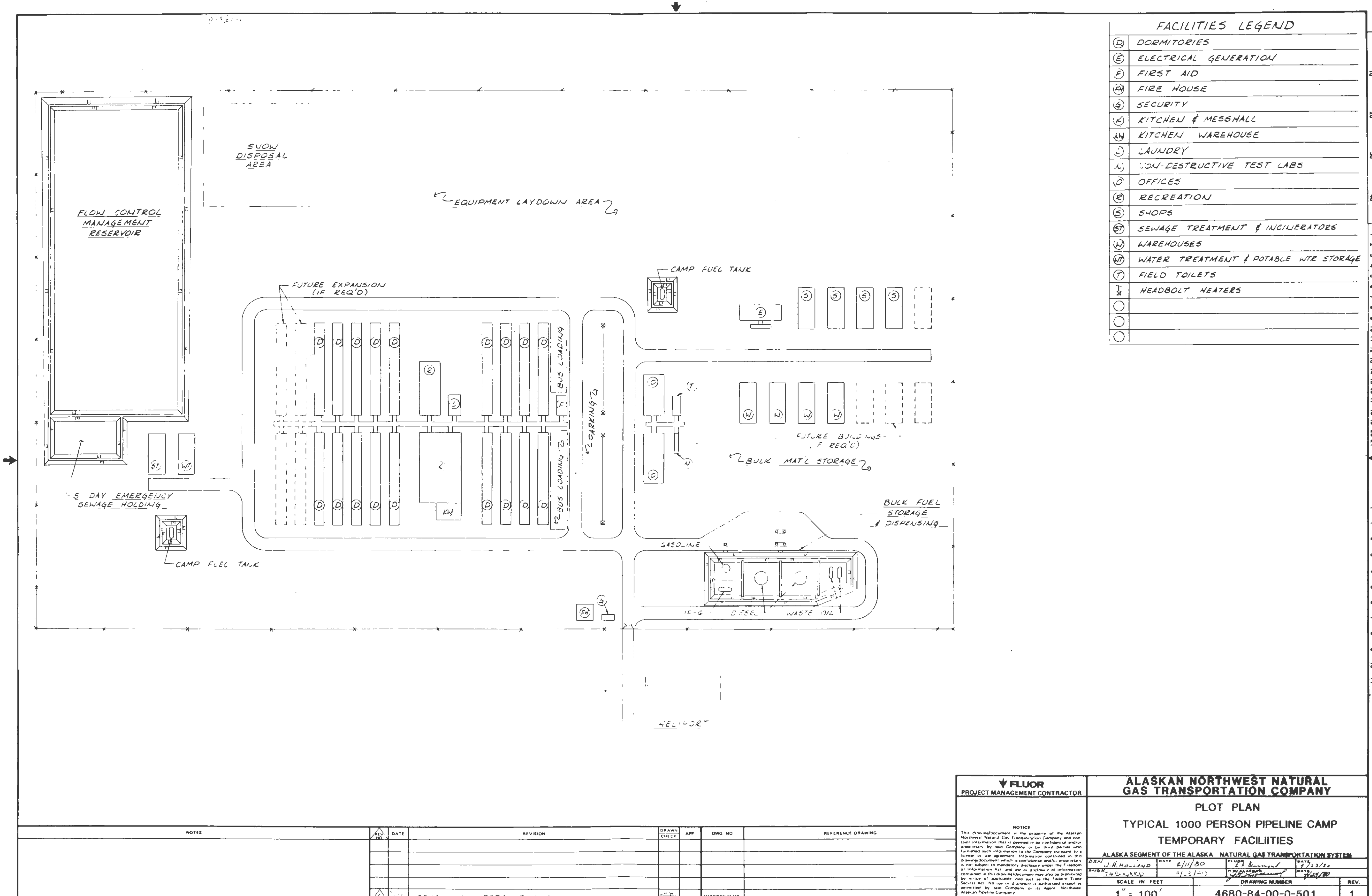
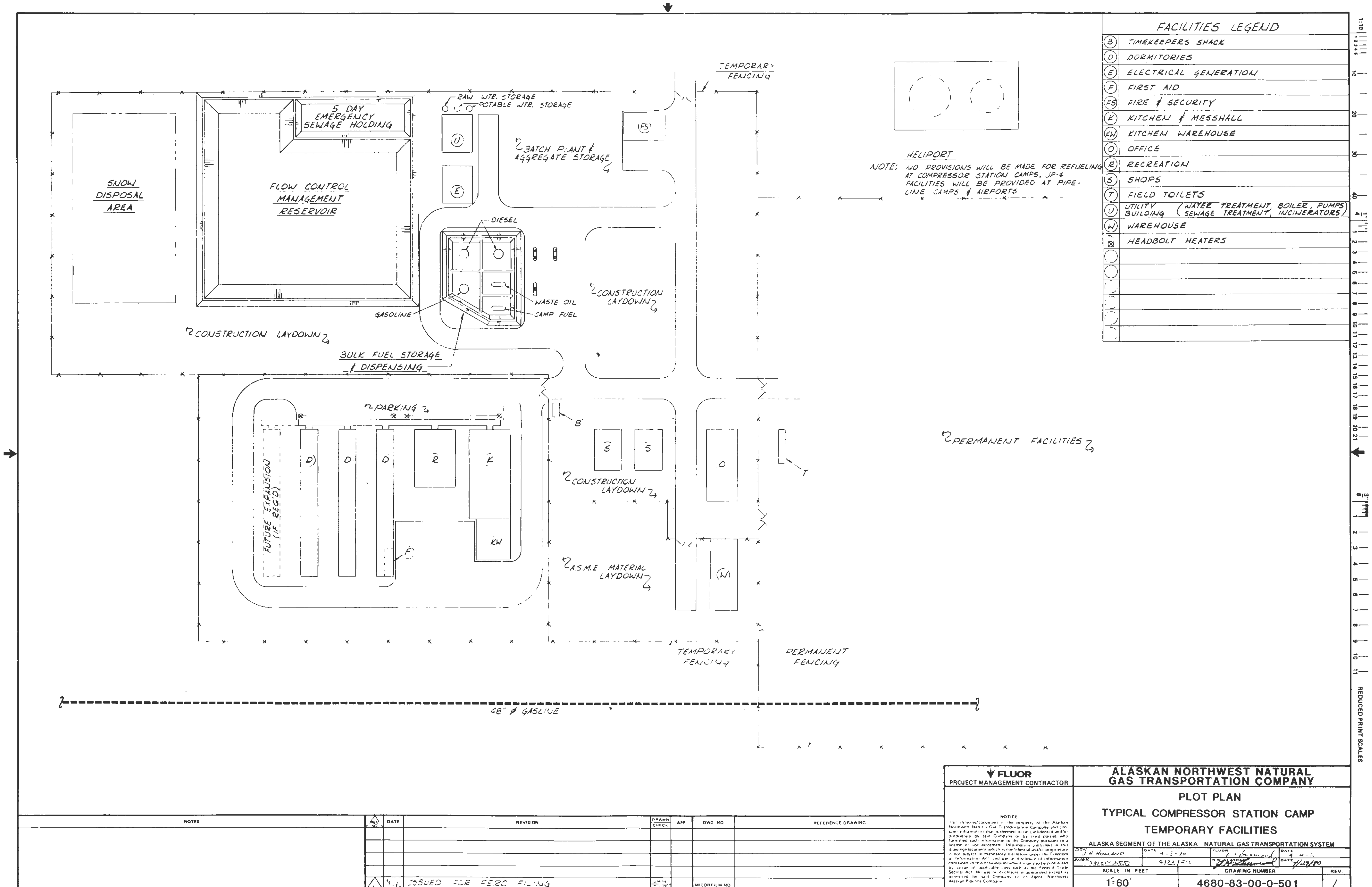


FIGURE Z-9.5-1-3

MAY, 1980



MAY, 1980

FIGURE Z-9.5-1-4

Docket No. CP80-
Exhibit Z-9.4
Hearing Exhibit No.

TABLE 1-1

DISTRICT HEADQUARTERS LOCATIONS AND COVERAGE

District Headquarters Name	District	Station	Milepost	District Coverage Pipeline Miles
Happy Valley	1	Prudhoe Meter Station	00	00
		CS #2*	80.1	
		CS #4	141.3	179.1
Prospect	2	CS #7*	273.9	
		CS #9	380.9	380.9
Fairbanks	3	CS #11	494.1	
		CS #13 (See Note 1)	579.7	579.7
Northway	4	CS #15*	684.9	
		Yukon Meter Sation	743.1	743.1

* District Maintenance Facilities and Headquarters.

NOTE 1. District Maintenance Facilities and Headquarters are located in the city of Fairbanks.

Docket No. CP80-
Exhibit Z-9.4
Hearing Exhibit No.

TABLE 1-2

OPERATIONS AND MAINTENANCE BUILDING LIST

	Building Size				
A. Compressor Station 7 & 15					
Buildings Typical at Each Site	Width		Length		Eave Height
1. Warehouse	50'	x	80'	x	16'
2. Maintenance Shop/Garage	50'	x	80'	x	16'
3. Office Building	36'	x	45'	x	8'
4. Living Quarters (Adjacent to Comp. Sta. Living Qtrs.)	50'	x	80'	x	8'
5. Hallway	12'	x	20'	x	8'-10'
B. Compressor Station 2					
1. Warehouse	50'	x	100'	x	16'
2. Maintenance Shop/Garage	50'	x	80'	x	16'
3. Office Building	36'	x	45'	x	8'
4. Living Quarters (Adjacent to Comp. Sta. Living Qtrs.)	50'	x	80'	x	8'
5. Hallway	12'	x	20'	x	8'-10'

TABLE 1-3

TRANSPORTATION EQUIPMENT LIST

ITEM	HAPPY VALLEY, DISTRICT 1	PROSPECT, DISTRICT 2	FAIRBANKS, DISTRICT 3	NORTHWAY, DISTRICT 4
4 x 4 Surburbans	7	6	6	7
Automobiles			3	
4 x 4 2-ton Truck with Hoist	1	1	1	1
Tractor, Low Boy Trailer	1		1	
Flat Bed Trailer	1		1	
TOTALS	10	7	12	8

Total Vehicles 37

TABLE 1-4

MAINTENANCE EQUIPMENT LIST

DESCRIPTION	QUANTITY
Truck Mounted Backhoe, 1/4 yd.	3
1 Ton Truck w/Portable Welding Unit	7
Portable Air Compressor	4
Portable Generator	4
All Terrain Vehicle	4
Enclosed Snow Mobile	8
Outboard Motorboat and Trailer, 16 ft.	4
4W Drive Tractor w/Front End Loader, 2 yd.	7
Combination Backhoe, 1-1/4 yd.	4
583 Side Boom	2
48 inch Pipe Bending Machine	1
D-7 Dozer	2
48" - 600# Stopple Equipment	1
Portable Blowdown Compressor, 4000 HP	1

TABLE 1-5

MAJOR SPARE PARTS LIST

DESCRIPTION	QUANTITY
Mainline Compressor Rotor Assembly (shaft, impeller, bearings, seals, coupling half)	2
Mainline Gas Turbine Assembly (gas generator, power turbine)	2
Mainline Compressor Accessory Drive Gear Box	2
Mainline Compressor Control Components (governors, control valves, miscellaneous items)	2 sets
Refrigeration Compressor Rotor Assembly (shaft, impeller, bearings, seals, coupling half)	2
Refrigeration Gas Turbine Assembly (gas generator, power turbine)	2
Refrigeration Turbine Accessory Drive Gear Box	2
Gear Reducer Gear Set (gear, shaft, bearings)	2
Refrigeration Compressor Control Components (governor, control valves, miscellaneous items)	2 sets
Generator Gas Turbine Assembly	2
Generator Turbine Gear Box	2
Generator Turbine Control Components	2 sets
Condenser Fan Motor	7
48 inch Pipe, X70	
0.600" Wall Thickness	18,000 feet
0.720" Wall Thickness	6,000 feet
48 inch Valve Assembly	1

EXHIBIT Z-9.5

TEMPORARY FACILITIES DESIGN

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

ALASKA SEGMENT OF THE
ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Docket No. CP80-
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TEMPORARY FACILITIES DESIGN

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TEMPORARY FACILITIES DESIGN

1.0 INTRODUCTION

The temporary facilities include all of the component installations required for use by the administrative personnel and work forces concerned with the construction of the gas pipeline, compressor stations, metering stations and other elements of the pipeline system.

The major components of the temporary facilities include the administrative headquarters for the project; the construction camps along the route of the pipeline; the access roads installed to the site of the pipeline work and associated areas; developed sites along the pipeline for required sources of borrow materials and disposal of excess and reject materials; and off-right-of-way areas for material storage and fabrication.

Management headquarters for Alaskan operations of NWA and the PMC will be established at Fort Wainwright. This installation will contain the communications center providing access to the construction camps and support facilities during the construction phase.

Temporary camps required for construction of the gas pipeline system will be developed at the compressor stations and locations along the route of the pipeline. The pipeline construction camps will serve as the operating base for spread Execution Contractors. Individual pipeline construction camps will vary in size to accommodate between 250 and 1,300 persons. It is anticipated that during construction, labor force adjustments may be required to maintain scheduled progress within specific pipeline spreads. Therefore, dormitory units and life support systems may be moved from one camp to another to accommodate this labor adjustment. The utilization of existing pipeline camps and the spacing of the new camps will be based on the following criteria:

- o Support the implementation of the spread management concept

- o Minimize travel time by the construction workforce

- o Minimize the number of camps to avoid impacts to the environs by multiple concentrations of population centers
- o Minimize costs of support facilities
- o Maintain construction progress by eliminating crew accommodation constraints

Compressor station construction camps will be located adjacent to the permanent compressor station facilities. Station camps will accommodate 250 to 275 persons and camps will be planned to facilitate expansion similar in concept to pipeline construction camps, should construction scheduling/progress deviations warrant such action.

Compressor station construction camps will also support metering station construction personnel.

Airfields will be provided along the pipeline route at convenient intervals to complement surface transportation of personnel and materials. These will include ten existing airfields, originally developed by Alyeska, located at or near pipeline construction camps as well as public or governmental airports that are located at Fairbanks, Tanacross, Northway, Deadhorse, and Fort Greely.

Access roads for temporary service will be provided from the highway to support areas such as camps, pipeline construction areas, borrow and disposal sites, off right-of-way material storage areas, pipe and equipment storage yards, and airfields. About 300 material sites have been identified along the pipeline route to handle the anticipated needs for borrow materials.

Other temporary facilities are remote from the pipeline route. A pipe yard will be established at Fairbanks to receive, store, clean, coat, double-joint and insulate (as required) mainline pipe prior to shipment to intermediate pipe storage yards. West coast transfer points will be utilized for shipment of materials to the Fairbanks pipe yard or to other staging areas.

Location Of Temporary Facilities

Location of the temporary facilities for the pipeline construction camps, compressor station construction camps, and the airfields are shown in Figure Z-9.5-1-1.

A listing of pipeline and compressor station construction camps along with their approximate mileposts is given in Table 1-1. In addition, Table 1-2 gives a separate listing of the existing TAPS camps which will be relocated and rehabilitated for use on this project.

Fort Wainwright Facilities

A plot plan of the Fort Wainwright facilities indicating the buildings to be utilized for the Alaskan Headquarters and the Fairbanks Execution Contractor's camp facilities is shown in Figure Z-9.5-1-2.

Layout Of The Camp Facilities

A typical plot plan for the three pipeline camps located at new sites along the Delta-leg of the pipeline is shown in Figure Z-9.5-1-3. Plot plans for individual sites will be developed after site specific information is available and camp size is finalized.

The layout of the existing pipeline camps to be utilized from Delta Junction north will remain essentially as they are. Modifications will be made to accommodate changed population, fuel systems, or sewage treatment requirements.

A typical plot plan for the seven new compressor station construction camps is shown in Figure Z-9.5-1-4. Site specific plot plans will be developed as information on exact locations are finalized.

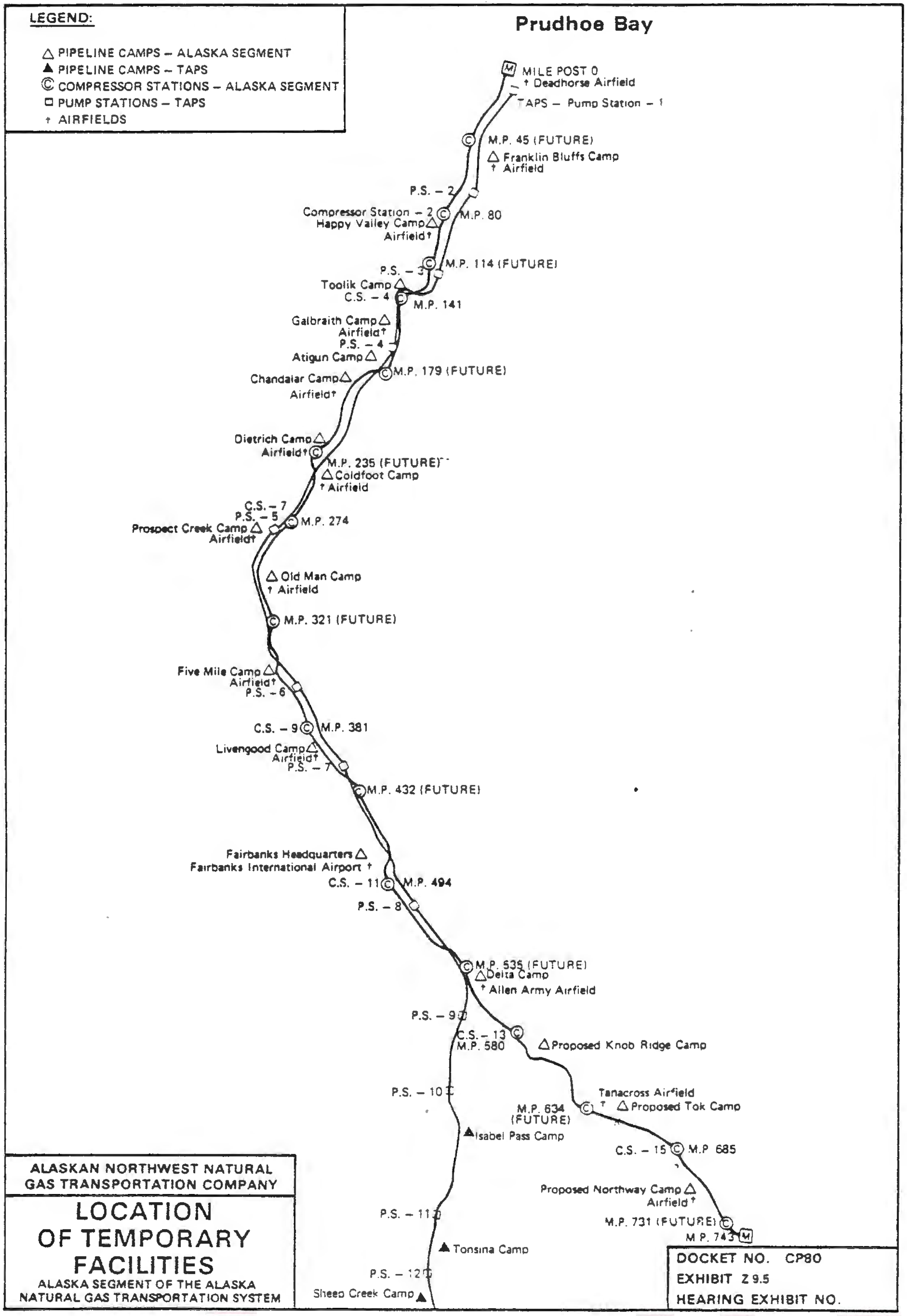

FIGURE Z-9.5-1-1

MAY,1980

FORT WAINWRIGHT FACILITIES

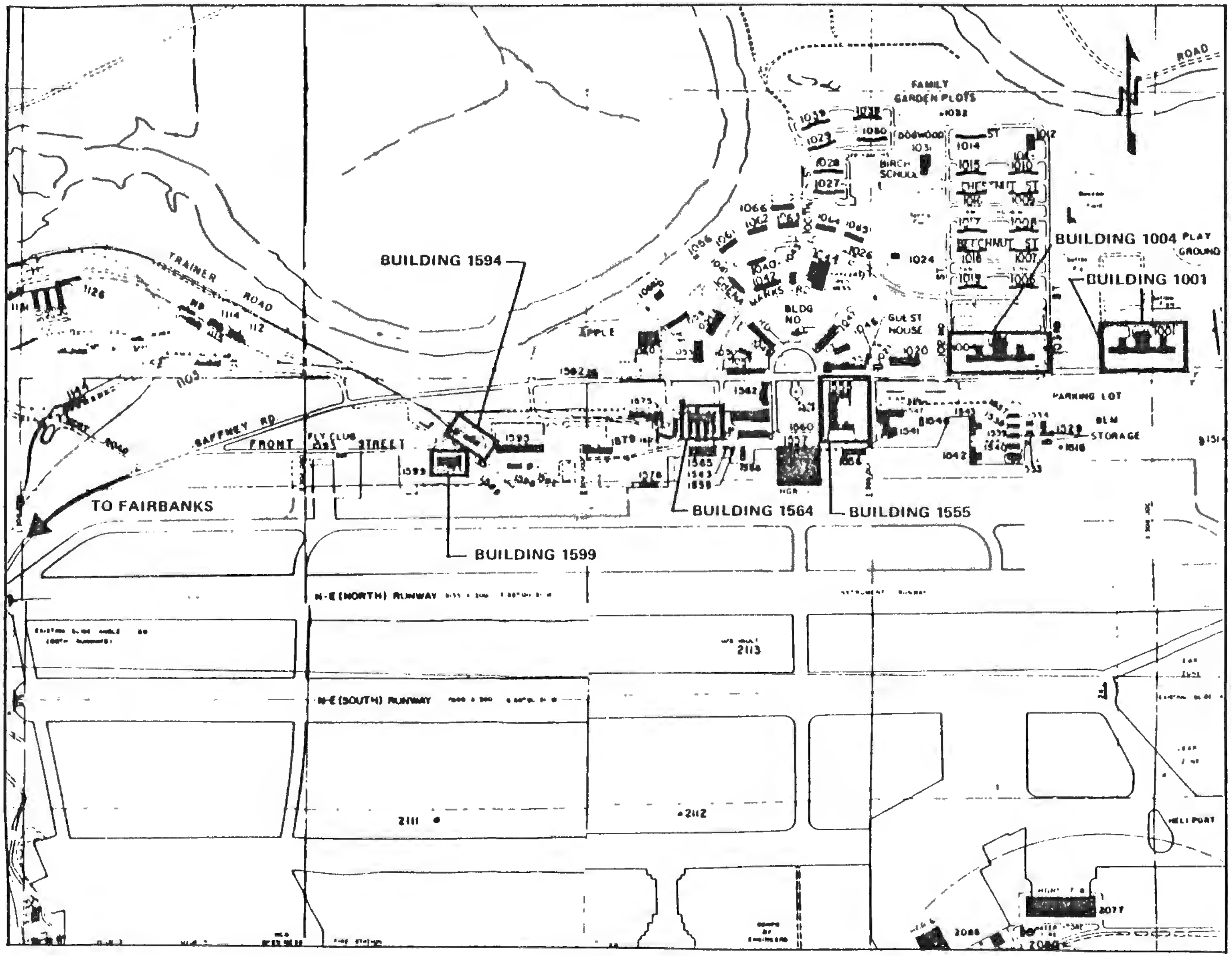

FIGURE Z-9.5-1-2

MAY, 1980

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Hearing Exhibit No.

TABLE 1-1

CONSTRUCTION CAMPS

The following pipeline and compressor station camps will be activated for construction of the pipeline project:

Camp	Milepost* (Approx. Alaska Segment)	Status
Franklin Bluffs	44	Existing TAPS Site
Comp. Sta. 2	80	New Site
Happy Valley	88	Existing TAPS Site
Toolik	136	Existing TAPS Site
Comp. Sta. 4	141	New Site
Galbraith	146	Existing TAPS Site
Atigun	169	Existing TAPS Site
Chandalar	178	Existing TAPS Site
Dietrich	209	Existing TAPS Site
Coldfoot	245	Existing TAPS Site
Comp. Sta. 7	274	New Site
Prospect Creek	284	Existing TAPS Site
Old Man	310	Existing TAPS Site
Five Mile	357	Existing TAPS Site
Comp. Sta. 9	381	New Site
Livengood	406	Existing TAPS Site
Fort Wainwright	463	Existing Facilities
Comp. Sta. 11	494	New Site
Delta	539	Existing TAPS Site
Comp. Sta. 13	580	New Site
Knob Ridge (tentative)	610	New Site
Tok (tentative)	646	New Site
Comp. Sta. 15	685	New Site
Northway (tentative)	701	New Site

*Mileposts refer to NWA January 1980 route.

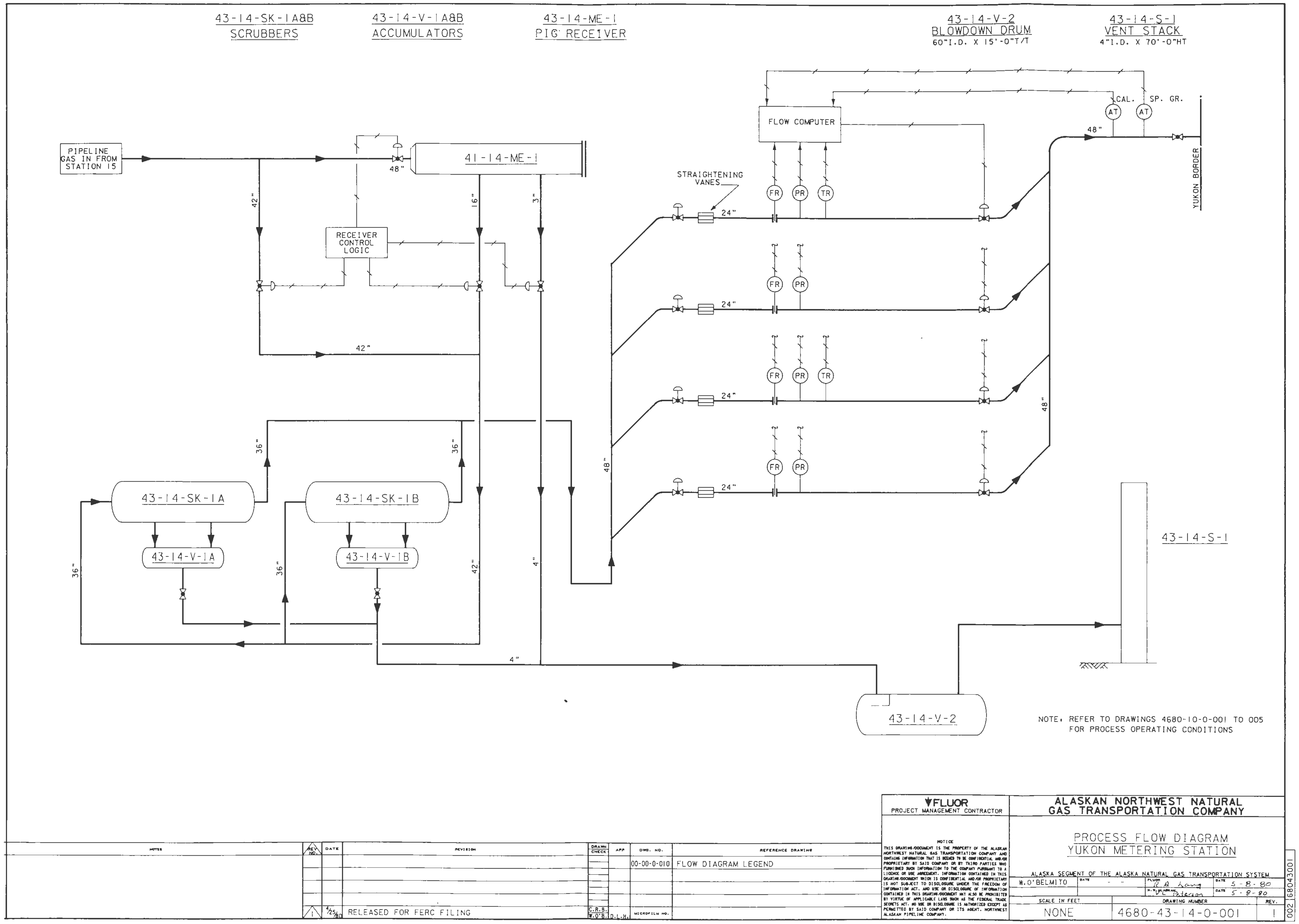
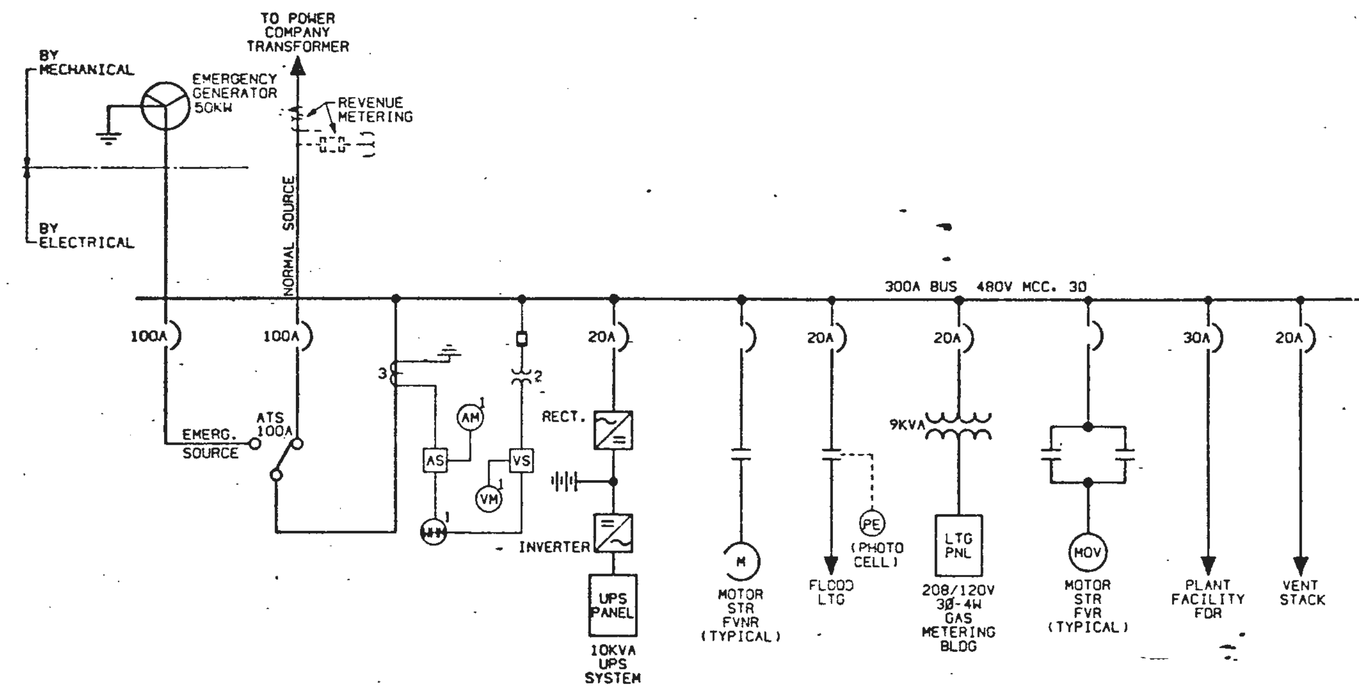


FIGURE Z-9.2-3-4



FLUOR PROJECT MANAGEMENT CONTRACTOR

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

ELECTRICAL ONE LINE DIAGRAM
PRUDHOE BAY METERING STATION

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

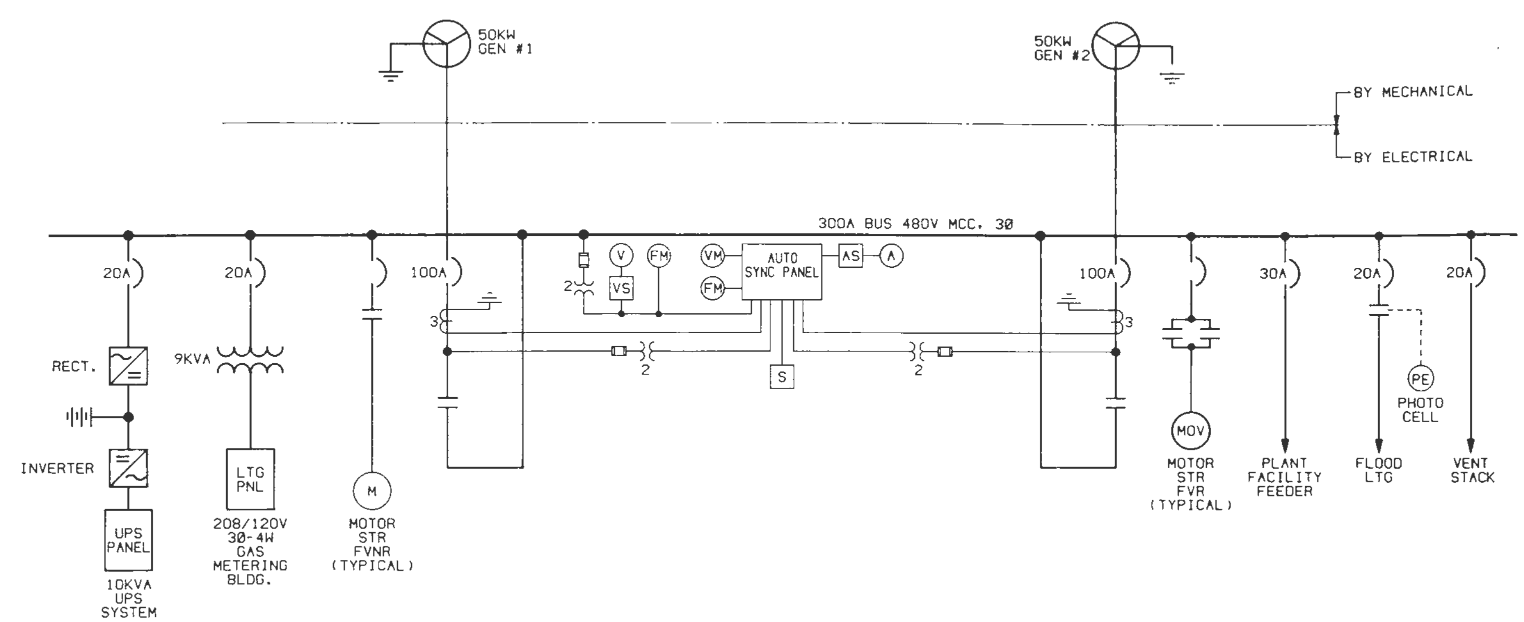
SCALE IN FEET: NONE
DRAWING NUMBER: 4690-41-00-6-00

RELEASED FOR FERC FILING

DESIGN FILE NAME: 478024MAD.6C3

FIGURE Z-9.2-3-5

MAY, 1980



NOTES	REV. NO.	DATE	REVISION	DRAWN CHECK	APP	DWG. NO.	REFERENCE DRAWING
	1	5/12/80	RELEASED FOR FERC FILING.	F.D.	ANS	MICROFILM NO.	

VFLUOR
PROJECT MANAGEMENT CONTRACTOR

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ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

ELECTRICAL ONE LINE DIAGRAM
YUKON METERING STATION

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

A. SANDLER	DATE 05-12-80	FLUOR	DATE 5/12/80
			DATE 5/12/80

SCALE IN FEET	DRAWING NUMBER	REV.
NONE	4680-43-00-6-001	1

DESIGN FILE NAME: 478024MAC.603

FIGURE Z-9.2-3-6

MAY, 1980

4.0 SUPERVISORY CONTROL SYSTEMS

4.1 DESCRIPTION

Control Concepts

The Supervisory Control System (SCS) master station will be located in the Operations Control Center (OCC) in the Operations and Maintenance Facility in Fairbanks, Alaska.

This system will be designed to provide safe and efficient centralized control of the Alaska Segment of the gas pipeline system. The OCC will be the communications and control hub of the system and coordinate the segment operation with the gas conditioning plant and the Canadian facilities. The supervisory system at the OCC will provide current data on each compressor and meter stations and a data base for storage and retrieval. It will also support dispatch, maintenance, and management functions (reference Figure Z-9.2-4-1).

The SCS will provide for remote monitoring and control of the compressor stations from the OCC while minimizing the data communications load and maintaining the control integrity of the pipeline system. This will be accomplished by locating adequate control equipment within each compressor station to maintain independent control of the stations in case communications with the OCC are interrupted. Data and controls for optimizing pipeline operations will be located in the OCC.

Configuration

The SCS together with the station control systems provides for computer-aided automatic control of the Alaska Segment.

The design provides for local automatic controls, remote terminal units (RTU's) and local manual controls physically located near the controlled equipment. These local controls will provide for safe startup and shutdown, protection of equipment, response to load changes, and maintenance.

The local RTU's will be controlled by the station Central Control Unit (CCU). This CCU will provide monitoring and coordinated control of all station equipment through commands to the RTU's. The CCU's will be fully independent station control centers which report status and data to the OCC and automatically carry out instructions from the OCC.

The SCS system configuration is shown on Figure Z-9.2-4-2. The compressor and metering station control system configurations are shown on Figures Z-9.2-4-3 and Z-9.2-4-4. These figures show major components and signal transmission paths.

Functions

The primary functions of the OCC-based SCS will be to provide the means for dispatch, control, and monitoring of the pipeline system. Some of these are:

- o Overview monitoring of pipeline system compressor and metering station operating data.
- o Optimizing control of pipeline system.
- o Provide set-point adjustments for compressor and metering stations.

The system will also provide data for reports and analyses to Operations Management personnel. Typical examples are:

- o Gas flow accounting reports
- o Energy use analysis
- o Operating reports
- o Maintenance reports

4.2 EQUIPMENT DESCRIPTION

Control Computer

The control computer will continuously monitor the systems operating data. It will provide the operations data base and will be interfaced with the communications system, dispatcher's console, and backup computer.

The control computer will be programmed to continuously monitor the operating data; generate certain commands for station control based on that data; transfer raw and processed data to the dispatcher's console for display; and receive commands from the dispatcher's console for station control.

Backup Computer

The backup computer system will be identical to the control computer. It will automatically take over the control computer functions when the control computer is out of service.

Dispatcher Console

The dispatcher console will be the manned control station for monitoring and controlling the Alaska Segment of the pipeline system. It will include video (CRT) displays, digital displays, and control switches for the dispatcher's use. Critical functions will be provided with redundant features to assure reliable uninterrupted system control.

Programmer Console

The programmer console will include a keyboard, CRT display, and printer. It will provide for computer systems maintenance functions, diagnostics, and off-line program development. It will provide for system reporting capability.

Communications Controller

All real time information between the OCC and compressor and metering stations will be carried by the communciations system. The communications controller will monitor data quality, and interface between the communications system and the computer systems.

Facilities Description

The OCC facilities for the SCS will include the following:

- Control room
- Computer room
- Record and supply room
- Communications room
- Equipment room
- Battery room
- Offices

Primary electrical power will be obtained from commerical power. An emergency generator will provide power for communications equipment, computers, and support systems in case of commercial power outages. A battery based uninterruptible power supply (UPS) will provide continuous interference free, stabilized power to the computers and other sensitive equipment.

A dedicated heating, ventilating, and air conditioning system (HVAC) will be provided for the OCC. The HVAC system will be specifically designed to meet the computer and other OCC equipment requirements.

Continuous security provisions will control entry into the control room and other sensitive portions of the OCC facility.

4.3 DESIGN CRITERIA

Reliability

The SCS will be capable of performing the dispatch and monitoring functions with the high reliability afforded by proven state of the art electronic design. This will be accomplished by using highly reliable equipment configured to provide full backup of the priority functions. Essential support systems will also be provided with backup. The SCS will include diagnostic features that will continuously monitor its internal performance capability. In case of a malfunction, the backup system will automatically be placed in service.

The communications controller will continuously monitor the quality of both redundant communications channels from the stations to the OCC. In case of an excessive error rate on either channel, an alarm will be initiated. If the defective channel happens to be in use by the supervisory system, it will automatically switch to the alternate channel. Reference Exhibit Z-9.3 for further detail on the communications system design.

The overall configuration is arranged so that the safe operation of the pipeline system will not be jeopardized due to SCS or communications equipment malfunctions.

Control Security

SCS control security will be assured by advanced error checking techniques and echo checking. Each command will be repeated back to the OCC for comparison with the original command after being received at the station. The SCS will permit an execute instruction to the station only after verifying the echoed command. Commands by the dispatcher to change a station operating parameter will require verification and an execute instruction prior to acceptance by the SCS. The system will be programmed to reject improper commands.

The Station CCU will be programmed to accept only commands that are appropriate considering the command sequence and station operating mode.

The control concept restricts OCC commands to adjustment of major control set points and operating modes. The Station CCU will be programmed to control individual equipment items, as required in response to pipeline load variations. Therefore, the dispatcher and OCC supervisory system are not required to issue complex or detailed command instructions. Only high level supervisory commands are required from the OCC.

The combined effect of these error detection and prevention features plus the station control concept assures a high degree of control security. In case of communications failure, station data and command updates will temporarily cease. However, station control will not be upset and will continue according to the last valid instructions. There will be no erronous or hazardous functions initiated.

4.4 OUTLINE SPECIFICATIONS

Digital Computers

A dual digital computer system with maximum memory capability and external support subsystems will be furnished. The primary computer will carry out real time data acquisition, supervisory control of pipeline parameters, optimizing and management data processing. The secondary or backup computer will assume control of system functions in case of primary failure. Custom programs resident in the computer will include transient analysis and pipeline operations programs. Two nine-track tape subsystems will be provided to store various programs, for editing and for updating programs. A redundant communications controller will be furnished to monitor the two full period high speed communcations channels with the stations. The controller will automatically switch to the properly functioning channel in case of abnormal conditions.

Dispatcher Console

This console will be the center of pipeline system monitoring and dispatch commands. It will consist of color video displays (CRT) with associated keyboards, printers and voice communication telephones and station selector keyboard. The CRT's will be complementary to one another and provide a variety of displays for the dispatcher/operator. Each will have its own logic unit and central processor to hold information and generate display formats. The printers will provide priority alarm printing as well as routine and demand process data logs. The data printer will log all dispatcher initiated command data.

Programmer Console

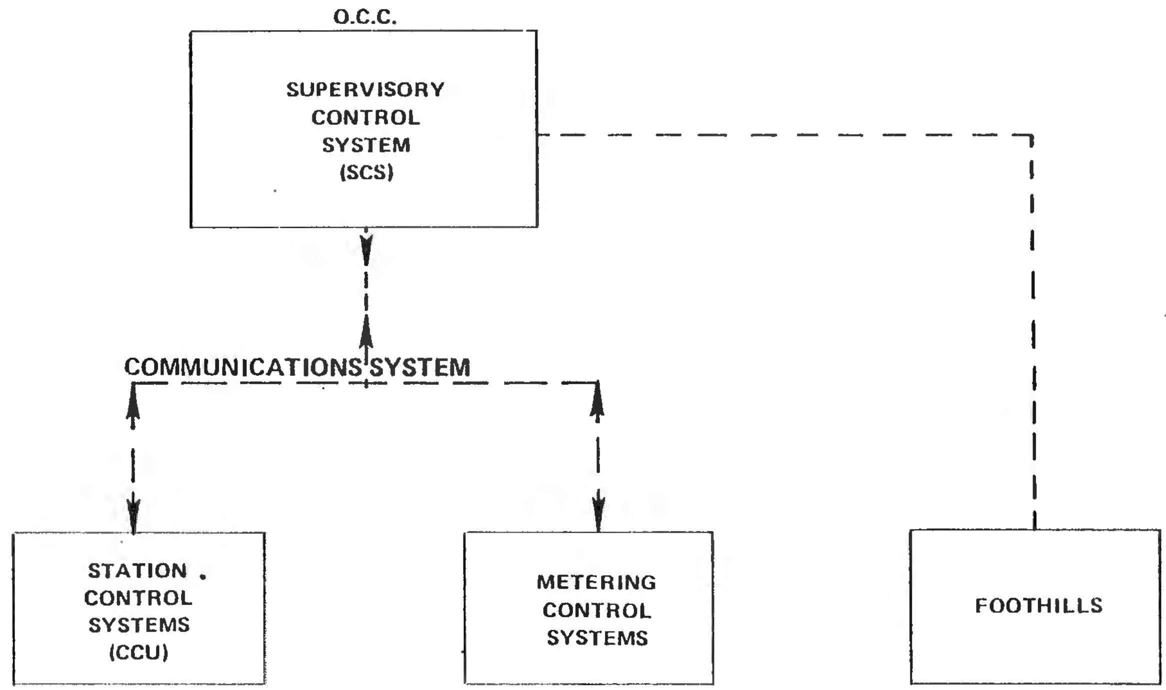
This console will be used for background mode programming, program editing and updating. It will consist of color video displays (CRT) with associated keyboards and high speed line printer. It will have the ability to provide a variety of displays including those available at the dispatcher console.

4.5 ALTERNATE CONTROL CENTER

An alternate control center will be established at Compressor Station No. 11 to provide for continued centralized control of the pipeline system in the event that the OCC is disabled. The alternate control center will be furnished with telephone and communications with all stations, the gas conditioning plant and the Canadian Segment. System documentation, including the contingency operating plan, shutdown procedures and safety procedures will be properly organized and maintained in the alternate control center.

When the alternate control center is to be used, it will be activated by trained personnel from Fairbanks. A chief dispatcher will immediately proceed to Station 11 and take over operations upon arrival. The chief dispatcher will control the pipeline according to the contingency operating plan and supporting programs. The dispatcher's log will be maintained manually.

SUPERVISORY CONTROL SYSTEM OVERVIEW



4.0 F&T

FIGURE Z-9.2-4-1

OCC SYSTEM
GENERAL CONFIGURATION

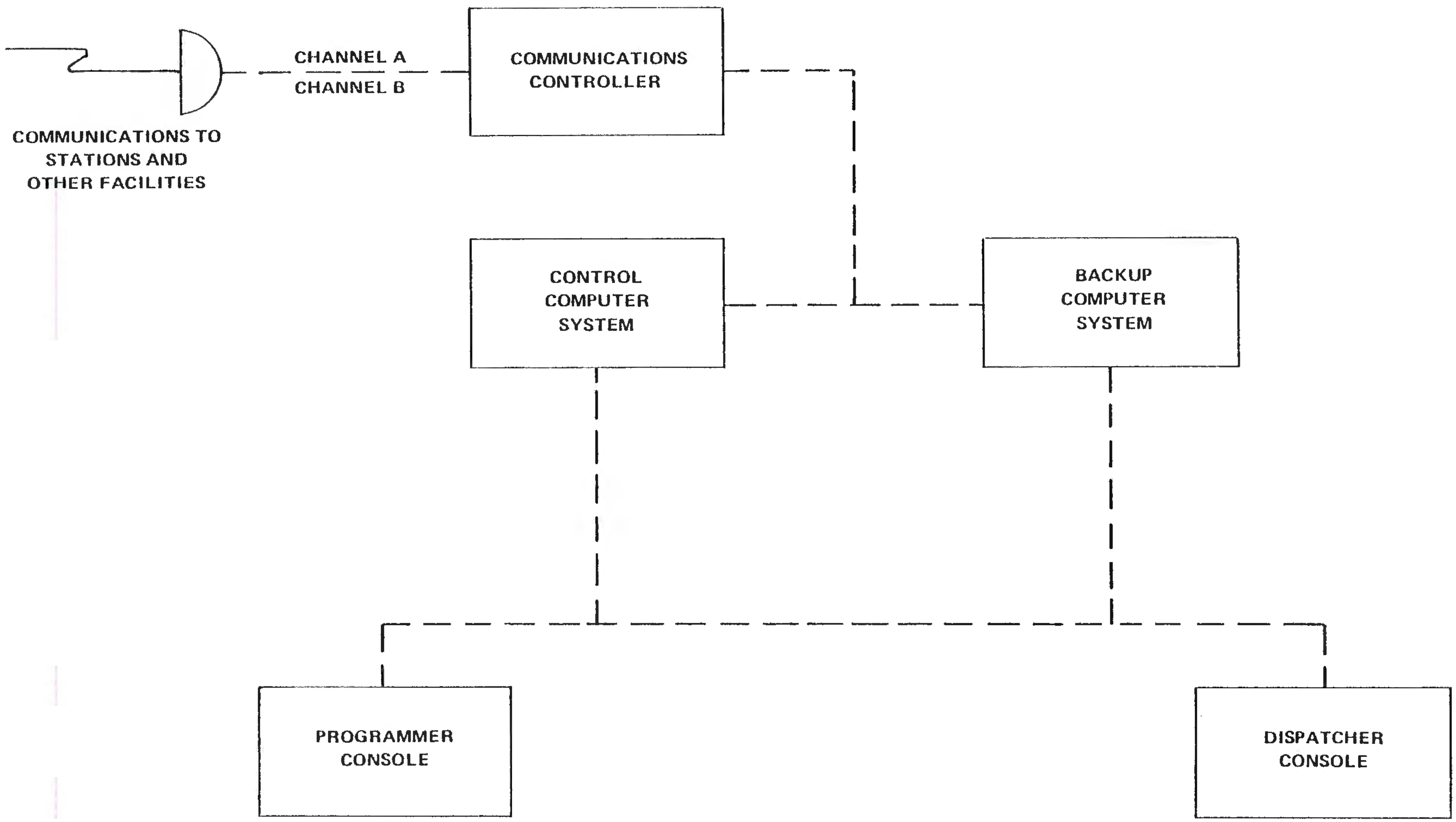


FIGURE Z-9.2-4-2

MAY, 1980

COMPRESSOR STATION CONTROL SYSTEMS
GENERAL CONFIGURATION

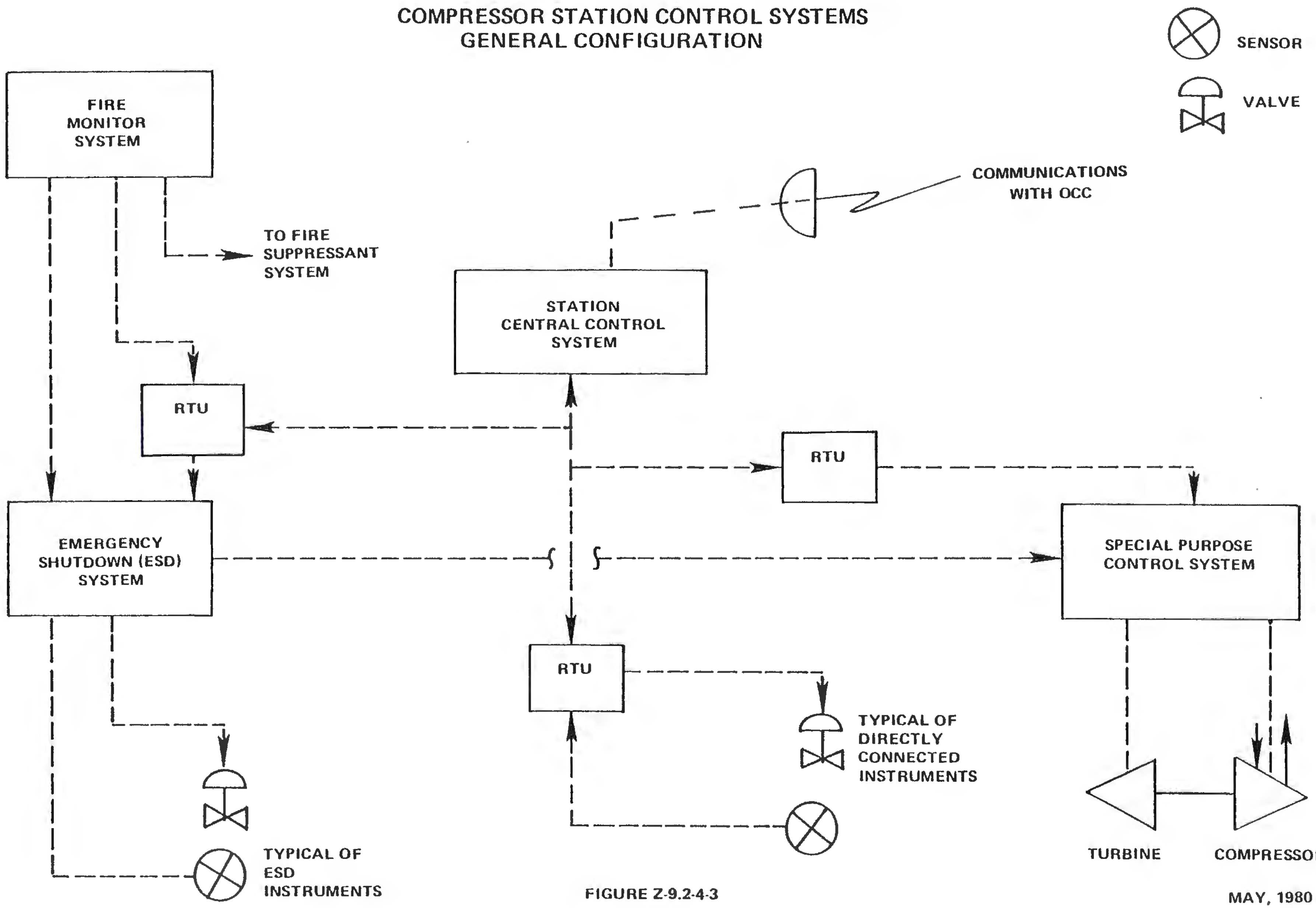


FIGURE Z-9.2-4-3

MAY, 1980

METERING STATION SYSTEMS
GENERAL CONFIGURATION

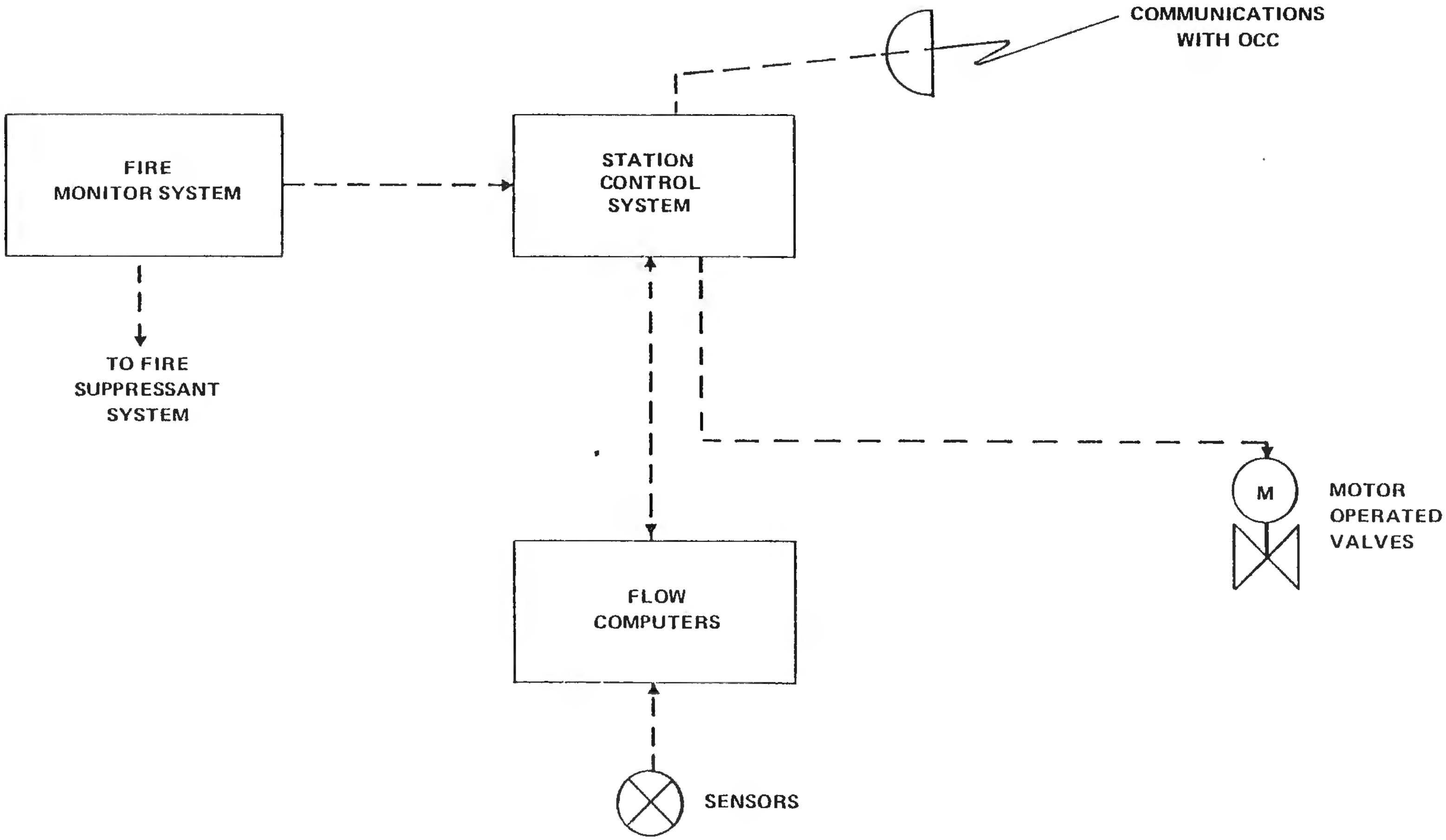


FIGURE Z-9.2-4-4

EXHIBIT Z-9.3

COMMUNICATIONS SYSTEM DESIGN

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

ALASKA SEGMENT OF THE
ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Docket No. CP80-
Exhibit Z-9.3
Hearing Exhibit No.

EXHIBIT Z-9.3

COMMUNICATIONS SYSTEM DESIGN

1.0 INTRODUCTION

This Exhibit describes the communications systems that will be used for communications during the construction and the operational phase.

During the construction phase, the communications system will provide voice and data lines among the various pipeline and compressor station camps, and the Construction Headquarters at Fort Wainwright near Fairbanks. Mobile radio equipment will also be provided to allow the construction team to communicate through a network of repeater stations to the fixed equipment at the stations, camps and intermediate facilities along the pipeline route. Telephones for construction force (personnel) morale usage will be provided.

The system installed during the construction phase will later be modified for use on the permanent communications system for the operational phase. This operational system will provide control lines between the OCC at Fairbanks, the seven initial compressor stations, and the two metering stations. Data communications capability will also be provided by this system, and will intertie with the worldwide communications system through commercial lines, as well as to the other pipeline segments in Canada and the lower 48. Mobile equipment will be provided for operations and maintenance crews.

Docket No. CP80-
Exhibit Z-9.3
Hearing Exhibit No.

COMMUNICATIONS SYSTEM DESIGN

TABLE OF CONTENTS

Docket No. CP80-
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Hearing Exhibit No.

LIST OF FIGURES

LIST OF TABLES

2.0 DESCRIPTION

Figure Z-9.3-2-1 shows a functional division of the communications system. Figure Z-9.3-2-2 is a flow diagram of the communications system. These systems and their essential elements are described below. Technical nomenclature and abbreviations used in this Exhibit are defined in the Technical Glossary, Appendix A to Exhibit Z-9.0.

2.1 COMMUNICATION NETWORK

Microwave will be used along the entire length of the pipeline to furnish the basic communications system. The compressor stations, metering stations, the Fairbanks Operations Control Center (OCC), construction camps and headquarters, temporary facilities and material control centers all will be connected to the project communications network.

The communication system for the permanent facilities will incorporate redundant equipment having automatic changeover capability in the event of failure, to achieve maximum end-to-end reliability. Construction facilities and other temporary facilities will not require redundant equipment.

The communications network will be designed so that a worst-case single failure, such as a total disruption in both directions, will affect only one location during the time required to repair the disruption.

Each communication station in the system will have communication equipment status alarms. These status alarms will be transmitted to Fairbanks over one or more dedicated multiplex (MUX) subcarriers, fully monitoring the essential performance characteristics of the communication station. Alarm status will be displayed at each site and at the central communication equipment located in the O & M Facilities in Fairbanks.

The communication network required for pipeline operations will be scaled down and modified from that used for the support of the construction phase. Fewer channels are required for the operational system since communication links will not be needed to the pipeline construction camps and airfields at the termination of the construction activities.

The microwave system will be multiplexed using standard CCITT MUX recommendations, in order to furnish voice grade channels to each location in the quantities required. Each channel will have the capability of passing signals for speech or data.

The communications network will also provide for control of the pipeline from the Alternate Control Center located at Compressor Station No. 11. This portion of the system will be arranged to bypass the Fairbanks OCC in the event of a major failure of the Fairbanks OCC.

2.2 SUPERVISORY CONTROL SIGNALS

Pipeline process status and control signals will be transmitted between each of the compressor and metering stations and the OCC as a serial bit stream. The data bit stream will be derived from communication data modems and will be transmitted via the communication network on multiplexed subcarriers. Error rate performance goals will be nominally one bit in error for every one million bits received. Error detection and correction will be by the communications internal control system at the OCC. The method used for data correction will be by block retransmission. For additional description of the supervisory control system, see Exhibit Z-9.2 (refer to Figure Z-9.3-2-3).

2.3 DIAL TELEPHONE SYSTEM

Each compressor station will be equipped with a small switching telephone system to provide intraconnections between and among the stations, within the station, and to the OCC switching system at Fairbanks.

The OCC dispatcher console will contain a telephone communications panel. The communications panel will be used for dialing up the various locations.

Metering stations telephone service will not include a switching system at the station, due to the small size of the station.

The construction telephone switching will be handled by EPABX's at each construction camp. The construction headquarters will contain the main EPABX used for the construction phase (refer to Figure Z-9.3-2-4).

2.4 MOBILE AND PORTABLE RADIOS

A UHF radio network will enable mobile communications throughout the entire length of the pipeline via interconnections with the microwave system. Localized mobile radio communications over reasonable ranges will be provided for the entire network via UHF repeaters.

The operational system will be adapted from that used for the field programs and construction phase. Existing repeater stations used for the construction phase may be removed, others relocated. Mobile radio control points at the construction camps and headquarters building will be relocated to the maintenance district headquarters and the OCC in Fairbanks for the operational phase.

Mobile radio coverage will be 95 percent of the area 95 percent of the time from and to all mobiles. Coverage from hand held portables will be less than that from mobiles due to the lower radiated power from portables. These portables will have extended range if their signals can be received by repeaters.

Portables used within the compressor station perimeters will be inherently safe types able to be operated safely in an explosive environment.

Continuous tone-coded squelch system (CTCSS) will be used for the mobile system as a means of avoiding nuisance interference. In addition, frequency pairs will be alternated between adjacent repeaters.

The UHF system interfaced via MUX with the microwave system will permit mobile radios in one section to communicate with mobiles in other sections, the OCC dispatcher, and Fairbanks construction headquarters. Special tone-encoded mobile units will provide normal telephone service.

UHF repeater stations will, insofar as is practicable, be colocated with microwave stations. Where this is not practicable, a radio link will be used (probably at 960 mHz) to the nearest microwave station. Figures Z-9.3-2-5 and Z-9.3-2-6 are station block diagrams depicting these arrangements.

2.5 RECORD COMMUNICATIONS (TELETYPEWRITER)

Record communications will be required between each compressor station which includes Operation and Maintenance facilities (numbers 2, 7 and 15) and the OCC during the operations phase of the pipeline.

Construction record communications will be required between each construction camp, the construction headquarters, material control centers and engineering offices in the lower 48 states.

The teletypewriter channels will not have to be dedicated channels due to light traffic loads; rather, they can be shared with the telephone system, and used for telephone channels when not in use for transmittal of digital data. Teletypewriter communications originating at any field site will be capable of being transmitted to any other site.

For these purposes, a "smart" terminal will be used capable of forms storage and recall, and having an editing and store-and-forward capability.

FUNCTIONAL DIVISION OF COMMUNICATIONS SYSTEM

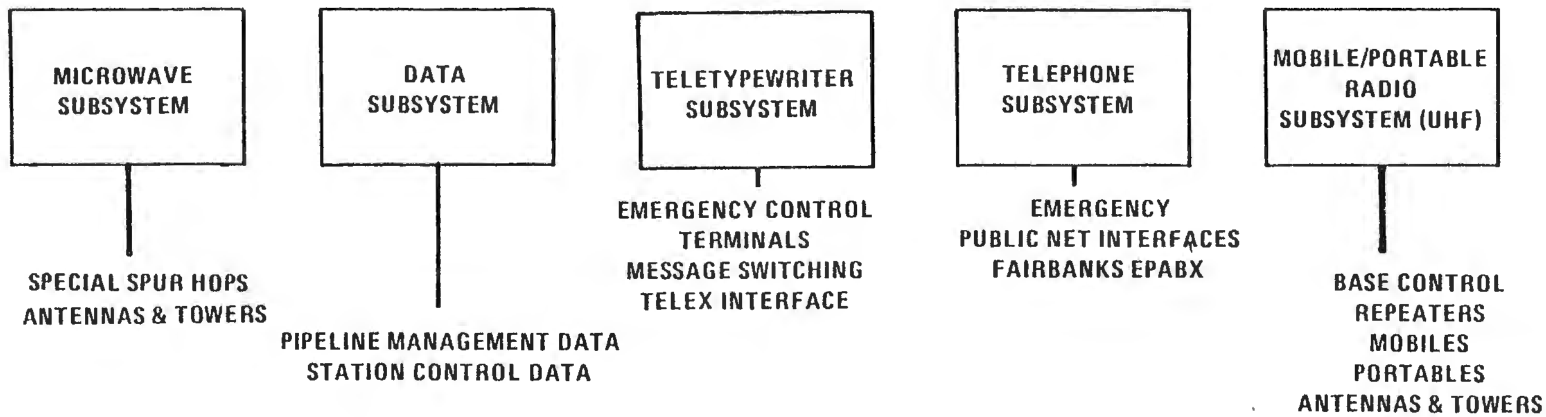


FIGURE Z-9.3-2-1

FLOW DIAGRAM OF COMMUNICATIONS SYSTEM

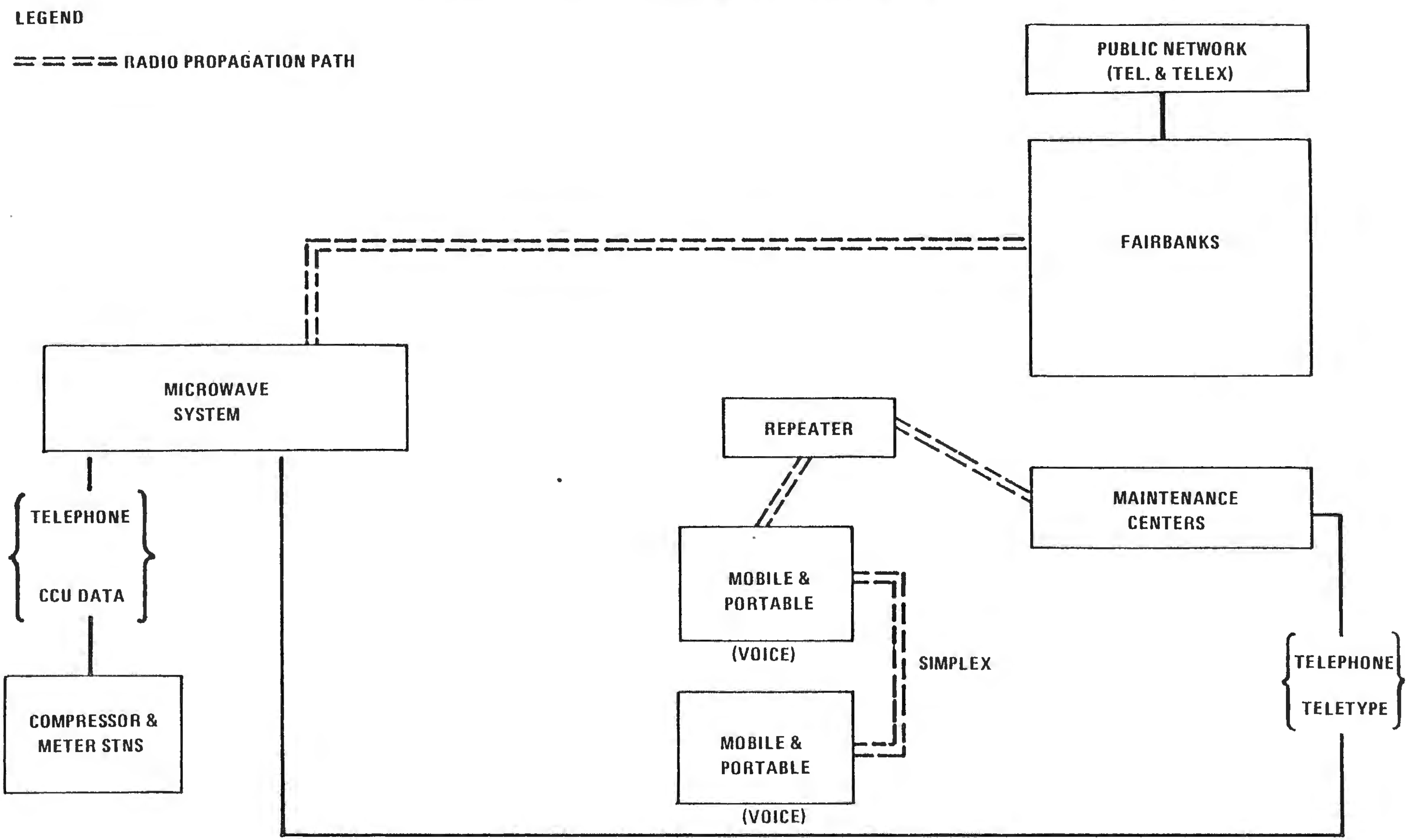


FIGURE Z-9.3-2-2

MAY, 1980

BLOCK DIAGRAM OF COMPRESSOR STATION COMMUNICATIONS

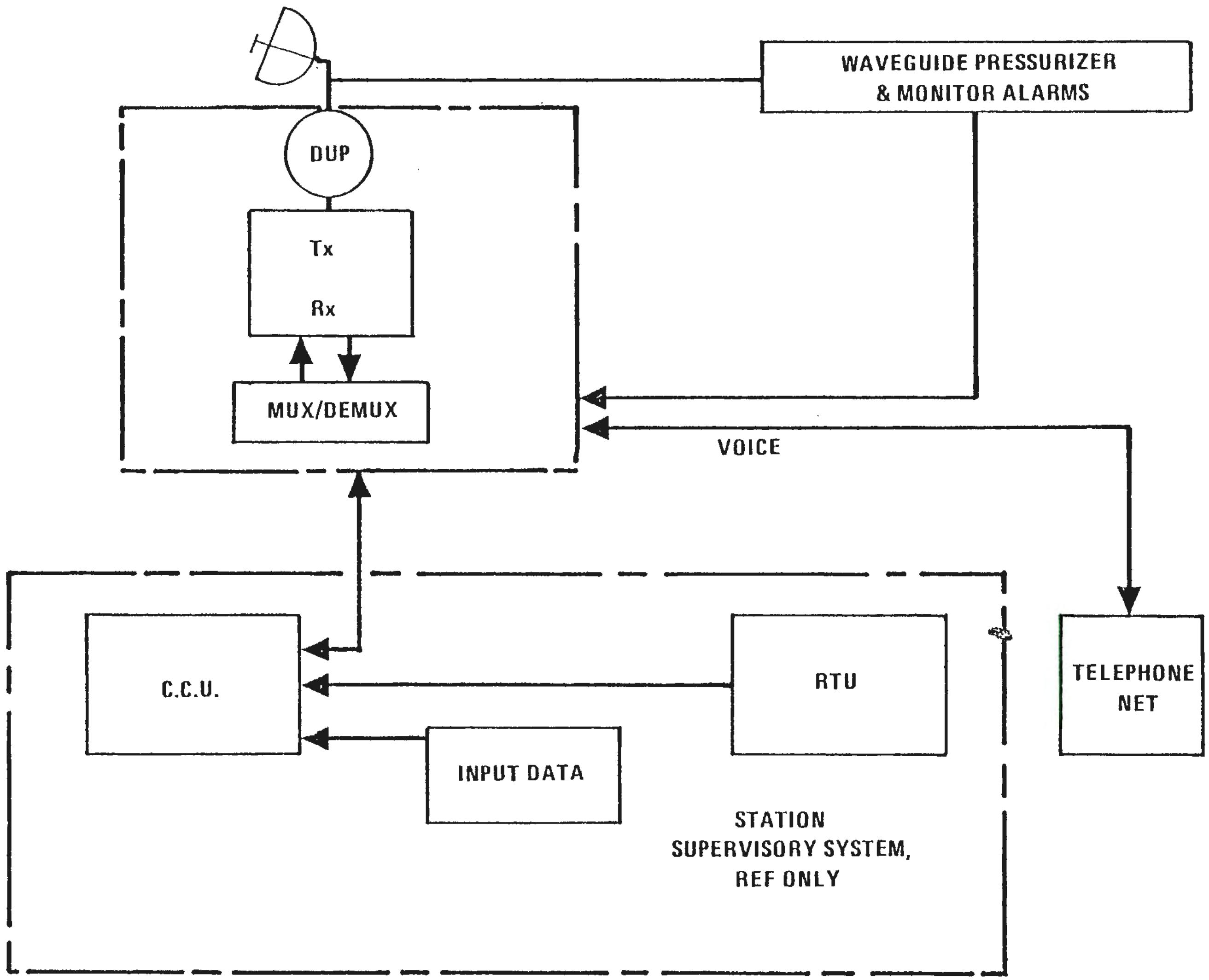


FIGURE Z-9.3-2-3

MAY, 1980

TYPICAL EPABX

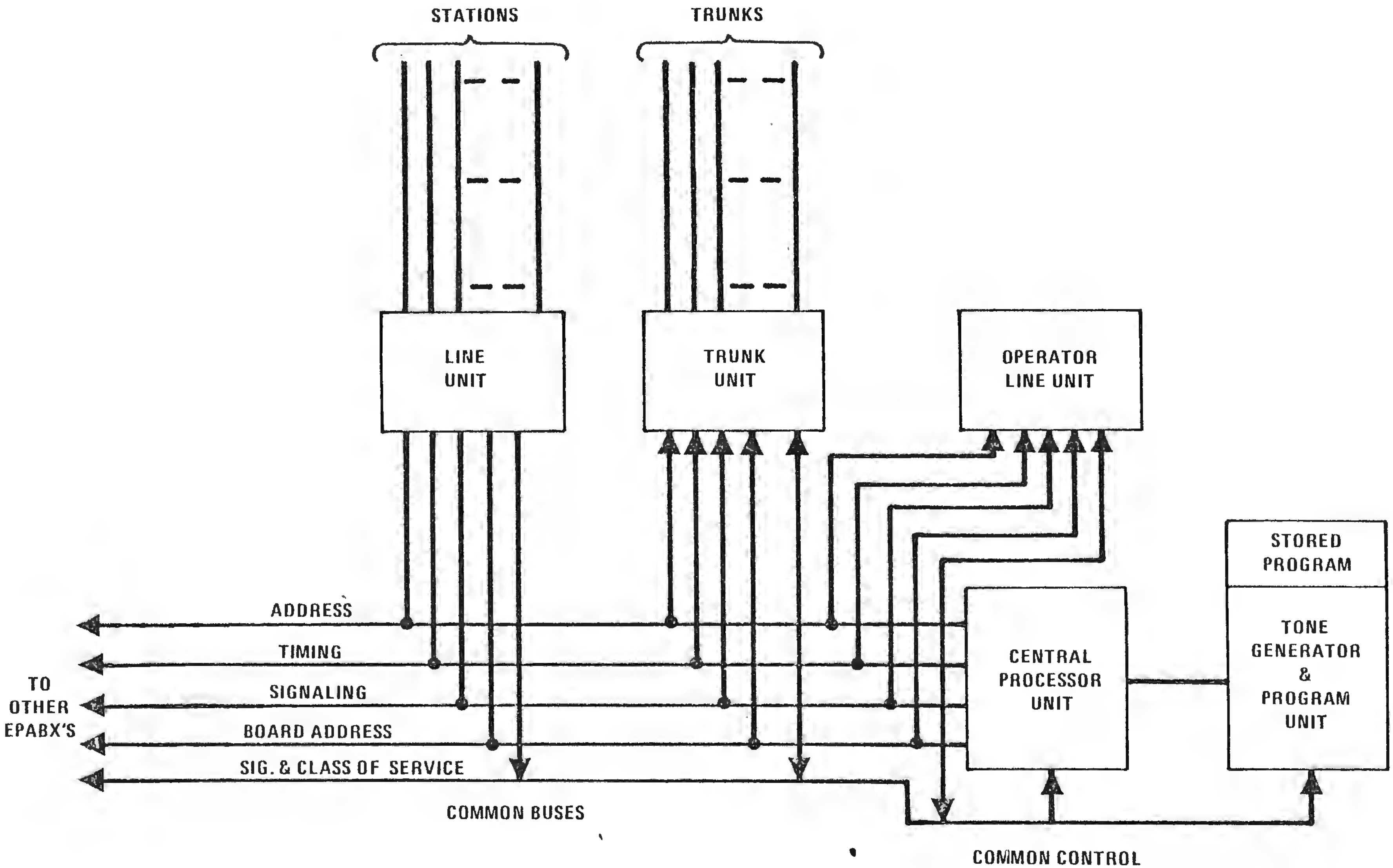


FIGURE Z-9.3-2-4

MAY, 1980

BLOCK DIAGRAM OF TYPICAL UHF REPEATER STATION COLOCATED WITH MICROWAVE STATION

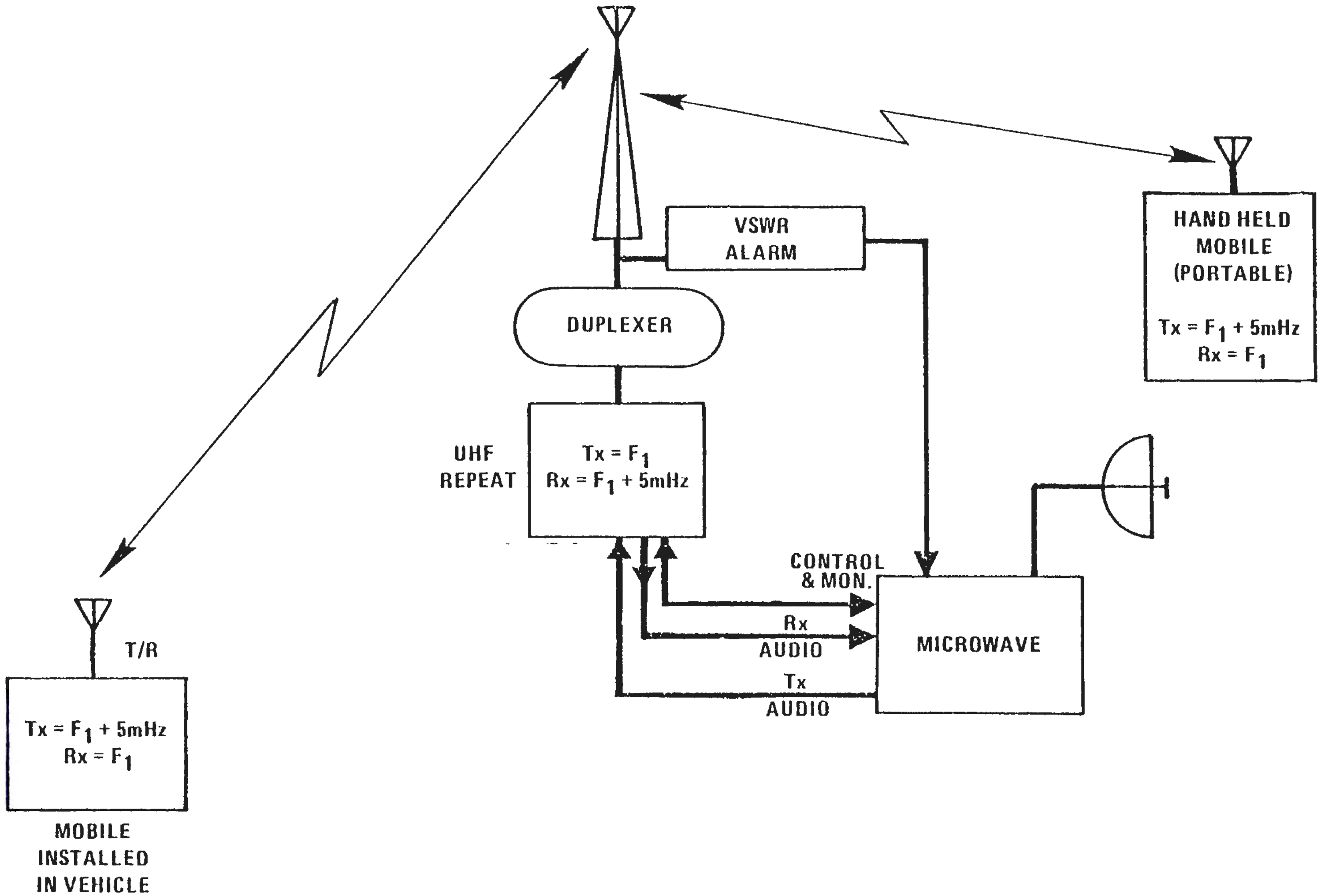


FIGURE Z-9.3-2-5

BLOCK DIAGRAM OF TYPICAL UHF REPEATER STATION NOT COLOCATED WITH MICROWAVE STATION

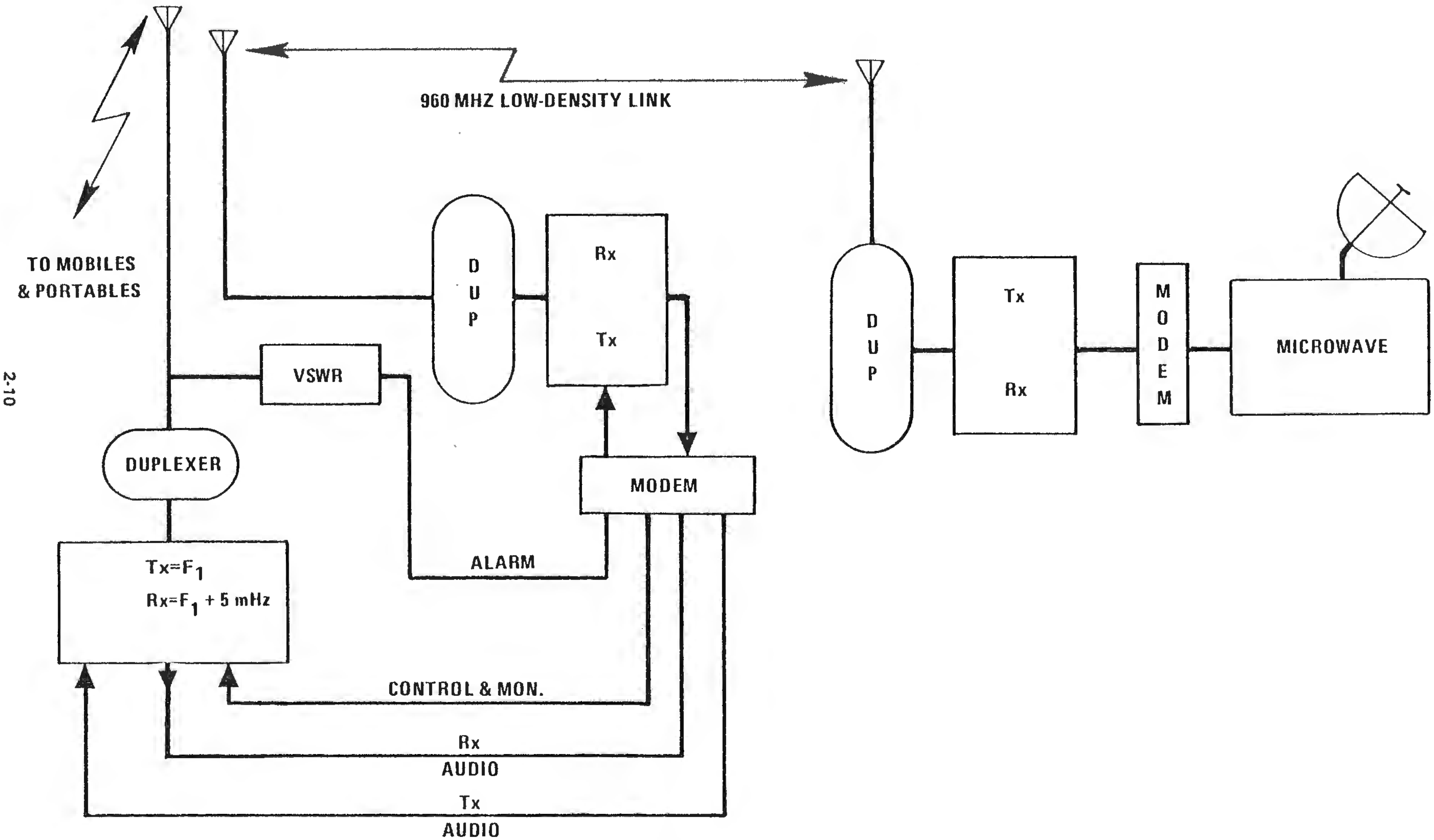


FIGURE Z-9.3-2-6

3.0 COMMUNICATIONS SYSTEM DESIGN CRITERIA

This section is not intended as a complete, detailed listing of design criteria. Rather, this section provides the most important, major design criteria which will be elaborated upon in detail specifications.

3.1 VOICE COMMUNICATIONS

The telephone network will have the capability of furnishing voice-grade channels and lines between each maintenance district headquarters, each compressor and metering station, and the OCC in Fairbanks, on a dial-up basis. The telephone system for operations will use MUX channels for the switched lines at all locations (refer to Table 3-1).

The construction phase network will include voice-grade channels between spread camps, their headquarter camps and the construction headquarters at Fairbanks.

The telephone system will include the capability for interfacing with the public network in Fairbanks. Telephone tie lines will connect the project locations in the lower 48 states with the Alaskan construction locations.

3.2 STATUS AND CONTROL LINKS

There will be provisions for high-speed digital data, from each compressor station's Central Control Unit (CCU) to be transmitted to the OCC for use by the Supervisory Control System and the dispatcher. The nominal error rate for this data will be one bit in error for every one million bits received.

Internal communications system alarms relating to the microwave and UHF system will also be transmitted to the OCC by use of dedicated channels. The communications system alarm and control data includes alarms and on-off controls from every microwave and UHF repeater station.

3.3 RECORD COMMUNICATIONS

The teletypewriter system will cover the field construction facilities during the construction phase and will be reduced to include the maintenance facilities and OCC during operations. The teletypewriter system will have the capability for forms storage and recall, CRT editing, store-and-forward, and will operate through a redundant message switcher at Fairbanks.

3.4 RESTORATION OF FAILED CHANNELS

The communication network will be generally configured in a redundant design so that upon failure of any subcarrier channel (MUX) or radio frequency channel (RF), automatic switching to an alternate will be provided. Alarm indications will note this action locally and at the communications maintenance facility.

3.5 SYSTEM RELIABILITY

The specification for end-to-end reliability of the communication system, considering redundant equipment and path margins, will be better than 0.9999 not including Mean Time to Repair (MTTR).

3.6 EQUIPMENT DESIGN

Equipment will be modular in design and easily replaceable in the field, insofar as is practicable. This does not include, for obvious reasons, large parabolic antennas, towers, and field-constructed items.

Design reviews will be conducted periodically to assure that systems, equipment, and modules are technically competent to meet requirements. Vendor Quality Surveillance will be conducted throughout the program to monitor design, fabrication and testing.

3.7 DOCUMENTATION

As built documentation will be provided for the communication systems, subsystems and component equipment. Instruction manuals for specific equipment will be descriptive only of the options actually furnished and will omit nonapplicable matter. A schematic diagram, printed circuit diagram, or parts list, for example, will apply to the particular piece of equipment as delivered and installed, and will omit all material not actually used.

The system design contractor will furnish detailed system drawings, wiring diagrams, wiring tables, and troubleshooting guides for the over-all system, for each subsystem, and for the interfaces in addition to specific manuals for individual equipment. This documentation will be organized in an orderly and suitably indexed fashion and will also be furnished on microfiche for computer processing.

During the design phase, there will be frequent reports as to the progress and scheduling of design and procurement, and all interfacing problems that develop.

During the construction phase, there will be reports concerning shipments and movements of personnel and equipment, and schedules.

3.8 MAINTAINABILITY

In general, field maintenance will consist of module replacement or identification of problem area. Major repairs will be done at the central maintenance area at Fairbanks, the manufacturer's plant or service facilities.

The communication equipment will be designed to be easily maintainable and accessible within limits of the best modern practices.

3.9 UHF MOBILE RADIO SYSTEM COVERAGE

The UHF mobile radio system will be designed to assure 95 percent area, and 95 percent time availability coverage throughout the entire length of the pipeline. In most cases this will require multiple repeaters.

The UHF mobile radio system will include a continuous tone-coded squelch system to minimize nuisance interference and yet standardize on equipment throughout the system. Each mobile or portable will be able to communicate, via the nearest repeater, to another mobile or hand held portable in the repeater's range. Mobile interconnections to the maintenance dispatcher, to OCC, or to another section's repeater will be possible by inter-ties with the microwave system. The UHF radio frequency pairs will be alternated for the length of the Alaska Segment. The operational phase will require one alternated pair. During construction, this may require additional alternated pairs.

3.0.4
4

Smaller flanges will be manufactured from standard ASTM low temperature materials in accordance with purchase document requirements. Flanges will be Class 600 unless otherwise specified.

Steel used for flange manufacture will be fully killed, fine grained materials that will properly respond to heat treatment. The final chemical composition selection will be contingent on successful completion of the required weldability tests.

Reduced dimensional tolerances, forging techniques, and additional nondestructive examination requirements have been specified in Specification SP-4680-50-28 to ensure required manufacturing quality levels are maintained.

Fracture toughness requirements have also been specified based on Charpy V-Notch energy to provide an inherent resistance to fracture initiation at the design conditions.

2.3.11 Valves

Large diameter (26 inches and larger) block valves will be butt welding end, trunnion mounted ball valves with double block and bleed, and floating seat construction in accordance with project specification SP-4680-50-25. Check valves will be dual plate, spring loaded wafer type construction. For buried installation, the body materials will be suitable for 0°F and the top works for -50°F. Valves will be ANSI 600 rated unless otherwise specified. Valve bodies, welding ends, bonnets, and valve cover materials will be in accordance with API-6D, Table 3.1 plus additional specification requirements. In order to ensure a high degree of quality, supplementary nondestructive testing, hydrostatic testing, welding, casting quality, repair and mechanical property testing will be imposed.

Fracture toughness requirements have been specified in Specification SP-4680-50-25 based on Charpy V-Notch energy to provide an inherent resistance to fracture initiation at the design temperature.

2.3.12 Water/Glycol Heating System

The water/glycol heating system will be located in the utilities building. The system will be capable of recovering a capacity of 11.1 MMBtu/H from exhaust gases leaving the utility turbine generators. This heat is absorbed by circulating a water/glycol mixture which enters the heat recovery unit at 160°F and leaves at 230°F. The flowrate will be 435 gallons per minute.

The water/glycol heating system will consist of a waste heat recovery unit, two full capacity circulating pumps, a glycol storage tank, a natural gas combustion unit, a supply air fan, interconnecting piping, and a control assembly necessary for a complete operable water/glycol heating system. The system will consist of a heater, circulating and storage skid.

The circulating pumps will be a centrifugal type, and constructed of a suitable material for the service and temperature intended. Each pump will be motor driven and capable of flowing 435 GPM of 60 percent ethylene glycol in a water solution.

The heating medium storage tank will be cylindrical, horizontal and constructed of steel with the necessary nozzles. The tank will have a capacity of 1,500 gallons.

An 11.1 MMBtu/HR combustion unit, utilizing line gas as fuel, will provide the heat source in the event that both of the turbine generators are not available. A pressure reducing station for fuel gas entering at 500 psig will be provided.

A centrifugal type supply air fan will be provided in conjunction with the combustion unit. The fan is only used when both turbine-generators are not available.

Controls will maintain constant supply of water/ glycol at the set temperature by controlling the quantity of exhaust gases or by regulating the firing of gas in the combustion unit. The controls will also include necessary safety features.

2.3.13 Fire and Gas Detection System

Fire and gas detectors will be located within buildings and hallways in each of the compressor stations. The number of sensors and their locations will be determined in conformity with NFPA Codes and Standards.

The gas detectors will operate when subjected to abnormal flammable gas concentration and will be based on diffusion sampling or continuous sample draw principles.

The fire detectors will be ultraviolet, infrared or thermal type sensors capable of detecting incipient fire conditions. The gas and fire monitors will be packaged on free-standing rack cabinets. A battery backup system will be provided to power the system during main power outage.

The fire and gas monitors will be suitable for large multi-point systems. Each channel will be provided with a separate monitoring circuit, alarm and switch contacts for activating devices external to this system. The sensors, as well as the monitors, will be cross zoned to establish gas or fire detection in an area by two independent sensors providing inputs to two separate monitoring and control circuits.

2.3.14 Cathodic Protection

The primary cathodic protection system will be a deep well impressed current system. If there are areas in the compressor stations which do not receive the full necessary protection from the primary cathodic protection system, a secondary system utilizing sacrificial anodes or surface distributed impressed current anodes will be used.

Criteria for protection will be -0.85v pipe to soil potential with respect to the copper/copper sulfate reference electrode or as specified by NACE RP-01-69.

The following material and system components will be provided:

- Rectifiers
- Impressed current anodes
- Sacrifical anodes (as required for auxiliary protection)
- Test stations
- Insulated cathodic protection cable
- Data recording, receiving and sending equipment

2.3.15 Station Control System

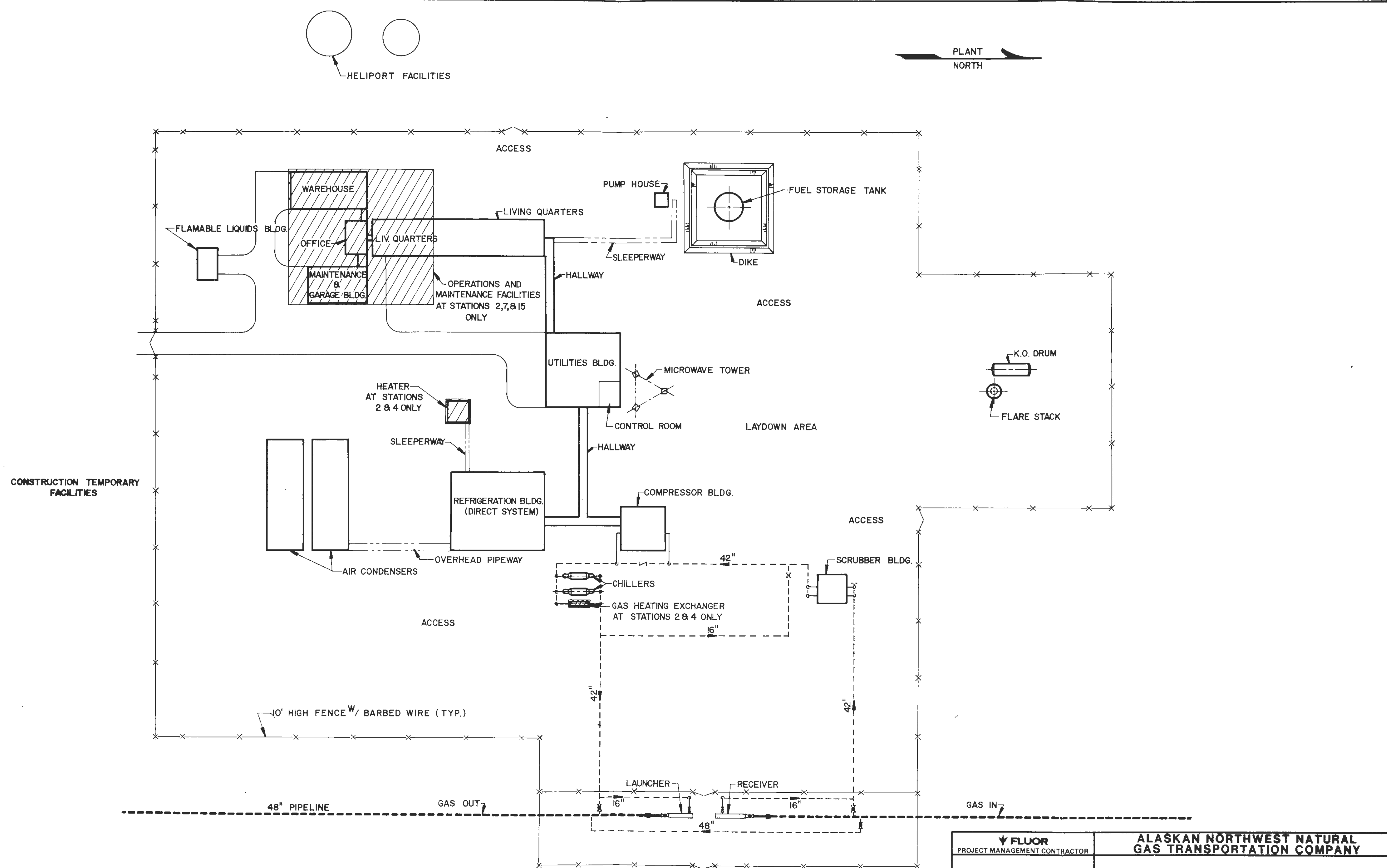
The distributed control system in each compressor station will consist of the following equipment:

Several microprocessor based Remote Terminal Units (RTU) capable of providing process control functions such as proportional, integral and derivate control algorithms, computations, data reduction, data logging, interlock logic, and local display of process data. Critical functions will be backed up by a redundant microprocessor. Each RTU will be furnished with a battery backup system to provide logic power during primary power outage.

A station console with two color video displays (CRT), two printers, and trend recorders for real time trending of several process variables. The two color CRT's will be used for overview, group and detail displays, graphic presentations, trend information, and alarm summaries. These two CRT's will be complementary to each other to provide redundancy.

The two printers will provide priority alarm logging indicating time of activation of alarm and the time the alarm deactivated. The printers will also provide routine process data logs, demand logs, and historical trend information. The two printers will be complementary to each other to provide redundancy for alarms.

The central control unit (CCU) will carry out control strategies not included in the RTU, data logging, higher level calculations, build pictorial blocks for graphic display, provide basic timing, polling of all points in the system, message control, coding and checking. It will incorporate the serial communications interface to communicate to the Operations Control Center (OCC). Additional expandable memory in the form of a disc subsystem will be provided for data storage. The CCU will be provided with a backup system so that the essential functions will continue without interruption. The console and the central control unit will be powered from the uninterruptible power source.



FLUOR
PROJECT MANAGEMENT CONTRACTOR

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

TYPICAL COMPRESSOR STATION
OVERALL PLOT PLAN

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

NOTES	REV. NO.	DATE	REVISION	DRAWN CHECK	APP	DWG. NO.	REFERENCE DRAWING
	1	5-80	RELEASED FOR FERC FILING				
						MICROFILM NO.	

	DATE		DATE
R. PICHLER	5-7-80	Roger A. Laws	5-7-80
B. WASLEY		V. Peterson	5-19-80

SCALE IN FEET	DRAWING NUMBER	REV.
1" = 60'-0"	4680-20-00-0-500	1

FIG. Z-9.2-2-1

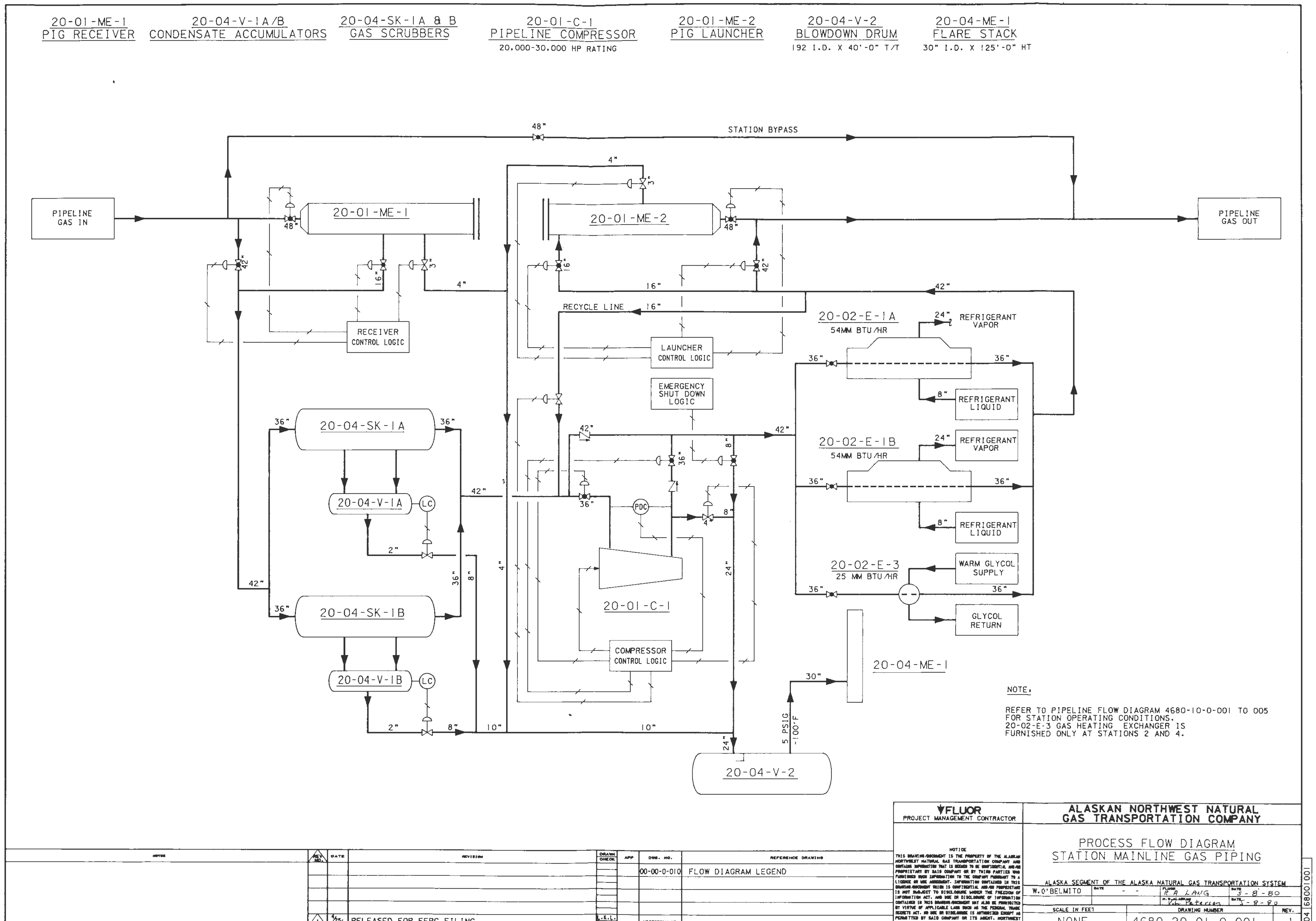


FIGURE Z-9.2-2-2

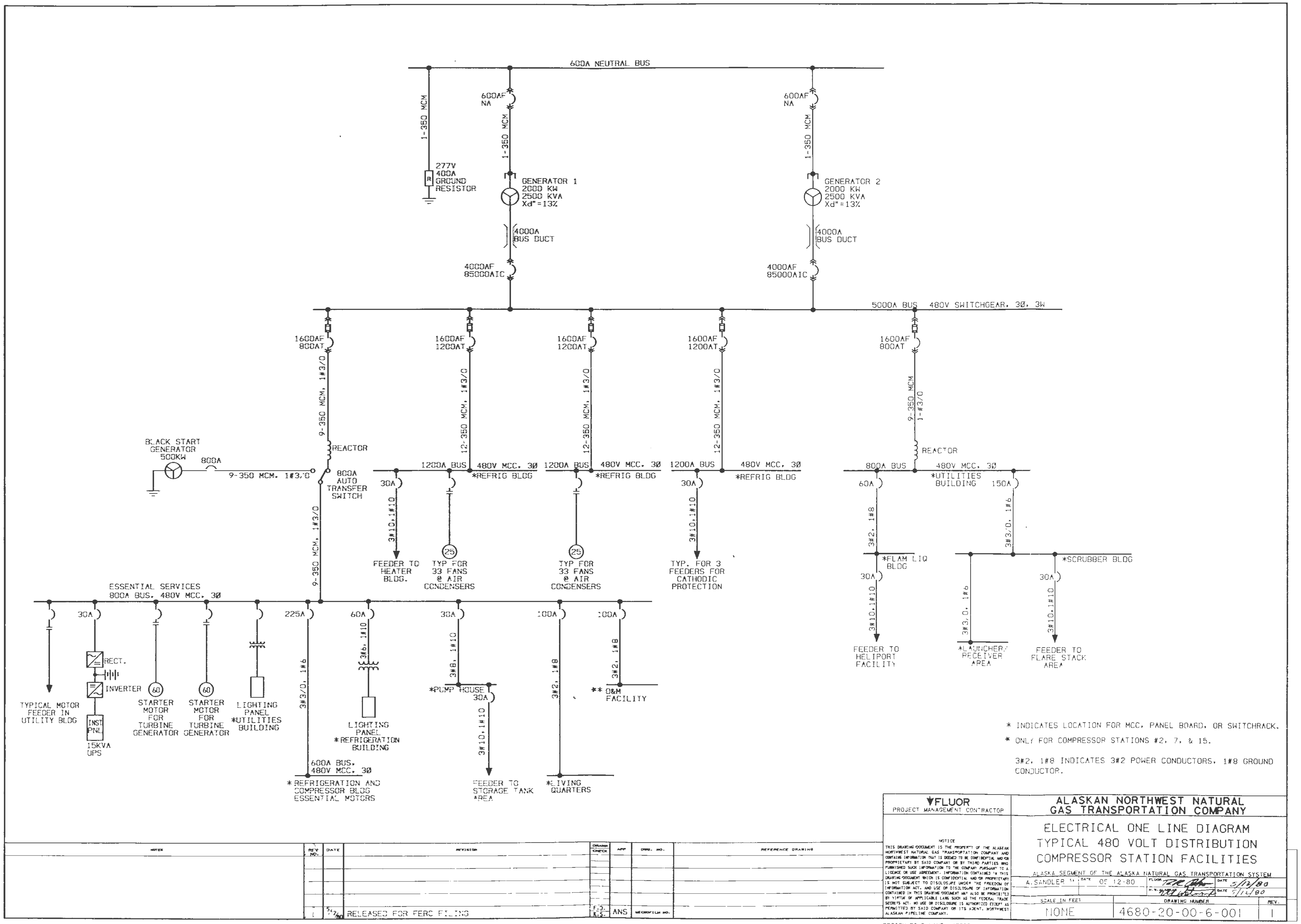


FIGURE Z-9.2-2-3

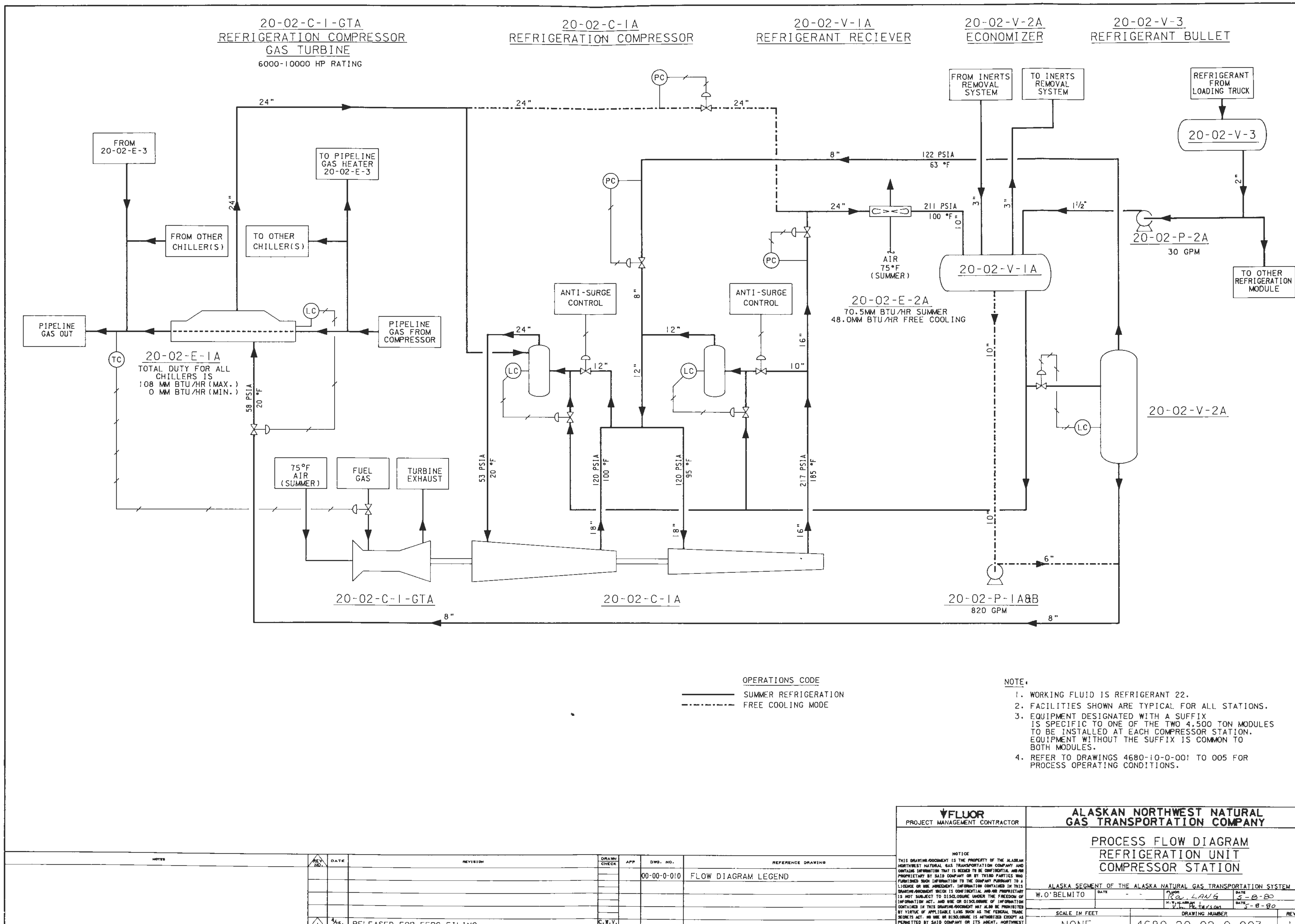


FIGURE Z-9.2.2-4

2.0 ft

Docket No. CP80-
Exhibit Z-9.2
Hearing Exhibit No.

TABLE 2-1
BUILDING LIST

COMPRESSOR STATIONS NO. 2,4,7,9,11,13,15

Building Typical at Each of 7 sites:

		Building Size Width		Length		Eave Ht.
1.	Utility Building	100'	x	100'	x	16'
2.	Refrigeration Building	100'	x	128'	x	34'
3.	Compressor Building	60'	x	60'	x	24'
4.	Flammable Liquids Building	30'	x	40'	x	10'
5.	Scrubber Building	40'	x	40'	x	23'
6.	Pump House	20'	x	20'	x	12'
7.	Living Quarters	50'	x	150'	x	8'
8.	Hallways	12'	x	385'	x	10'-12'

METERING STATIONS

A. Prudhoe Bay

1.	Metering Building	80'	x	80'	x	20'
2.	Control Building	10'	x	20'	x	8'
3.	Generator Building	20'	x	30'	x	16'
4.	Pump House	10'	x	10'	x	12'
5.	Hallway	12'	x	30'	x	10'-12'

B. Yukon

1.	Metering Building	80'	x	80'	x	20'
2.	Control Building	10'	x	20'	x	8'
3.	Generator Building	20'	x	40'	x	16'
4.	Pump House	10'	x	15'	x	12'
6.	Hallway	12'	x	30'	x	10'-12'

TABLE 2-2
LINE CLASS SUMMARY

Line Class	Class Rating	General Material	Temperature Range	Service
A	150 RF	Steel	-20/250°F	Diesel Fuel Hydrocarbons Glycol Nitrogen
AN	150 RF	Steel (Low Temp)	-20/100°F	Natural Gas Fuel Gas
AR	150 RF	Steel	-20/110°F	Refrigeration (Freon 12 or 22)
AV	150 RF	3-1/2 Ni	-110/100°F	Blowdown
CN	300 RF	Steel (Low Temp)	-20/100°F	Natural Gas Fuel Gas
FN	600 RF	Steel (Low Temp)	0/100°F	Natural Gas
FNM	600 RF	Steel (Low Temp)	0/100°F	Natural Gas
FV	600 RF	3-1/2 Ni	-110/100°F	Blowdown
L	125 FF	Steel	-20/160°F	Instr. Air Plant Air Plant Water Vacuum Sewer
LC	None	PVC	0/100°F	Hypochlorite Chlorine Pumped Sewer
LD	150 Scrd	Galvanized Steel	40/120°F	Potable Water
VA	150 RF	304 SS	-20/200°F	Lube Oil
VH	1500 RF	304 SS	-20/200°F	Seal Oil

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3.0 METERING STATION DESIGN

3.1 DESCRIPTION

Design and criteria previously stated for the compressor stations, where applicable, apply to the metering stations.

Locations

The gas being transferred from the Prudhoe Bay gas conditioning plant to the pipeline system will be metered at the point of receipt and again at the Yukon Border as it leaves the Alaska Segment and enters the Canadian Segment. The proposed site of the Prudhoe Bay metering station was selected to locate the metering station as close to the gas conditioning plant as possible. The Yukon Border metering station is located at the Yukon Border.

Layout and Equipment Spacing

A typical overall plot plan for each metering station is shown on Figures Z-9.2-3-1 and Z-9.2-3-2.

The plot plans illustrate the proposed layout arrangement of the buildings. Each metering station site will require approximately 2.5 acres to provide the recommended spacing between buildings and outside equipment.

Access

Entrance into either metering station plot is provided by one gate in the perimeter fencing. The plots have one other gate which is an emergency exit.

Process

Two metering stations will be provided for gas custody transfer.

The Prudhoe Bay metering station will have four parallel meter runs for flow measurement. One meter run will be a spare. The gas is analyzed for density, specific heat and stream composition.

The Yukon metering station also has four parallel meter runs with one as a spare. The flow measurements and gas analyses are the same as described above for the Prudhoe Bay metering

3.2 DESIGN

Foundation

The following contain soil and foundation conditions for each metering station.

Thermistors will be provided at each metering station to monitor the subsurface temperature conditions.

- Prudhoe Bay - The following description for Metering Station Number One is based on a nearby NWA borehole N29-12.

  The assumed soil stratigraphy and thermal conditions are as follows:

Stratum	Description
I	Organic cover having an average thickness of 0.5 feet.
II	Brown, slightly organic silt with significant visible and clear ice to a depth of 7 feet.
III	Frozen grey, fine to coarse sand and gravel. No visible ice.

  Permanently frozen soils were encountered at this boring below depths of about 1.5 feet. Deformations due to thaw degradation of the silt will be significant. The sands and gravels are expected to be thaw stable.

  The site of the metering station is essentially level. The organic cover will not be stripped or disturbed within the plan area of the site. A two-inch thick layer of insulation will underlie a four foot thick compacted granular pad over the site. Pile foundations will support structural and operating components.

- Yukon Border - The subsurface information at Metering Station No. 2, is limited to what is available from the Route Soil Condition Sheet 131. This data suggests the following subsurface stratigraphy and thermal conditions:

Stratum	Description
I	Residual soils originating from the underlying bedrock.
II	Metamorphic bedrock with a variable degree of weathering.

It is not known at this time whether the site is permanently frozen or not.

The metering station is located on a saddle with a potential for some development relief. It is planned that the site will be developed by cut and fill type construction methods. Cut and fill slopes will be determined when additional data is available.

The site may be finished with a four foot thick pad of compacted non-frost susceptible granular material. At the present time, it is not known whether insulation will be required at this site. Pile foundations will support structural and operating components of the station.

Building Heating and Ventilating

Heating and ventilating the buildings at both metering stations will be by means of redundant gas-fired furnaces and warm air duct systems.

The pump houses will be heated electrically with explosion-proof wall heaters.

Emergency ventilation for the metering buildings at the Prudhoe Bay station and at the Yukon Border Station will be by means of emergency ventilation supply units. The air will be exhausted through dampered air relief hoods. The equipment and dampers will be interlocked with the fire and gas detection system.

Electrical

The electrical power generation and distribution systems are different for each metering station. Figure Z-9.2-3-5 shows the Prudhoe Bay electrical design and Figure Z-9.2-3-6 shows the Yukon Border's system.

The Prudhoe Bay metering station will have access to an outside electrical power source for its primary power. In the event that the primary power supply is disrupted, a backup, diesel engine driven generator will automatically come on line to provide power.

At the Yukon Border metering station, no outside electrical power source is available. The station must be capable of generating the power that is required. This station has two diesel driven generators. One electric generator operates continuously and the other is used as an automatically started standby in case the primary generator fails to operate.

Both metering stations will have an uninterruptible power supply unit which will include a rectifier, batteries, an inverter, associated controls and switchgear.

The electric generators at both the Prudhoe Bay and Yukon Border metering stations each have a capacity of 50kW, 480V, 3 phase, 60 Hz.

Measurement and Control Systems

The "Smart" remote terminal units (RTU) located in the control rooms at Prudhoe Bay and Yukon Border metering stations will carry out the reporting and control functions, with the exception of gas flow computations.

At the Prudhoe Bay metering station, the RTU will carry out data reporting, control and interlock functions associated with the gas meter runs, and pig launcher.

At the Yukon metering station, the RTU will carry out data reporting, control and interlock functions associated with the gas meter runs, gas scrubbers, blowdown system, pig receiver.

At each metering station, volume, mass and heat throughput of gas through the four meter runs will be computed by a microprocessor based flow computer having 100 percent redundancy.

The flow measurement in each meter run will be accomplished using a concentric orifice plate and differential pressure transmitter. Each flow measurement will be compensated for pressure, temperature and specific gravity at flowing condition. The flow computer will perform a continuous update of supercompressibility factor, expansion factors and Reynolds number corrections.

A densitometer, a calorimetric analyzer and a gas chromatograph will be provided at each metering station. The densitometer and calorimeter at each station will be common to the four meter runs that meter the gas. Circular chart recorders with flow integrators will provide local indication and record of the flow at each meter run. The gas chromatograph will be used for the determination of hydrocarbon dew point and presence of sulfur or its oxides in the gas stream.

The RTU and the flow computers will have a battery backup system to sustain their operation in the event of a main power outage.

3.3 MATERIAL AND EQUIPMENT

Meter Runs

The metering stations at Prudhoe Bay and Yukon will be equipped with four 24-inch diameter by 39 feet long metering runs.

Each metering run will consist of the orifice fittings, orifice plate, meter tube, and straightening vanes.

The orifice fittings will be equipped with an upper compartment and sealing mechanism for removal of the orifice plate while the meter tube is under pressure. Gear mechanisms, for raising the orifice and valving, will be designed for efficient and safe change or inspection of orifice plates.

Vertical supports (davits) will be provided with large orifice fittings to facilitate lifting the plates for inspection or removal.

Dual orifice taps will be provided on the orifice fittings for connections to the flow transmitters.

Meter tubes and fitting material will be in accordance with piping standards for this project.

The orifice fitting will have a welding neck for upstream connection to meter tube, and a flanged outlet for the downstream side of the orifice fitting.

Orifice plates will be the square edged concentric type. Plates and meter tubes will be manufactured according to AGA Report No. 3. Meter tube ends will be flanged for piping connection to the incoming valve. All welds will be 100 percent radiographed and each meter tube will be equipped with in line straightening vanes.

Flow Metering Equipment

At each of the metering stations, redundant flow computers will be provided to compute total and instantaneous gas flow in conformity with AGA Reports No. 3, 5 and NX-19. One will compute the flows in the meter runs while the second will be on standby ready to take over operation should the primary computer fail. The metering stations will each have four meter runs with orifices for measuring elements and differential pressure transmitters. The parallel meter runs will make use of individual pressure transmitters and temperature transmitters, and shared densitometer and calorimeter. Differential pressure transmitters will operate at a maximum of 400 in. H_2O differential.

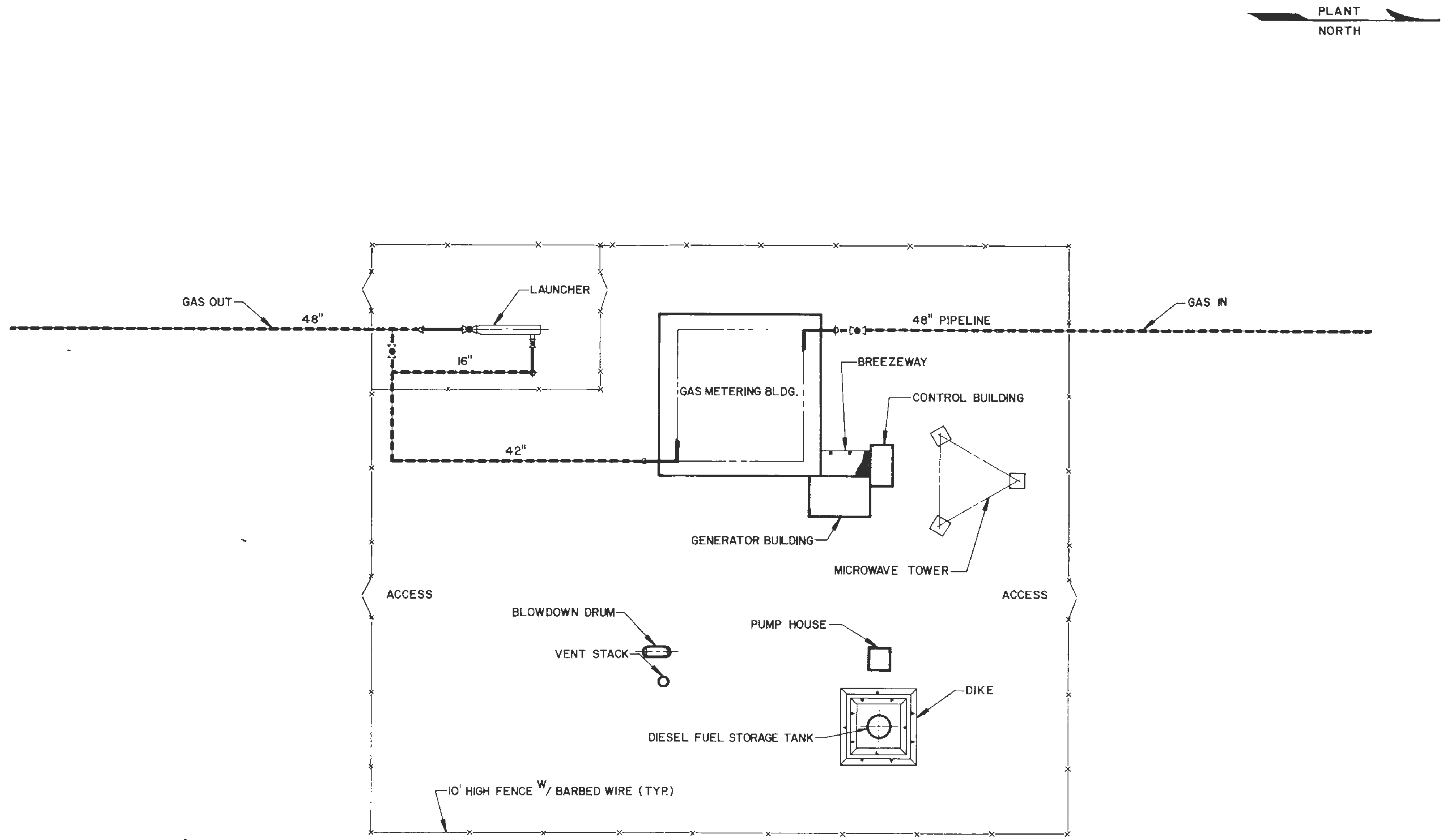
The microprocessor based flow computers will be, used to compute the gas standard volume using a preprogrammed computation routine. The flow computer will perform continuous update of Reynolds's number factor (F_y), expansion factor (Y), flowing temperature factor (F_{tf}), density factor (F_1), supercompressibility factor (F_{py}) and orifice expansion factor (F_a).

In addition to the flow computer, conventional circular chart recorders with integrators will be provided in each metering station to record and integrate gas flow. A record of gas temperature and pressure will also be provided on these recorders.

Metering Station Remote Terminal Units

A remote terminal unit in the form of a minicomputer will be provided at the Prudhoe and Yukon metering stations. This system will log and store metering data, monitor each flow transmitter for signal validity, and carry out interlock logic functions associated with the pig launcher/receiver operation. Failure of a flow transmitter will automatically switch to a standby meter run, if the standby meter run is required to meet the flow demand.

Hardware configuration will include a mainframe with semi-conductor memory, a printer terminal and operating system and an EIA standard asynchronous communications interface. The system will be capable of handling both analog and digital inputs. Hardware components except the printer terminal will be packaged in a free-standing rack cabinet. This system will be located in the metering station control room.



NOTES	REV. NO.	DATE	REVISION	DRAWN	CHECK	APP	DWG NO	REFERENCE DRAWING
	1	5-80						
							MICROFILM NO	

FLUOR
PROJECT MANAGEMENT CONTRACTOR

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

GAS METERING STATION
PRUDHOE BAY
OVERALL PLOT PLAN

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

NOTICE
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R. PIEHLER	DATE 5-7-80	FLUOR R.A. LANG	DATE 5-7-80
B. WASLEY		N.W. ALASKAN V.L. Peterson	DATE 5/19/80

SCALE IN FEET	DRAWING NUMBER	REV.
1" = 30'-0"	4680-41-00-0-500	1

FIG. Z-9.2-3-1 FORM E-727 2/80

REDUCED PRINT SCALES

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3.0 pt

	Percentage of Working Unit Stress
o Dead load plus full roof live load plus crane load	100%
o Dead load plus wind load plus 1/2 crane load	133%
o Dead load plus 50 percent roof snow load plus seismic forces applied concurrently along the three major axes of the structure	167%*

*Not to exceed yield value of the material.

The final specification will include paragraphs on dead loads, operating loads, test loads, earthquake loads, vibration loads, erection loads, maintenance loads, and transport loads.

Preparation of the sites will include the following activities:

- o Clearing and grubbing
- o Disposal of cleared waste material
- o Protection of the permafrost
- o Excavation (side slopes, trenching, drainage and erosion control as required)
- o Embankments and fills

Corrugated galvanized metal pipe will be used for underdrains, trench drains, and culverts.

The diesel fuel tank containment area will be lined for protection against any environmental damage that may occur due to a spillage. The linings, flashings and boots will be made of 30 mil thick reinforced chlorinated polyethylene sheets. All factory seams will be heat-welded or adhesive bonded. All field seams will be adhesive bonded.

The fencing around the station sites will be made of 6 gauge, 2 inch mesh galvanized fabric. The chain link fabric will extend 3 feet below grade and 3 feet outward to prevent animals from burrowing into the site. The top of the fence will have 3 strands of barbed wire supported by outriggers. Fencing materials will be galvanized. Maximum post spacing will be 10 feet. Face edges and bends of the wire fabric will be reinforced with tension wire.

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2.2.2 Foundation Design

All compressor stations are located at sites which have continuously frozen soils or combinations of frozen and unfrozen soils. These foundations will be designed to prevent thawing of the permafrost.

Most of the sites will be protected from permafrost degradation by a layer of insulation overlaid with a gravel pad. The thickness of insulation and gravel pad will be site specific depending upon the soil and climatic conditions of the location under consideration.

The buildings will be elevated on steel pile foundations above a gravel pad to allow for ambient air circulation to prevent transfer of heat from the buildings to the ground. The circulation of ambient air over the ground will maintain the natural freeze/thaw cycle of the active zone.

Equipment will be supported on steel piles that will support the equipment weight through any noncompetent active zones into the permafrost. The embedment of piles into the permafrost will prevent "frost jacking" of the structures.

The diesel fuel storage tank will be placed on a granular fill and sand layer. The tank will be surrounded by an earthen dike to contain any potential leakage of diesel fuel. An impervious liner will be placed beneath the diked area and in the containment dike slopes to prevent percolation of diesel fuel into the natural soils.

Above ground piping will be elevated above grade by structural steel supports carried on steel piles.

Geotechnical Aspects of Foundation Design:

- o Compressor Station 2 - Subsurface data is based upon two NWA boreholes, N29-14, N29-15, and nearby APSC boreholes.

The general soil stratigraphy and thermal conditions for this site are as follows:

Stratum	Description
I	A surface horizon of organic silty sand up to 1.5 feet thick.
II	A dense coarse sandy gravel with numerous cobbles and scattered boulders extending to depths of 40 feet or more.

Permanently frozen soils were encountered below depths of approximately six feet. Above this depth some seasonal thaw degradation may occur. The gravel below this depth is expected to be thaw stable.

The site is comparatively flat and where necessary will be stripped of unsuitable surface materials. A five to six foot thick insulated compacted nonfrost susceptible granular pad is planned for the development of this site.

- Compressor Station 4 - Site-specific subsurface data is not available at this time. Nearby APSC borings have been used for the following preliminary interpretations.

Stratum	Description
I	An organic silt usually having a thickness of less than 1.0 foot.
II	Dense silty gravel with some sand, cobbles and boulders, extending to a considerable depth (granular till). Contains inclusions of remnant glacier ice.

APSC boreholes indicated frozen ground throughout.

For planning purposes, the surface of this site will be disturbed as little as possible. A topographic relief of some 50 feet indicates that a terraced, nonfrost susceptible compacted granular fill be utilized with insulation beneath to reduce thermal degradation and fill quantity requirements.

- Compressor Station 7 - No borehole information has yet been obtained at the proposed site.

Nearby APSC borehole logs indicate a soil profile that may be generalized as follows:

Stratum	Description
I	Frozen silt with some sand and gravel extending to approximately 10 feet below ground surface.
II	Frozen sandy gravel and gravelly sand with a trace of silt and scattered cobbles extending to a depth of at least 50 feet below ground surface.

Use of a granular fill pad with an underlying layer of insulation is considered feasible for the development of this site. The frozen soil at this site is anticipated to be thaw unstable.

- Compressor Station 9 - Subsurface data consists of two NWA boreholes, N34-21 and N34-22. Nearby APSC boreholes have also been referred to for general information purposes.

The soil and rock stratigraphy and the thermal conditions for this site are approximately as follows:

Stratum	Description
I	A 0.2 to 0.5 foot thick surface organic soil layer.
II	Brown, comparatively loose and partially frozen silt varying in thickness between two and eight feet. The lesser silt horizon in borehole N24-21 was frozen and contained visible ice. The greater silt horizon in borehole N34-22 was unfrozen.
III	In borehole N34-21, a frozen horizon of colluvium having a thickness of about two feet.
IV	In borehole N34-22, an unfrozen brown silt with rock fragments to a depth of about 20 feet.
V	Frozen broken and weathered bedrock increasing in competence with depth and containing horizons of ice.

The depth to frozen ground varied appreciably across the site; one foot in borehole N34-21; 20 feet in borehole N34-22. Visible ice was reported in both soil and rock horizons. Deformations of varying magnitude may be anticipated during seasonal thaw and general site thaw degradation.

The site is on a slope with a development relief of over 50 feet. Significant cut and fill grading operations are required for preparation of this site. Five feet of nonfrost susceptible compacted granular fill will be utilized to finish grade this site.

- Compressor Station 11 - The borehole data revealed the following soil stratigraphy and thermal conditions:

Stratum	Description
I	Surface organic soils mantle the site varying in thickness between 0.5 feet and 1.5 feet.
II	Frozen aeolian silts with visible ice and massive ice to a depth of 50 feet. Some massive ice horizons were over 10 feet thick.

The soils are frozen over the depths explored.

The site is comparatively flat. The soil and thermal conditions indicate that cuts should not be made within the plan dimensions of the site. It is recommended that a terraced granular pad of nonfrost susceptible materials and insulation be placed on the station site. Thermal control installations may be required for specific areas on this site in conjunction with a pile design.

- Compressor Station 13 - The subsurface data is taken from two NWA boreholes, N35-10 and N34-11.

The subsurface stratigraphy and thermal conditions for this site are as follows:

Stratum	Description
I	A thin organic mat covers the site area; typically less than 1.0 foot thick.
II	Brown sandy silt about four feet thick; frozen below a depth of one foot.
III	Frozen sandy gravel with occasional cobbles extending to depths of 50 feet or more.

The subsurface soils were frozen below a depth of one foot for the entire depth drilled. No visible ice was reported within the gravels.

This site is comparatively flat having a relief of about 15 feet. Unsuitable surface materials will be stripped prior to the placement of compacted nonfrost susceptible granular material for site preparation. Nominal slopes will be utilized to finish the fill slopes.

- Compressor Station 15 - A limited number of boreholes provide the following preliminary information:

The subsurface stratigraphy and thermal conditions for this site are extrapolated from sources outside the site and therefore, actual site conditions may vary considerably from that indicated:

Stratum	Description
I	A one foot thick organic mat covers the site.
II	An unfrozen horizon of brown silty sand varying in thickness between 5 and 25 feet. Adjacent information infers that this horizon may vary considerably in thickness over the area of the site.
III	Unfrozen and weathered granitic bedrock is anticipated to occur beneath the overburden soils.

No thermal data is available for this site at the present time. Soil information suggests possible discontinuous frozen ground may prevail over portions of this site.

This site is centered on a hill with a natural topographic relief of some 150 feet. It is planned that the site will be developed by cut and fill methods. Fill sections will consist of suitable nonfrost susceptible granular materials. A five foot thick granular fill pad is needed for final grading of the plant site. No insulation is planned at this time. Thermistors will be placed at the compressor station sites.

2.2.3 Structural Steel

Structural steel will be designed per the American Institute of Steel Construction (AISC) "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings." Structural steel which is not within the insulated shell of heated structures will be of material appropriate for cold weather application. Steel within the insulated shell of heated structure will be of conventional materials.

2.2.4 Buildings

The primary function of the buildings is to provide an efficient working environment for personnel and equipment. The extreme climatic conditions at the various sites and the short building season are important design considerations. These requirements will be met in the most efficient way by the use of preengineered and prefabricated modular buildings.

The buildings are classified by the following types of construction:

- Type I - Preengineered buildings for operational structures that will house equipment and materials such as the utility building, scrubber building, refrigeration building and main compressor building.

- Type II - Prefabricated modular buildings for non-operational structures such as living quarters, offices and interconnecting hallways.

The preengineered steel buildings will consist of structural steel frames, girts and purlins and will be set on steel panconcrete slabs. These buildings will be elevated above grade. Insulation and weatherproofing is necessary to provide a comfortable work environment and the walls and roofs will be insulated sheet metal panels with factory applied finishes to withstand the adverse climatic conditions. Metal connections through the walls and roofs, which in the past have accumulated frost and moisture within similar structures, will be avoided.

The buildings and interconnecting hallways will be fabricated in sections or subassemblies to facilitate their being transported to the sites where they will be erected on previously prepared foundations.

The compressor stations, metering stations and operations and maintenance facilities require modular buildings for personnel living quarters, offices and interconnecting hallways. These buildings will be factory fabricated modular units that will be assembled at the jobsite.

These units (except interconnecting hallways which are steel frame construction), will be a wood frame construction with steel or aluminum wall and roof panels. The frame wall construction is secured to the floor system and is supported on a steel pile foundation or mounted on skids.

The building fabricator will provide insulation and a moisture membrane in the walls, roof and under the floor. The insulation and moisture membrane help to maintain comfortable living conditions by minimizing any heat loss.

These modular units are adaptable. They can be made permanent by attachment to a concrete foundation or they can be bolted to skids for easy detachment and relocation.

The compressor station buildings are constructed from 10 foot wide modules. The lengths of the modules vary, depending on the site and use requirements.

The living quarter buildings at Compressor Stations 4, 9, 11, and 13 will have twenty sleeping rooms. At Stations 2, 7, and 15 where operations and maintenance facilities are required, the living quarters will have thirty-six sleeping rooms.

The living quarter modules will consist of sleeping rooms, bathrooms, kitchen, dining room, t.v. lounge, commissary, post office, laundry room, and storage. Interior walls will be vinyl covered gypsum wallboard with matching trim. Floors will be carpeted, except in kitchen and bathroom areas. In areas where carpeting is not provided, seamless vinyl flooring will be used. The living quarters will be completely furnished by the fabricator with such items as kitchen equipment, pots, pans, tableware, linens, furniture, drapes, beds, and writing tables.

Heating and ventilation systems will be provided for the occupant's comfort. Double-glazed windows, vestibules and weatherstripping will be provided to aid in weatherproofing.

The primary functions of the building heating and ventilating systems are as follows:

- Maintain acceptable inside temperatures under normal operating condition with outside temperatures ranging from -60°F to +80°F.
- Provide year-round minimum ventilation rates during normal operation to remove possible traces of hydrocarbon vapors and maintain a healthful environment for operating personnel.
- Provide high volume emergency building ventilation to dilute potential buildup of hazardous hydrocarbon vapor concentrations during abnormal operating conditions.

The following design criteria will be used for the design of the heating and ventilating systems:

- Winter Ambient Temperature: -60°F
- Summer Ambient Temperature: +80°F
- Minimum Building Temperature Under Normal Ventilation Conditions:

  Living quarters and control rooms: +70°F

  Flammable liquids building: Ventilation only, with manually controlled heaters for use during occupied periods.

  Shop areas: +65°F

  All other buildings: +55°F

- Maximum Building temperature (summer); +95°F
- Heating Medium - Water/glycol

  Supply temperature at heating coils: +215°F

  Return temperature: +145°F

- Ventilation - Buildings which are classified hazardous will be ventilated year-round by means of mechanical air supply systems and gravity exhaust systems. The normal ventilation rate will be one air change every 15 minutes (4 air changes per hour), minimum. The emergency ventilation supply air will be one air change every 4 minutes (15 air changes per hour) and will not be heated.

  The flammable storage building will have a manually controlled mechanical ventilation system, providing a ventilation rate of 45 air changes per hour. Explosion-proof electric wall heaters will be used to heat the building during occupancy. For building areas not requiring emergency ventilation, the minimum ventilation rate will be 5 CFM per occupant or as required for heat removal. Sufficient makeup air will be provided to offset exhaust from toilets and kitchen hoods, to maintain a slight positive building pressure. With the exception of outside air required for ventilation, the air handling systems for the areas will be of the recirculating type with thermostatically controlled outside air mixing dampers to allow once-through ventilation during warm weather.

Emergency ventilation systems will be started and stopped automatically upon signals from the fire protection control systems. In addition, emergency ventilation fans will be provided with individual manual override switches to permit operation of the emergency fans for supplemental summer ventilation purposes.

Hallways between buildings will be provided with independent heating and ventilating units which will supply sufficient outside air to maintain a positive pressure in the hallways with respect to the connecting buildings.

Acoustical enclosures over the gas turbines will be provided with independent once-through ventilation and heat removal capabilities. Enclosures will be maintained at a negative pressure as related to the building pressure. Ventilation will be by mechanical exhaust fans with automatically controlled standby fans. Fans and dampers will be interlocked with the fire suppression control system to assure closing of ventilation openings prior to activation of the Halon fire suppression system. Ventilation air will be ducted to and from the outside.

To minimize the number of spare parts and provide interchangeability, equipment for all locations will be as similar in design as possible, subject to design performance requirements.

- <u>Dampers</u> - Air intake ducts and air exhaust ducts penetrating the building shell will be protected by dampers which will close automatically when the associated supply or exhaust fans are shut down. In addition, dampers and fans will be interlocked with the building fire protection control system to assure closing of ventilation openings prior to activation of the Halon fire suppression system.

  Where required, dampers will be protected against freeze-up by means of heating coils.

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- Humidity Control - Humidifiers will be installed only in the living quarters and the control rooms.

- Air Filters - Standard throw-away type fiberglass filters will be installed in the air handling systems for the living quarters and for the control rooms. Filters will be located to prevent ice from forming due to ambient conditions.

- Hoods - Outside air openings will be protected by rain hoods to minimize ingress of rain and snow.

- Seismic - Heating and ventilating equipment and supports for equipment, ductwork, and piping will be designed to meet the seismic design criteria.

- Explosion-proof Requirements - Heating and ventilating equipment and controls, except equipment located in nonhazardous areas, will be of explosion-proof construction to meet Class I, Group D, Division 1 or 2 ratings as defined by the National Electrical Code.

  The equipment, including fans, air handling units, heating coils and dampers will be heavy duty, industrial type. Exposed ductwork, as well as roof hoods and dampers, will be galvanized steel construction. Heating coils will be copper-tube, aluminum fin construction.

Plumbing fixtures, equipment and piping will be furnished and installed by the modular building fabricator. Plumbing will be provided for the toilet facilities, kitchens and laundry rooms in the living quarters and toilet facilities in the operations and maintenance offices at Stations 2, 7, and 15.

In a toilet room located adjacent to the operations and maintenance offices, plumbing will be piped to a water closet, lavatory and electric water heater.

In the living quarters, plumbing will be piped to the private lavatories in each sleeping room and to the water closets and showers common to a pair of adjacent rooms. The number and size of plumbing fixtures will be determined by the building fabricator.

The kitchens will be equipped with sinks, dishwasher and garbage disposal and the laundry rooms will have two automatic clothes washers, two clothes dryers and one mop sink.

The building fabricator will supply an electric water heater sized to provide sufficient hot water.

Table 2-1 contains a list of the buildings and their sizes. Note that the building sizes are column to column dimensions (where applicable).

2.2.5 Piping

The structural behavior of the station piping will be analyzed using computer programs. Design criteria have been established and piping design will conform to the loading conditions listed below:

- o Internal Pressure
- o Temperature Differentials (Positive and Negative)
- o Weight of Pipe and Contents
- o Soil Overburden and Friction
- o Buoyancy
- o Earthquake (Operating and Contingency)
- o Winds
- o Frost Heave
- o Settlement
- o Construction Loads

Stress calculations will be made on lines of 12 inch and larger diameter and where assurance is required as to the flexibility of the system. Piping flexibility will be assured by a change in the line routing direction or by use of expansion loops or joints.

Forces and moments will be calculated for equipment piping connections. These will be checked against the load limits. The piping configurations which exceed these limits will be modified to eliminate the problem.

The following stress limits, which conform to the 49CFR, Part 192, apply to the design of the main gas piping:

Loading	Type of Stress	Stress Limit
Internal Pressure	Hoop	0.500 SMYS
Pressure + Weight + Wind	Longitudinal	0.375 SMYS
Thermal Expansion	Longitudinal	0.720 SMYS
Pressure + Weight + Wind + Thermal Expansion	Longitudinal	1.000 SMYS
Pressure + Weight + Design Operating Earthquake	Longitudinal	0.500 SMYS
Pressure + Weight + Design Maximum Earthquake	Longitudinal	1.000 SMYS

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Seismic effects on the station piping will be evaluated using a dynamic analysis computer program. Results of the analysis are used to ensure that the seismic design criteria are satisfied. If the pipe stress limits are exceeded in any instance or if the support reactions exceed the structural capability, the piping or support design will be modified to eliminate the problem.

The compressor station piping and flange materials and thicknesses are designed in accordance with the formulae found in the code or regulation that is applicable to each class rating. Table 2-2, under the Class Rating column, contains the code or regulation that applies to each rating. The following pages discuss the compressor station piping by system.

Piping that is within a building will be routed to accommodate equipment operation, maintenance and support requirements. The distribution systems will be grouped for common pipe supports. Clearances and line spacing will incorporate the building steel, electrical, heating and ventilating clearance and maintenance requirements.

Buried portions of the line from the compressor discharge to the chillers and portions above ground and inside buildings will be insulated.

The piping within the refrigeration building will be insulated and the piping outside will be both insulated and electric heat traced. The tracing will be activated, as required, during winter and shutdown conditions. The insulation thickness will vary per pipe size.

The main buried header to the flare is centrally located to gather blowdowns from equipment within the buildings. Piping within the buildings will be insulated but the main run to the flare will not.

The fuel gas piping will be made of carbon steel. The piping inside buildings and aboveground will be insulated. Buried pipe will be both insulated and electric heat traced. Fuel gas from the metering skid, which is located in the scrubber building, is routed underground to the gas compressor building. The piping is then routed from the compressor building to both the refrigeration and utilities buildings via the hallways.

The plant and instrument air piping will be made of carbon steel. Piping inside buildings will not be insulated but

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piping that is outside buildings and aboveground will be. Buried sections of pipe will be both insulated and electric heat-traced. The air compressors will be located in the utility building and the piping will be routed through the hallways to the users which will be located throughout various buildings.

The potable water system will be made of carbon steel. The lines from the water well to the utility building will be insulated and electric heat-traced. The piping from the well to the raw water storage tank will be routed both buried and aboveground. The lines are then routed from the water treatment equipment to the living quarters via the hallways.

The hot water/glycol heating piping will be a closed system and will be made of carbon steel. The piping will be insulated to prevent loss of heat. From the utility building, where the glycol system equipment will be located, the piping will extend to the buildings requiring heat via the hallways.

The diesel fuel piping will be made of carbon steel. This system will be aboveground and will not be insulated but it will be electric heat-traced. The piping will be routed from the diesel fuel storage tank to the pumphouse where the transfer pumps will be located. From the pumphouse, the piping will be routed aboveground on a sleeperway to the gas/diesel fuel turbine generators located in the utility building. Joints in the diesel fuel piping will be all welded and an adequate number of metering devices will be installed to maintain proper inventory control.

The nitrogen system will be made of carbon steel. Piping that is routed within the buildings will be insulated and pipe that is buried will be electric heat-traced. From the utility building where the nitrogen cylinders will be stored, the piping will be routed through the hallways to the various users in each building.

2.2.6 Electrical

The electrical system will be designed for continuous and reliable service, safety to personnel and equipment, ease of maintenance and operation with minimum power losses, mechanical protection and interchangeability of equipment and addition of future loads.

The equipment and installations will be in accordance with applicable portions of the latest edition of Standards and Codes.

Areas will be classified by type and degree of hazard as defined in the National Electrical Code, supplemented by recommendations in the American Petroleum Institute Recommended Practices and Gas Transmission and Distribution Piping Systems.

A typical electrical power generation and distribution system for the compressor stations is shown on Figure Z-9.2-2-3.

Each station will be self-sufficient in electric power, with its own power generation and distribution system. One of the two dual-fuel gas turbine/generator sets, rated 2000 kw, 480 V, 3 phase, 60 Hz each, will normally supply station electric power. Starting emergency power for the turbine/generator sets will be supplied by the (black-start) generator rated at 500 kw, 480 V, 3 phase, 60 Hz. Turbine/generator design will provide for the use of diesel fuel in emergencies and during start-up, and natural gas fuel from the pipeline for normal operations. Switching of fuel during operation will be included. The turbine/generator sets will be designed for short period overloads and ten second short circuit capabilities. The black-start generator will be driven by a diesel engine.

The maximum demand load at each station is calculated to be 1900 kw. During the normal mode of operation, one generator will be running with the second generator set acting as standby. If the failure of both operating generators or the main distribution switchgear occurs, the black-start generator will start automatically. This black-start generator supplies power via an automatic transfer switch to the essential-services Motor Control Center (MCC), which in turn supplies power to essential loads. These loads include lube oil and seal oil pumps for pipeline compressors and gas turbines, starter motors for turbine/generator sets, diesel fuel pumps, and life support systems including emergency lighting. An uninterruptible power supply (UPS) unit consisting of a rectifier, battery, inverter and static switch will provide continuous power for essential instruments and control system loads. This unit will maintain voltage and frequency regulation during shutdown and switching surges. The UPS rectifier will receive its power from the essential services of the MCC.

A common neutral grounding resistor will be provided for both main generators to reduce ground fault current. Only the operating generator neutral will be grounded during normal operations with automatic switching to the standby generator neutral when the standby generator is supplying power to the Main Distribution Switchgear and the operating generator is shut down.

The main distribution switchgear consisting of two generator feeders and five distribution feeders will be located in the Utilities Building. The black-start generator and the essential services MCC will be located in a separate area. Power to Living Quarters, Operation and Maintenance Facilities, Flammable Liquids Building, Pump House and the Heliport area will be distributed from MCC's in the Utilities Building. There will be three MCC's in the Refrigeration Building for power distribution to refrigeration compressors and auxiliaries, air cooler fans and the Compressor Building. These MCC's will have provisions for future expansion. Switchracks in the Launcher/Receiver area, Scrubber Building and Pump House will be of explosionproof design suitable for use in hazardous locations.

The power cable will be installed in louvered bottom, ventilated type cable trays for indoor installations. For outdoor locations, an underground rigid steel conduit and wire system will be used. Instrumentation and computer wiring will be installed in cable trays or rigid steel conduits and will be separated from power conductors to avoid noise interference.

Convenience receptacles and 480 V welding outlets; electrical heat tracing with thermostatic control will be provided with heater cable suitable for the service and area classification.

System ground return wires will be run with the main power cables from system ground buses in the motor control centers to the loads and also from 480V Switchgear to the MCC's.

2.2.7 Emergency Shutdown System (ESD)

An emergency shutdown system will be provided at each compressor station to safely shut down major equipment, to depressurize the station piping and to bypass the station. Emergency shutdown occurrences will be annunciated and logged at the compressor station console and at the Operations Control Center dispatcher's console.

The ESD will receive inputs from the fire and gas monitoring system sensors or from the manual ESD station. If any inputs are received by the ESD system, the station shutdown sequence will be initiated. Equipment will be shut down and the necessary gas will be depressurized to the flare. The interlock logic requirements to effect shutdown will be carried out by microprocessor-based programmable logic controllers. The station central control system will provide backup equipment in each station to assume control from the primary operating system, in case of a primary system failure.

A battery backup system will be provided for the ESD to keep the system operable during primary power outages.

2.2.8 Control Systems

Each compressor station will be automated with monitoring and control equipment to provide for safe and efficient unattended operation. A Compressor Station operator will not be required to monitor and supervise the compressor station control system during normal operation. The hierarchy will start with local control systems supplied with the mechanical equipment and other local instrumentation. This equipment will be monitored and supervised or controlled by strategically located control units (Remote Terminal Units or RTU's). The RTU's will report data to and receive control changes from the station Central Control Unit (CCU). Station CCU's will be linked by communications with the Operations Control Center (OCC). See Figure Z-9.2-4-3 for a diagram of the Compressor Station Control Systems General Configuration.

Equipment start/stop functions will be controlled by various elements in the control hierarchy so that a stop function initiated at any control station will override the commands from any station higher in the hierarchy. Pushbuttons or selector switches for local manual control of equipment and motorized valves will include provisions for locking in the off position. Circuit breakers in the power feed to equipment will also be designed for locking in the off position. This order of control will be provided to assure that the final authority on operating mechanical equipment or motorized valves will always reside with the personnel or control system nearest to the equipment.

Specialized local control systems will be provided with the gas turbine driven units. These systems control startup and shutdown sequences, load, antisurge, and safety functions. The local control panel includes measurement and status indicators for maintenance and test purposes.

The RTU's will be "smart" remote multiplexers for the CCU. An RTU will monitor the data and perform control functions within an assigned area. These functions will include establishing operating modes and parameters for:

- Local control systems for gas turbine driven units.
- Controlling system parameters such as flow, temperature, or pressure of other related systems.
- Sequential control for interlock systems.
- Monitoring various measurements for transmission to the CCU.
- Comparing measurements with limit values for alarm detection.
- Implementing operating mode and parameter changes received from the CCU.

The CCU will be the master controller and data bank for the RTU's, cathode ray tube video displays (CRT's), and printers. The CCU will support the station operation independent of the OCC. The OCC inputs will be required only for set point changes due to operating conditions or load changes. The CCU will also supply all station data to the communications system for transmission to the OCC and will receive and implement OCC commands to stations. Printers will be provided to automatically log alarms and operating data. The CRT's will provide displays of data and control functions in various formats suitable for startup, maintenance and contingency operation. The CCU console will include a keyboard and other manual input controls to facilitate startup, maintenance and contingency operations.

A seismic monitoring system will be provided in accordance with the Project Stipulations. Seismic monitoring sensors, designed to measure maximum acceleration only, will be located at the compressor and metering stations and at the OCC. Each installation will consist of an instrument set to be triggered at increasingly larger motion acceleration threshold levels. The data will be transmitted to Fairbanks and displayed at the OCC Dispatcher console for evaluation and for forming the basis for any decisions that may be required. Supplementary information from existing seismic monitoring systems will also be transmitted to the OCC.

The seismic monitoring system will provide seismic alarm level monitoring only. Seismic data recording, processing and analysis will not be provided.

Each location will be equipped with a triaxial accelerometer assembly. Each axis will have an accelerometer mounted to a precision machined base. The accelerometer assembly will be installed on a large concrete base to accurately measure ground acceleration.

The analog signal from each accelerometer will be monitored for maximum acceleration level. The threshold alarm limits will be program-adjustable.

An actuated threshold alarm at a compressor station will be communicated to the central control system for local alarming and transmission to the OCC in Fairbanks. At a metering station, an actuated threshold alarm will be communicated to the RTU/CCU system and transmitted to the OCC in Fairbanks. Actuated alarms at the Operations Headquarters in Fairbanks will be communicated directly to the OCC supervising computer system.

2.2.9 Blowdown and Flare

Each compressor station will be provided with a blowdown and flare system for emergency and routine venting of station piping or disposing of condensate.

The flare header will receive hydrocarbon vapors from vents and relief valves, except for the compressor discharge relay valve, in the compressor station. The header will also receive hydrocarbon condensate from the gas scrubbers. The header will connect to the blowdown drum which will be designed to hold up to 15,000 gallons of pipeline condensate at atmospheric pressure. Atmospheric heat will vaporize the low temperature light ends. The vapors will discharge into the atmosphere.

Gas from the blowdown drum will flow into the flare stack. This stack will be provided with a fluidic seal to reduce air intrusion down the stack. Pilot burners, a remote ignition system, and a natural gas purge for the flare header will also be provided.

The flare stack will be sized for a maximum flow of 570,000 LB/HR of saturated, light hydrocarbon gases.

2.2.10 Nitrogen Purge

Each compressor station will contain a gaseous nitrogen system to provide inerting and purge gas for various station operations. Maximum expected usage is expected to be about 750 SCF per month per station.

The nitrogen will be supplied in standard "K" bottles each containing approximately 250 SCF of the gas at 2,200 psig. The bottles will be manifolded in two groups of six with a three-way valve between the groups. One set of six bottles will be on-stream at all times.

2.2.11 Instrument and Utility Air

Each compressor station will be equipped with a utility and instrument air system consisting of air compressors, coolers, free-moisture removal equipment, air dryers, and associated controls required for fully automatic operation. This equipment will be located in the Utilities Building. A distribution system will supply utility and instrument air to users in the Compressor Building, Refrigeration Building and other locations in the station, as required.

Instrument air will be used to operate pneumatic control system components, while the utility air will be used for power tools, cleaning, or other maintenance operations.

Compressed air supply will be 300 SCFM at 100 to 110 psig. Two packaged air compressor units (one primary and one backup) of 300 SCFM capacity each, will be provided to ensure that at least one unit will be available for service at all times. Both units will be electric motor driven. System controls will be arranged so as to assure automatic start and operation of the backup unit in case of failure of the primary compressor. The backup compressor will also operate in the event the system demand exceeds the capacity of the primary machine.

Instrument and utility air will be dried to a dew point of -50°F. The dryer will be a packaged unit and will automatically regenerate the desiccant on a preset cycle.

Compressed air supply pressure will be regulated so as to provide air preferentially to instrument air users should the system pressure drop below 100 psig. In this event, utility air users will automatically be cut off until the pressure is restored to a higher level.

An air reservoir will also be provided to hold sufficient air for an orderly shutdown of pneumatically-controlled systems, in the unlikely event that both air compressors fail to operate.

2.2.12 Fuel Gas Conditioning

A fuel gas conditioning system will be provided to supply fuel gas acceptable for use in gas turbine drivers for the gas compressors, refrigerant compressors and electric generators.

Fuel gas will be extracted from the pipeline at 1000 - 1100 psig and 0°F to 30°F, heated, filtered and reduced in pressure prior to distribution at approximately 500 psig. Final pressure to the equipment will be regulated at the point of use. Heating will be accomplished through a water/glycol heat exchanger with a heating capacity sufficient to offset the Joule-Thomson effect accompanying the reduction in pressure.

The system will consist of two half-capacity water/glycol heat exchangers, two full capacity 5 micron gas filters, pressure regulating valve, temperature controls, and interconnecting piping all mounted and supported on a structural steel skid.

2.2.13 Diesel Fuel

Arctic diesel fuel will be used for startup and backup to the primary fuel (pipeline gas) supply to the gas turbine electric generator sets at each station. Diesel fuel will also be used for vehicles.

Diesel fuel will be delivered by tank truck to the unloading station adjacent to the pump house and from there transferred to the 500 bbl storage tank.

A pump will draw fuel from the storage tank and deliver it to a gas turbine electric generator day tank approximately 500 feet away for use in the generators, incinerators and water/glycol heaters. This system will also have a duplicate spare pump as a standby. A third identical pump will be supplied to fuel vehicles at each station.

2.2.14 Halon Fire Protection

Fire protection will be provided by a Halon 1301 extinguishing system. Each of the fire protection systems will be designed to provide a six percent (by volume) concentration of Halon 1301 to the affected area. Within 10 seconds after actuation (at 70°F using 360 or 600 psig pressure), the affected area would be flooded by discharging the system. Each Halon system will incorporate a backup to provide protection in the event of a recurrent fire condition after a discharge.

Buildings which are not divided by walls or partitions will be protected by total flooding of Halon 1301. In buildings that are divided or partitioned, each area will have a separate Halon system to contain localized fires. Where machinery enclosures exist, an additional Halon system for the enclosed volume will be provided.

The fire protection system will include automatic controls to shut down the fan units, close the supply and the return dampers in ducts, initiate warning alarms and initiate preset time delays prior to the discharge of Halon. Manual discharge controls will also be provided in or near each protected zone. Annunciation will be provided at entrances to areas where Halon has been discharged. Systems requiring more than one cylinder for the main and reserve will be manifolded together and mounted in a unitized rack. The racks will be designed for periodic inspection of pressures and easy removal of cylinders for refurbishing without disabling the system.

Cylinders contained in each rack will be of uniform size. Nozzle locations and header sizing will be designed to maximize efficiency and minimize waste of Halon 1301 due to excessive flooding. The system will be designed for easy inspection, testing, weighing and maintenance without the removal of cylinders.

2.2.15 Potable Water

At stations 4, 9, 11, and 13, the station housing will be designed to accommodate 20 persons. Each of these stations will have an on-site storage capacity capable of providing a 21-day supply of water for 20 people. Stations 2, 7, and 15 which include Operations and Maintenance facilities, will be designed to accommodate 36 persons. Each of these stations potable water storage capacity will be 31,400 gallons providing an 18-day supply of water for 36 people.

Potable water will be delivered by tank truck or from wells, depending on the station location, to a storage tank. From there it will be pumped through a media filter; after being chlorinated and on to the hydropneumatic tank for distribution on demand to the potable water distribution system. The hydropneumatic tank will be pressurized by plant air.

2.3 MATERIAL AND EQUIPMENT

2.3.1 Gas Turbine Compressors

The following contains the design specifications by component.

- Mainline Compressors - The mainline compressors and their accessories will be high efficiency, centrifugal, process-type units with proven operating histories in pipeline service.

The compressor cases will have vertically split steel cases rated for at least 1400 psig. Flanges will be arranged for side inlet and side discharge. The outboard shaft end will be extended through the bearing housing to facilitate the future additions of a heat recovery supplemental turbine driver. The compressor cases will have flow capabilities to meet future expansion. Impellers will initially be sized for optimum flow. These impellers can be replaced with higher flow impellers if desired.

Compressor seals will be the proven oil film or contact type. Sealing system will include seal oil pumps, overhead seal oil tank and adequate instrumentation to ensure sealing during startup, shutdown, and operating conditions.

Compressor will have combined lube and seal oil system. Lube-seal oil system components and seal oil trap assemblies will be assembled into a separate lube-seal oil console by the turbine or compressor manufacturer. The console will be factory-tested and shipped to the jobsite as a complete component. The console will be located to facilitate proper drainage and degasification of all lube and seal oil.

Air-cooled lube oil coolers will be used. These will be remotely mounted in the side of the building near the lube-seal oil console. Ductwork will be provided to use either building or outside air for cooling, and the hot air will be exhausted either into the building or to the atmosphere. Main and auxiliary fans will be supplied to ensure that cooling can be provided in case of a fan failure.

The lube and seal oil systems will be provided with main, auxiliary, and emergency oil pumps to ensure uninterrupted service and full equipment protection during normal operations and during startup and shutdown periods. Three separate sources of power will be used to drive these pumps and to ensure reliability.

Gas turbine drivers will be two-shaft, aircraft derivative type with proven performance on pipeline or comparable applications. These turbines will have BHP capabilities of approximately 20,000 to 30,000 BHP and will directly drive the mainline compressor. The gas turbine and compressor will be baseplate mounted and be supplied as a complete packaged module. This module will include factory mounted components/systems as follows:

- Natural gas starting turbine
- Natural gas fuel and control system
- Ignition system
- Synthetic lube system for the hot gas generator
- Bearing and temperature monitoring devices for bearings and critical components
- Speed governor system
- Coupling alignment indication

Components will be mounted, supported, wired and piped for easy maintenance and will require minimum site erection work.

Inlet air filters will be of the inertia type and will be selected for minimum maintenance and proven performance under atmospheric conditions comparable to the site conditions. These filters will incorporate provisions to prevent arctic icing which occurs under special humidity/ temperature conditions between +20 and +40°F.

The inlet air filters will be mounted adjacent to the end of the building and the connecting ductwork will include a silencing section, plenum chambers, and expansion joints.

The exhaust silencer will also be mounted adjacent to the side of the building and will be elevated. Exhaust from the side of the turbine will slope vertically to provide accessibility around the mainline turbine-compressor module without interfering with the overhead bridge crane. This system will be complete with plenums and expansion joints.

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Provisions will be made for replacing exhaust silencer with a waste heat boiler, if a waste heat recovery system is later to be added.

An acoustical enclosure will be provided over the gas turbine assembly for noise and fire control. The enclosure will be ventilated to ensure that any gas leakage will be quickly vented before a combustible mixture develops. An automatic Halon system will also be provided for extinguishing any fire that may occur.

A control panel will be supplied with each turbine compressor unit. This panel will be provided with alarms, indicators, vibration readout instruments for all bearings, temperatures, and pressures of lube and seal oil systems, turbine temperatures and speeds, compressor antisurge system and the station inlet and discharge flows, pressures and temperatures. Control panel functions will be electronic and compatible with the station central control system and associated remote terminal units.

2.3.2 Direct Gas Refrigeration

The refrigeration systems are represented on Figure Z-9.2-2-4. Both refrigeration systems at the compressor stations will provide the cooling capacity necessary to maintain the natural gas stream flow of approximately 2,400 MMSCFD at temperatures below 32°F. The cooling system will be provided to remove the heat of compression and any ground heat gained between the stations. Each Refrigeration system will be compression/expansion type using Freon gas. Each system will consist of several skid-mounted assemblies and will include a refrigerant compressor, a gas turbine driver, gas chiller, air-cooled condenser, economizer, pumpdown unit, refrigerant receiver, circulating pump, controls and interconnecting piping.

The gas chiller will be a horizontal shell and tube heat exchanger with natural gas in the tubes and refrigerant in the shell. The refrigerant will be compressed by a multiple stage centrifugal compressor driven by a combustion gas turbine through speed reducing gears.

The economizer will be open type and equipped with a liquid level controller.

The refrigerant receiver will be a horizontal pressure vessel designed to hold 125 percent of the system refrigerant.

The air-cooled condensers will be extended surface type heat exchangers with multiple electrical driven fans.

The purge units will be automatic thermal purge type capable of removing noncondensible gases and moisture.

The pump down unit will be a reciprocating compressor with air-cooled condenser and automatic controls capable of transferring or collecting the system refrigerant charge into the refrigerant storage tank.

The combustion gas turbines will be twin shaft types with a multistage compressor, through flow combustor and axial power turbine. The ISO rating of the gas turbines to meet the required service will be 10,600 Hp.

The refrigerant circulating pump will be a horizontal single stage centrifugal type designed for freon service.

The control system will be electronic and compatible with the station central control system and associated remote terminal units. It will have the capability to accomplish sequential or simultaneous operation of the refrigeration system components.

2.3.3 Gas Turbine Electric Generators

The electric generator package will be supplied complete with the local control panel, air-cooled lube oil cooler, inlet air filter/silencer and waste heat boiler. The generator-turbine will be mounted at grade, and the inlet air filter will be mounted on the side of the building and connected to the turbine with horizontal ductwork. The exhaust duct will run horizontally to the waste heat boiler/silencer unit at the end of the building. This arrangement will allow using the installed crane to handle the ductwork, and to move the generator for maintenance.

The generator will be an 1800 rpm unit with brushless excitation, force fed lubricated sleeve bearings, Class B insulation and solid-state excitation control. A generating voltage of 480 volts in a 2,000 kw unit will be specified to eliminate the need for stepdown transformers.

The speed-decreasing gear will be either a planetary gear unit manufactured by the turbine manufacturer or a separate double-reduction gear unit manufactured by a reputable gear manufacturer. The generator-gear-turbine train will be torsionally analyzed to ensure all components are compatible.

The gas turbine drive will be a single shaft unit of either the aircraft derivative type or a light industrial unit which is designed for modular maintenance. The lubrication system will be mounted in the baseplate and the unit will be complete with electric motor/hydraulic starting, dual fuel, speed governing and control systems.

One waste heat recovery exhaust-silencing system will be supplied for the two generating units. The turbine's exhaust gases will flow through a waste heat boiler and heat a water/glycol mixture which will be pumped through the station for space and fuel gas heating. Provisions will be made to supplementally fire the waste heat boiler with either natural gas or arctic diesel fuel in case there is not enough turbine exhaust gas to meet the load requirements. This will ensure that the station can be adequately heated in the event the gas turbine generators are not operating.

The inlet air filter/silencer will be selected for minimum maintenance in atmospheric conditions comparable to the site conditions. Both newly developed self-cleaning media and inertia filter systems will be considered. A silencer module will be incorporated in the inlet air structure.

The local control panel will provide readouts to include lube oil pressures and temperatures, bearing monitoring devices, temperatures of the turbine gas and the generator windings, and speed, voltage and operating time indicators. Excitation and speed control will be provided to the electrical control panel for frequency synchronizing. Local control panel functions will be electronic and will be compatible with the station central control system and associated remote terminal units.

2.3.4 Liquid-Vapor Separator (Scrubbers)

The separator assembly will be capable of removing 99.9 percent of particles 10 microns or larger from the pipeline gas at flow rates of 1,200 to 2,500 MMSCFD. Design pressure will be 1,320 psig.

Each separator assembly will consist of two vessels with internals and minimum liquid storage capacity of 2,000 gallons. Each vessel will have supports, the necessary nozzles and clips for installing insulation.

2.3.5 Gas Heating System

The pipeline gas heating system will be capable of producing 25 MMBtu/HR by means of a gas-fired heater unit. The heat produced will be absorbed by circulating water/glycol as a heating medium. The medium will enter the fired heater at 70°F and leave at 200°F at a flowrate of 500 gallons per minute. The pipeline gas temperature will be raised by a heat exchanger where the heating medium enters at 200°F and leaves at 70°F. The pipeline gas heating system will consist of a pipeline gas heat exchanger, a gas-fired heater, two full capacity circulating pumps, a water/glycol storage tank, a supply air fan, interconnecting piping, and a control assembly necessary for a complete operable water/glycol heating system. The system will consist of the heater skid, a gas-fired heater skid, and a circulating and storage skid.

The pipeline gas heater will be a tube and shell heat exchanger capable of 25 MMBtu/HR, increasing the pipeline gas temperature from 25°F to 32°F.

The circulating pumps will be centrifugal type with the construction and material suitable for the service and temperature intended. Each pump will be motor driven and capable of flowing 500 GPM of 60 percent ethylene glycol in water solution.

The storage tank will be cylindrical, horizontal, and made of steel with the necessary nozzles. The tank will have a capacity of 2,400 gallons.

A control will maintain a constant supply of water/ glycol at a set temperature by controlling the quantity of exhaust gases or by regulating the firing of gas in the combustion unit. The control assembly will also include safety features necessary for the water/glycol heating system.

2.3.6 Emergency (Black-Start) Generators

Emergency electric power generation equipment will be provided to operate essential equipment. Emergency generator starting and transfer of power will be automatic upon loss of power or failure of auxiliary substation supplying any equipment train, group of equipment trains, or buildings. Emergency power will be 480 V, 3 phase, 60 Hz and will be delivered to that equipment where power interruption would cause major loss, damage or unsafe working or living conditions. Provisions will be made for load testing the generators and their drivers on a scheduled basis.

Transfer equipment will be provided to automatically switch from the normal source of power to the emergency generator in the event that the normal source is interrupted. Manually operated switches will be provided for test purposes in order to test operation of the transfer scheme without affecting normal source of power to the essential loads.

The fuel oil storage tank will be located outside. A fuel oil supply line will run from the gas turbine supply loop to the day tank for each emergency generator. The day tank will be built into and will form the sub-base of the diesel generator unit.

Instrumentation for the emergency generators and their drivers will also be supplied. The control panel for each generator will have an alarm that will interface with the RTU. The local control panel instrumentation will be electronic and will be compatible with the station central control system and the associated remote terminal units.

The emergency generator sets and their supporting auxiliaries will contain design features which assure high quality, ease of maintenance, corrosion resistance, and easy starting. These features will include closely governed speed during progressive generator loadings.

2.3.7 <u>Sewage System</u>

The sewage system will consist of low volume flush toilets, urinals, showers and wash basins which are connected to a 1000 gallons vacuum sewage collection tank. A vacuum of approximately 15 inches of mercury will be maintained in the collection system by one of the two vacuum pumps.

Sewage will be transported from the vacuum sewage collection tank to a rotating strainer by one of two centrifugal pumps. Gross solids will be separated and will drop into a drum or other similar container with a plastic liner. Collected solids will be removed periodically and will be disposed in the solid waste incinerator. A new plastic liner will be placed in the drum.

The filtrate from the strainer will drop into a sump. Sewage flowing through the strainer will be chlorinated in the sump. Mixing will be accomplished by placing air diffusers in the sump. This feature will also inhibit production of obnoxious odors which could be caused by anaerobiosis of the sewage from extended detention time in the sump.

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Filtered, chlorinated, aerated wastewater will be metered with a positive displacement pump, into the exhaust stack of the electric generator turbine. Wastewater will be injected into the stack enclosure through a fog nozzle, or similar device, to ensure the formation of a fine water mist which intimately contacts the hot turbine exhaust gases. Injection will be accomplished under predetermined conditions of exhaust gas temperature and residence time in the stack such that all liquids are entirely vaporized.

2.3.8 Station Pipe

Reference design conditions are 1280 psig maximum allowable operating pressure and a temperature range of 0° - 100°F. The design location is equivalent to Class 1 with an operational hoop stress of 50 percent of the specified minimum yield strength.

Pipe Sizes and Wall Thicknesses

Outside Diameter (inches)	Wall Thickness (inches)
36	0.658
42	0.768

The pipe will fully meet the requirements for Grade 70 of API-5LX or API 5LS, the additional requirements set forth in project specification SP-4680-50-30, and associated purchase documents.

The specification SP-4680-50-30 provides for improved mechanical properties, restricted dimensional tolerances, and fracture toughness levels suitable for the operating conditions. Additional inspection requirements have been imposed to ensure that required quality levels are maintained.

The steel will generally be a low carbon (0.10% maximum), controlled rolled or normalized type with the maximum levels of other alloying established to provide a steel compatible with field welding conditions.

Fracture toughness requirements have been specified based on Charpy V-Notch energy to provide an inherent resistance to fracture initiation at the design conditions. A drop weight tear test minimum shear area requirement at the design temperature has been specified for brittle fracture prevention.

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2.3.9 Station Fittings

The design conditions are 1280 psig maximum allowable operating pressure with a minimum design temperature of 0°F. Fitting ends will be beveled to match the wall thickness of the pipe in which the fittings would be installed.

Butt welding large diameter fittings (26 inches and larger) for gas transportation will be in accordance with the requirements of MSS SP-75 for Class WHPY 65, additional requirements of project specification SP-4680-50-27, and associated purchase documents. Smaller fittings will be manufactured from standard ASTM low temperature materials in accordance with purchase document requirements. The pressure rating of all fittings will be equal to or exceed the pressure rating of the matching Grade 70 pipe.

Steel used for fitting manufacture will be fully killed, fine grain materials that properly respond to heat treatment. The final chemical composition selection will be based on successful completion of the specified weldability tests. The maximum carbon equivalent will be 0.47 based on the equation stated in Paragraph 7.3 of MSS SP-75.

In order to ensure consistent manufacturing quality, stringent heat treatment control, restricted defect repair criteria, and additional nondestructive examination requirements have been specified, in Specification SP-4680-50-27. Also, fracture toughness requirements have been specified based on Charpy V-Notch energy to provide an inherent resistance to fracture initiation at the design conditions.

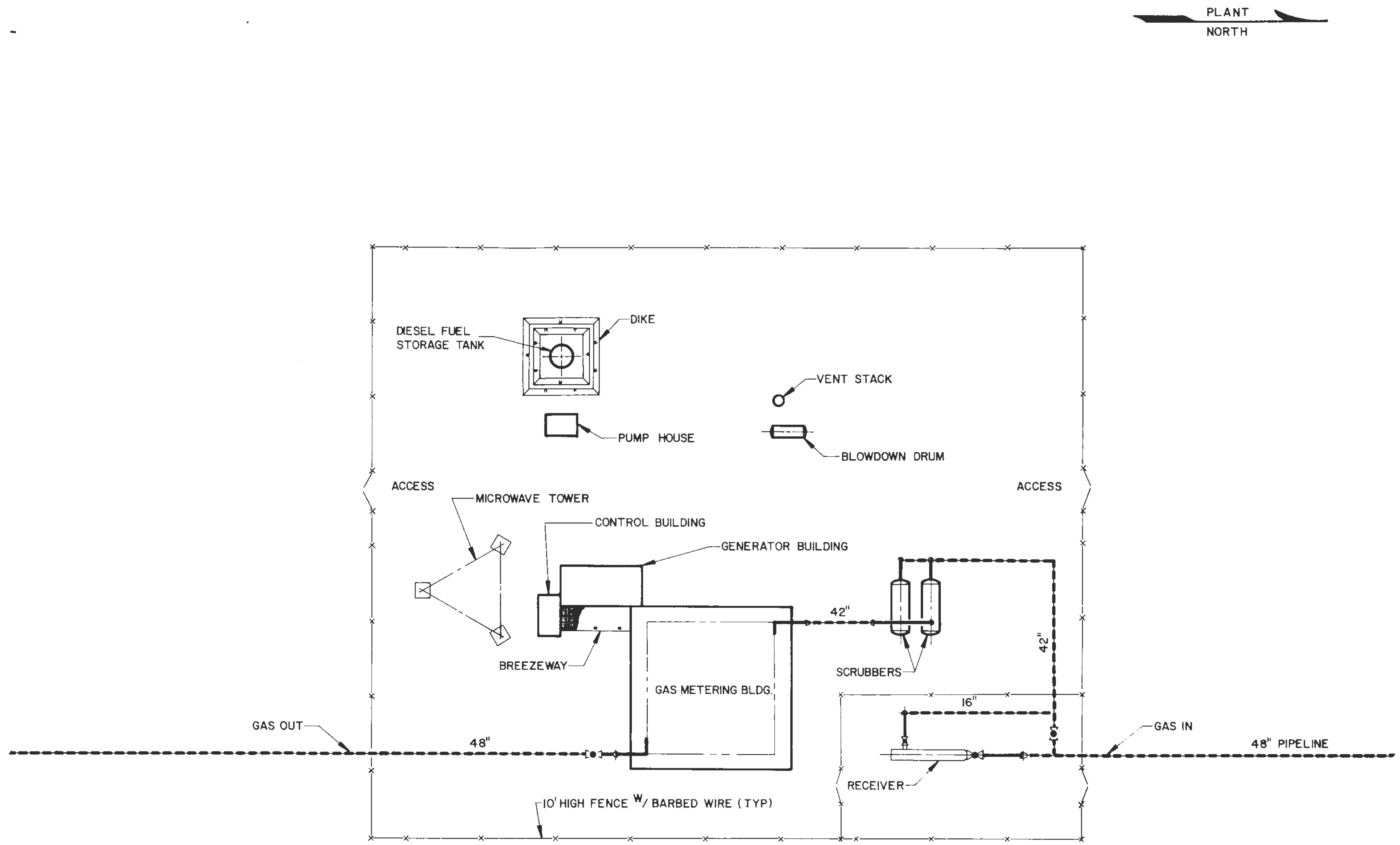
WHY NOT 70,000 TO MATCH PIPE?

2.3.10 Flanges

Flanges will be welding neck or blind type with a 65,000 psi specified minimum yield strength for gas transportation service.

The design conditions are 1280 psig maximum allowable operating pressure with a minimum design temperature of 0°F for below ground and -50°F for above ground applications. Butt welding beveled ends will be bevelled to match the bevel on the pipe in which the flange will be installed.

Large diameter flanges (26 inches and larger) for gas transportation will be in accordance with the requirements of MSS SP-44 Grade F65, additional requirements of project specification SP-4680-50-28, and associated purchase documents.



NOTES	REV NO	DATE	REVISION	DRAWN CHECK	APP	DWG NO	REFERENCE DRAWING
	1	5-80	RELEASED FOR FERC FILING				
						MICROFILM NO	

FLUOR
PROJECT MANAGEMENT CONTRACTOR

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

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GAS METERING STATION
YUKON
OVERALL PLOT PLAN

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

R. PIEHLER	DATE 5-7-80	FLUOR R.R. LANG	DATE 5-7-80
B. WAGLEY		N.W. ALASKAN V. L. Peterson	DATE 5/19/80

SCALE IN FEET	DRAWING NUMBER	REV.
1" = 30'-0"	4680-43-00-0-500	1

FIG. Z-9.2-3-2 FORM E-727 2/80

REDUCED PRINT SCALES

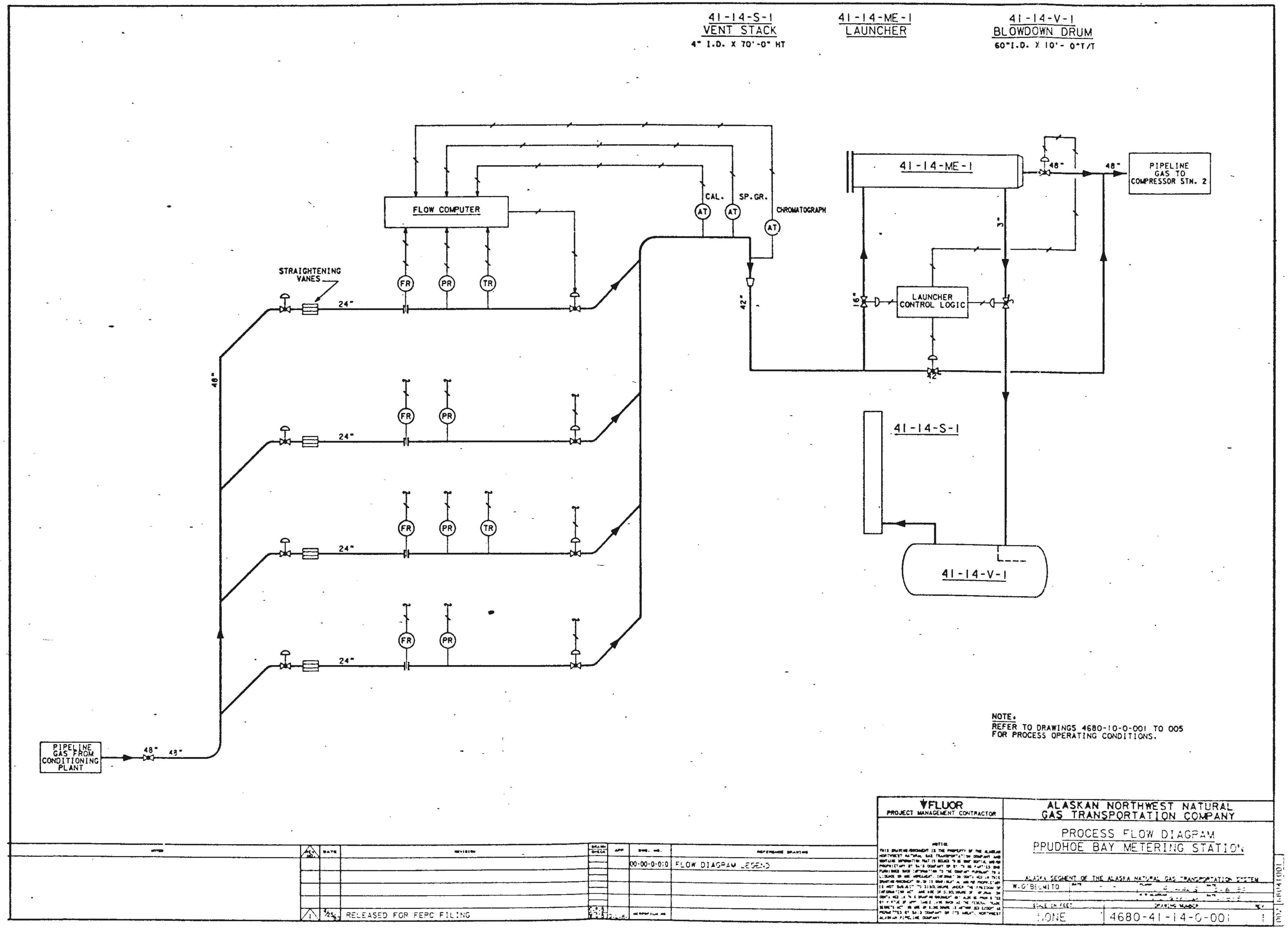


FIGURE Z-9.2-3-3

Docket No. CP80-
Exhibit Z-9.5
Hearing Exhibit No.

2 FPC Res 0

TABLE 1-2

EXISTING CAMPS TO BE RELOCATED

Facilities available at TAPS construction camps for relocation to new sites for the pipeline project:

TAPS Camp	Milepost (Approx.- Alaska Segment)	Miles South of Delta Camp (Approx.- Along TAPS)	Relocated to (Tentative)
Pump Sta. 3	111		Compr. Sta. 2
Pump Sta. 4	150		Compr. Sta. 4
Pump Sta. 5	283		Compr. Sta. 7
Pump Sta. 6	363		Compr. Sta. 9
Pump Sta. 7	422		Compr. Sta. 11
Pump Sta. 9		16	*
Pump Sta. 10		51	Compr. Sta. 13
Isabel Pass		79	Knob Ridge
Tonsina		197	Tok
Pump Sta. 12		201	Compr. Sta. 15
Sheep Creek		247	Northway

*Facilities and equipment to be distributed among the other camps to make-up for shortages and damaged units.

Docket No. CP80-
Exhibit Z-9.5
Hearing Exhibit No.

3.0 UTILITIES AND SERVICES

3.1 POTABLE WATER SUPPLY, TREATMENT AND DISTRIBUTION

Existing equipment and related facilities for withdrawing, treating, storing and distributing potable water at construction camps will be used. Groundwater sources will be tapped at new camps where practical to minimize requirements for elaborate treatment process equipment and to avoid conflicts with fish habitat. Infiltration galleries in streams or rivers and pumping stations in large lakes will be developed where groundwater is unavailable. Intake structures for water withdrawal equipment and extraction rates will be designed to avoid harm to fish.

Raw water transmission piping will be located aboveground on wooden sleepers. Arctic piping, employing solvent-welded PVC pipe, including electrical heat-tracing and a blown urethane insulation outer annulus shrouded by corrugated metal pipe, will be used for the transmission line.

Treatment process equipment requirements will vary according to raw water quality. Existing equipment at pipeline construction camps consists of pressure filters, with sand filter media, and hypochlorinators. Existing physical-chemical package treatment plants, presently located at TAPS pump station construction camps may be relocated for use at the compressor station camps.

Drinking water standards promulgated by the Environmental Protection Agency and Alaska Department of Environmental Conservation will be followed.

Withdrawal rate control, enforcement of water conservation measures in camp, and use of contingent water supplies will be included in the overall water use plan and in the design of water systems to control water usage at camps affected by periods of low supply. Exact treating requirements will be determined after assessment of primary and secondary source water qualities.

3.1.1 Water at Pipeline Construction Camps

Pipeline construction camps will have their water storage tanks located in the heated water treatment building. Table 3-1 is a breakdown of primary potable water supplies at the camps and expected treatment process requirements. The water supply withdrawal equipment will be protected by a structure which is heated and lighted where practical to facilitate maintenance during winter.

Figure Z-9.5-3-1 is a block flow diagram illustrating the water withdrawal, transmission, treatment, storage and distribution system.

Potable water quality will be monitored during use to confirm compliance with Alaskan Drinking Water Standards.

A diesel engine driven fire water booster pump will be provided to take water from the storage tanks and pump it through the distribution system to provide flow requirements as specified by the Alaskan Department of Public Safety, Division of Fire Protection.

3.1.2 Water at Compressor Station Construction Camps

Table 3-2 is a breakdown of the probable primary sources for potable water at the compressor station camps and the expected treatment process requirements.

Figure Z-9.5-3-2 is a schematic of a typical water withdrawal, treatment, storage and distribution system at a compressor station camp.

Water will be withdrawn from the supply with a submersible pump and transmitted through arctic piping overland to the Utility Building. The water supply withdrawal equipment will be protected by a structure which is heated and lighted to facilitate maintenance during winter.

Raw water will be treated and monitored to ensure that Alaskan Drinking Water Standards are met. The treatment process will depend on raw water quality. Existing equipment, physical-chemical treatment plants, are capable of removing or reducing most of the key contaminants which may be encountered. Additional equipment may be required to treat waters which have high concentrations of hardness or iron. Well water will in most cases only require disinfection.

Water storage tanks will be located outside the Utility Building. The tanks will be insulated and protected with a metal sheathing against the effects of precipitation. During winter, an indirect fired boiler system with a hot water loop through each tank will be operated to maintain water above freezing temperature.

Arctic piping construction will be used in the recirculating potable water distribution piping network for freeze protection. The recirculating pumps operate on a demand basis.

Plant throughput will be sized to provide potable water for both camp consumption and onsite construction use. Instrumentation will be provided for both automatic and manual operation of the treatment plant.

3.2 WASTEWATER COLLECTION, TREATMENT, AND DISPOSAL

Per capita volume of wastewater generated in a camp is proportional to the camp population plus a relatively stable flow reflecting camp maintenance and cooking activities, which will not vary much regardless of the population. Past data indicates that average per capita daily flow of sewage will be between 60 gallons (peak camp populations) and 80 gallons (low, maintenance level camp populations).

In most cases, gravity sewers will convey wastewater from the source to a nearby lift station where it will be pumped to the treatment plant. Data from prior pipeline camp operations shows that influent five-day biochemical oxygen demand (BOD) and suspended solids (SS) concentrations in influent wastewater will be on the order of 460 mg/l and 500 mg/l, respectively. Approximately 50 percent of total influent BOD will be soluble (that which passes through a 0.45 micron filter). The high percentage of shower and laundry wastewater, together with short residence times in heat-traced collection lines may result in high influent wastewater temperatures. Despite the use of grease traps in the kitchen, influent wastewater will contain between 100 and 150 mg/l of oil and grease.

The waste water treatment plants at the existing camps are of two types: physical-chemical (P/C) and biological. A simplified block flow diagram for the typical construction camp P/C treatment plant is shown in Figure Z-9.5-3-3. All mechanical equipment will be housed aboveground in a heated building. Rotary screens or comminutors (pulverizers) will precede the aerated equalization tank. The tanks will be sized to contain between 35 percent and 65 percent of the daily hydraulic design capacity of the P/C unit. Coarse bubble aeration will provide complete mixing.

A simplified block flow diagram for a typical construction camp biological treatment plant is shown in Figure Z-9.5-3-4. All mechanical equipment will be housed aboveground in a heated building.

The biological package plant will be preceded by an aerated equalization tank. Incoming sewage will be comminuted or filtered (with a rotostrainer) before it enters the tank.

Sewage from the equalization tank will be pumped to the package plant aeration tank. Here sewage will be aerated and will be mixed with activated biomass for several hours before it will flow into the clarifier. Solids will settle and the clarified effluent will be chlorinated and held for a short time before being pumped to the FCMR.

The concentrated solids or sludge will be removed. The flow of sludge will be split to either recharge the concentration of microorganisms in the aeration tank or will be discharged. Waste sludge will be dewatered and incinerated.

A lined emergency holding pond will be constructed outside the Utility Building to hold untreated sewage or excess sludge in the event of an extended plant outage. The pond will be sized to retain five days flow at the design capacity of the treatment unit. The pond floor will be graded to facilitate collection of sludge.

The flow control management reservoirs (FCMR) at existing pipeline and pump station construction camps were designed to store treated waste water until such time that it could be discharged to surface waters during high flow periods. The reservoirs were sized to accommodate the flow volume anticipated during low surface water flow periods. The FCMR's at the pipeline camps which are to remain in place will be evaluated for reuse on a site specific basis. Reuse will be in accordance with the following criteria:

- FCMR's on sites that are impermeable will be sized to accommodate between 200 and 270 days flow, depending upon location.
- FCMR's on sites of highly permeable soil will be designed as percolation lagoons for direct infiltration into the ground.

At new sites, FCMR's may be constructed as described above or another type of environmentally acceptable direct infiltration method will be utilized.

Although present plans outlined above are to utilize sewage treatment package plants at existing construction camps, studies are being conducted to evaluate alternative methods of both wastewater treatment and disposal.

3.3 SOLID WASTE COLLECTION AND DISPOSAL

Solid waste will be generated by both camp operations and field construction activities. Solid waste which will be generated includes: kitchen garbage, sewage sludge, packing crates, camp construction dunnage, building insulation, and oils and grease. Most of these wastes will be incinerated. Recoverable scrap metal will be collected, segregated, consolidated, and transported to urban collection centers for processing. Nonrecoverable scrap metal and urethane insulation will be landfilled with incinerator residue. Construction dunnage (wood cribbing, packing crates and temporary wooden sleepers) and slash from clearing and grubbing operations may be open burned, provided that permission is obtained from applicable regulatory agencies.

From surveys of incinerators at existing camps it appears that new camp solid waste and sewage sludge incinerators may be required. The selection of sewage sludge incinerators will be based on the selection of the sewage treatment process. The disposal of stabilized sludge on land is also being evaluated.

Innocuous incinerator residue and scrap material accumulations will be transported to a landfill site developed for camp use (expected to be within 25 miles from each camp). Criteria for the siting of solid waste landfill sites will be developed with input from the ADEC, EPA, and land management agencies. Details of sanitary landfill development plans will be prepared after field surveys of potential sites have been made. Both trench and fill area methods of landfilling these wastes are being evaluated.

An area within the camp boundaries will be reserved for disposal of snow cleared during camp operations. Any solid wastes and miscellaneous materials inadvertently scooped up during snow removal operations will be collected from this site and disposed of after the snow has melted.

The following sections describe the solid waste collection, treatment and ultimate disposal processes at construction camps.

3.3.1 Solid Waste at Pipeline Construction Camps

Bins will be placed around the camp at strategic locations to accumulate solid waste. Bins will also be placed at mobile pipeline construction staging areas. Maintenance personnel will transport the solid waste bins to a designated area outside the Utility Building. A routine pickup schedule will be established to maximize incinerator throughput, yet avoid trash buildup.

Two areas outside the Utility Building will be developed for solid waste collection. These areas will receive solid waste that has been segregated at the source. One area will be used to store recoverable and nonrecoverable scrap metals, urethane insulation, and combustible and putrescible materials destined for the camp incinerator. The other subdivided area will be designated for storing and cooling incinerator ash residue.

Incinerators will be operated at construction camps in accordance with Alaskan Air Quality Standards (18 AAC 50). Refer to Figure Z-9.5-3-5 for a flow schematic of the camp solid waste disposal operations. The feasibility of using a multi-purpose incinerator for construction camps will be investigated. Existing pipeline camps are equipped with two types of incinerators. A pathological incinerator is dedicated for sludge combustion. The second incinerator is dedicated to combustion of camp refuse, kitchen garbage, and excess construction dunnage, and has both primary and secondary burners to assure that combustion is maximized and particulate emissions are minimized.

The solid waste incinerator has the capability of loading wastes in the primary chamber automatically. The system includes a storage bin, top-loading ram feed unit, skip hoist, hydraulically-operated stoking grates, and an automatic ash removal system. Both the pathological and solid waste incinerators are operated according to the following criteria:

Waste Generation Rates

Camp refuse and kitchen waste - 10 pounds per capita-day

Sewage sludge solids - 0.75 pound (dry) per capita-day
1.5 gallons (wet) per capita-day

Waste Incineration Rates (Combined)

Camp refuse and kitchen waste - 1500 to 1800 pounds per hour

Sewage sludge - 100 gallons per hour

Ash production rates from incinerator operations and non-recoverable scrap material generation rates averages about two pounds per capita-day.

Innocuous incinerator residue and non-recoverable scrap material accumulations will be transported to the nearest approved landfill.

3.3.2 Solid Waste at Compressor Station Construction Camps

Figure Z-9.5-3-6 is a flow schematic of the camp solid waste collection, treatment, and disposal operations. Solid waste will be stored in conventional garbage containers which will be placed at strategic locations around the camp.

The area outside the Utility Building will be used as a waste collection and segregation center. Debris and dunnage resulting from adjacent permanent facilities construction will be transported to the Utility Building. There, recoverable scrap metal will be consolidated for transport to urban collection centers for further processing. An area outside the Utility Building will be set aside for storing and cooling incinerator ash residue.

The incinerator will operate in the following manner. Combustible solid waste will be loaded manually into the horizontally-fed, hydraulic ram-loaded hopper. The ram feeder will charge the primary chamber of the incinerator when the operator activates a switch. Dewatered sewage sludge, which is atomized by pressurized air, will be admixed in a cylindrical hearth (muffle retort) which will be mounted horizontally, perpendicular to the primary chamber. Secondary combustion of primary chamber and muffle retort exhaust gases will be accomplished with a tangentially-fired afterburner in the stack.

The primary chamber and muffle retort will be stoked periodically. If the sewage sludge flowrate exceeds the combustion rate, sludge will settle on the hearth and will become carburized. Stoking the wet mass will assist its combustion. Innocuous ash and other inert materials will be stored (and ash cooled), then transported to the landfill.

The incinerators at compressor station camps will be operated according to the following criteria:

Waste Generation Rates

Camp refuse and kitchen waste - 7 pounds per capita-day

Sewage sludge solids - 0.75 pound (dry) per capita-day
1.5 gallons (wet) per capita-day

Excess combustible construction dunnage - 3 pounds per capita-day

Waste Incineration Rates

Camp refuse and kitchen waste - 300 pounds per hour

Sewage sludge - 30 gallons per hour

3.4 POWER GENERATION AND DISTRIBUTION

Current plans are to provide independent in-plant power generation at 480 volts, 3 phase, 60 Hertz. Purchased power where available is under consideration. Camp power generation systems will provide continuous electric power supplied by diesel engine-driven generators designed to meet each camp's electrical load. The power generation equipment will be selected on the basis of proven capability under similar applications and on the availability of spare parts and service personnel in Alaska.

Generator units will use low viscosity, winterized diesel oil for fuel. Standby power generators will be provided. Standardization will be considered in final sizing of these generators for interchangeability and common parts considerations. The complete power generation units will be skid-mounted for ease of maintenance.

Generators will usually be housed (banked) in prefabricated metal buildings. Power will be distributed to users within the camp in utilidors or through overhead lines to transformers and service heads at buildings. Camps will have floodlighting mounted on power distribution poles or on camp buildings at intervals throughout the camp to ensure adequate visibility at night.

3.5 FUEL STORAGE AND DISTRIBUTION

Fuel systems at construction camps will be designed to avoid chronic leakage problems which have been experienced in the arctic.

Bulk fuel storage depots will be developed at each camp to handle diesel oil, gasoline, aviation fuel and waste oils from vehicle maintenance activities. The depots will be constructed with gravel and earth enclosure berms around the storage vessels with an impervious liner for secondary containment placed in the bottom and sides of the enclosed area. The volume of the secondary containment will be 100 percent of the largest vessel capacity plus sufficient freeboard to accommodate entrapped precipitation.

Waste oil from vehicle maintenance will be pumped from waste oil sump in the vehicle maintenance area to the waste oil storage tank in the depot. Concrete slabs will be placed at the vehicle maintenance area and around the fuel dispensing equipment to contain accidental oil spills and simplify clean-up operations.

Various methods are being investigated for the disposal of waste oil. Some of the oil can be used to oil down roads, or the waste oil can be transported to the nearest refinery or waste oil plant for processing. Other possible methods will be evaluated during design to determine the most economic and environmentally acceptable plan.

Bulk fuel depots will be located at a safe distance from camp buildings and from water courses. Fuel equipment will be electrically grounded. Bulk fuel depots at pipeline construction camps will be dedicated to construction use. Separate berm enclosures and impervious linings will be provided for fuel storage vessels for camp use.

Present plans are to provide steel-fabricated tanks for fuel storage. Conventional construction using proper fabrication methods will provide trouble free operation. However, further study may result in recommendation of at least partial use of fabric or "bladder" tanks due to availability and capital costs savings. A variance must be obtained from the Alaska Department of Labor, however, before bladder tanks may be used.

Steel tanks will be either shop fabricated or field erected from shop fabricated components. Tanks larger than 20,000 gallons will be designed and field fabricated in accordance with API-650 code. Smaller tanks will be horizontal or drum type, shop fabricated in accordance with ASME Section VIII, Division 1. Tanks and drums will meet the requirements of the 49CFR Part 192 regulations. Tanks will be atmospheric and will be subjected to a hydrotest to check against leakage.

Fuel pumps will have explosion-proof motors and will be housed in an enclosure for protection from the weather.

Methods will be used on this project to assure a safe, reliable design for the camp fuel piping distribution network. Design, construction, operation and monitoring of the system will consider the following guidelines:

- Use of socket-weld steel joints.
- Locate fuel piping so it will be visually and physically accessible, either in utilidors, covered trenches, culverts or on sleepers above grade.
- Hydrotest fuel piping to code level.
- Install metering devices where needed to maintain proper inventory control, using in-line flow meters on piping and using gauges to check tank capacity.
- Employ flex connectors where required for accommodating thermal expansion/contraction or where frost heaving or differential settling is expected.
- Install in-line filters and heaters to reduce paraffin buildup in diesel fuel lines during winter.
- Implement frequent periodic documented inspection of fuel piping networks.

These and other similar measures will be prescribed in a document entitled Criteria for Fuel Storage and Distribution Systems.

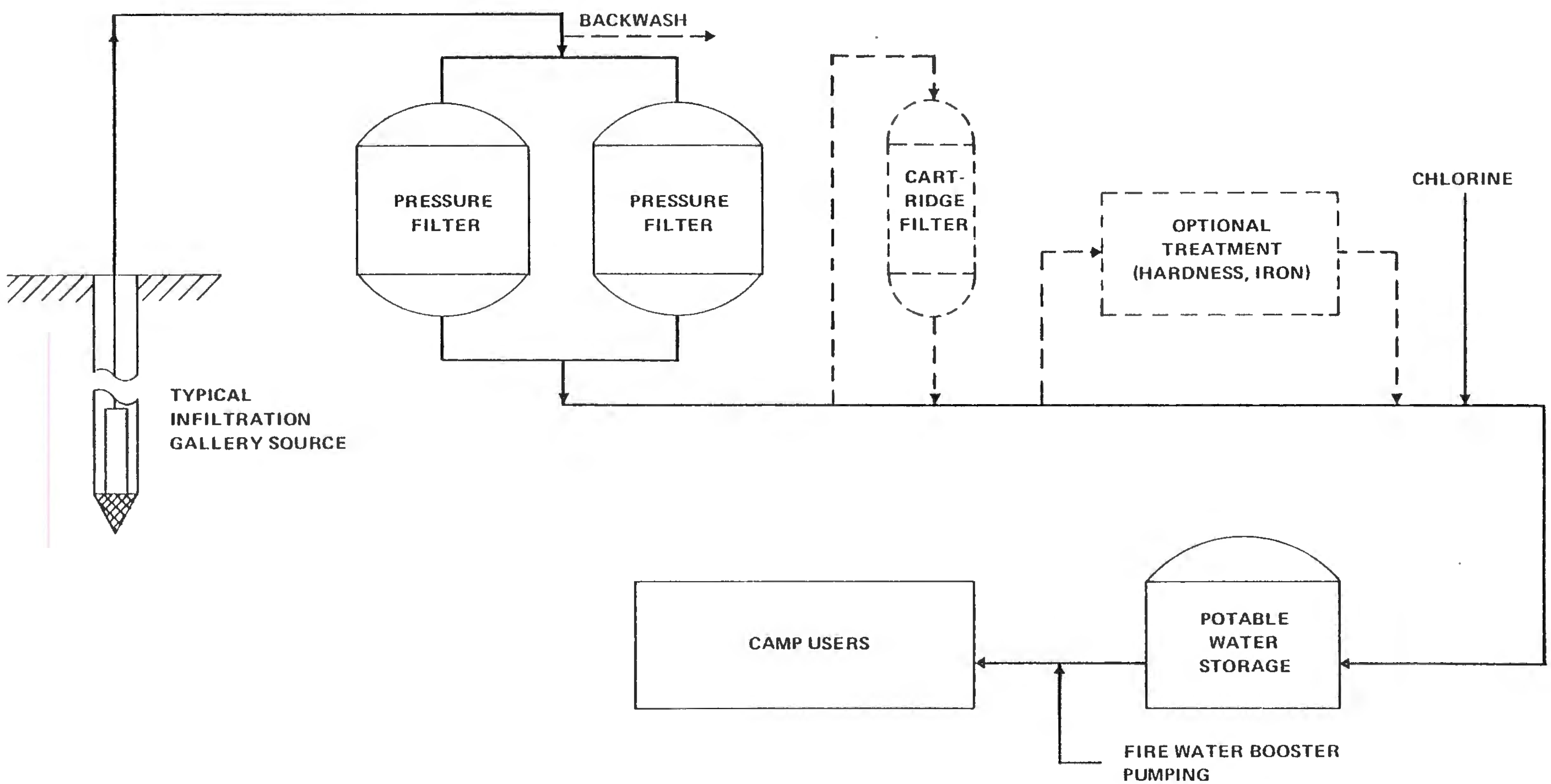
In addition, camp personnel will be required to conduct fueling activities in accordance with the terms of a Petroleum-Handling Procedures Manual, and must adhere to an Oil Spill Contingency Plan encompassing both construction and operation. This plan will, in turn, contain a detailed Spill Prevention, Control, and Countermeasures (SPCC) plan for each fuel storage area. The latter will prescribe oil spill contingency materials to be provided at camps to facilitate containment and cleanup of oil spills, and the means of deployment.

A key element of the contingency plan will be the organizational network for spill response, responsibilities for implementing oil spill control and countermeasure procedures, and key positions in each spread organization. If backup assistance by "on-call" outside spill response specialists is required, their interactions within the organizational network will also be defined.

To enact the program outlined herein at the existing construction camps, essentially all new fuel system construction will be required. Existing exposed piping in utilidors in the housing units will be surveyed for condition. Screw-thread joints will be replaced with socket-weld joints. Piping will be tested and existing steel tanks will be surveyed for reuse and tested for acceptance.

3.0 FAT

POTABLE WATER SUPPLY, TREATMENT, STORAGE AND DISTRIBUTION SYSTEM – PIPELINE CONSTRUCTION CAMPS



NOTE: TREATMENT & STORAGE FACILITIES ARE IN HEATED BUILDING

FIGURE Z-9.5-3-1

MAY, 1980

POTABLE WATER SUPPLY, TREATMENT, STORAGE, AND DISTRIBUTION SYSTEM – COMPRESSOR STATION CONSTRUCTION CAMPS – FULL CAPABILITY OPERATION

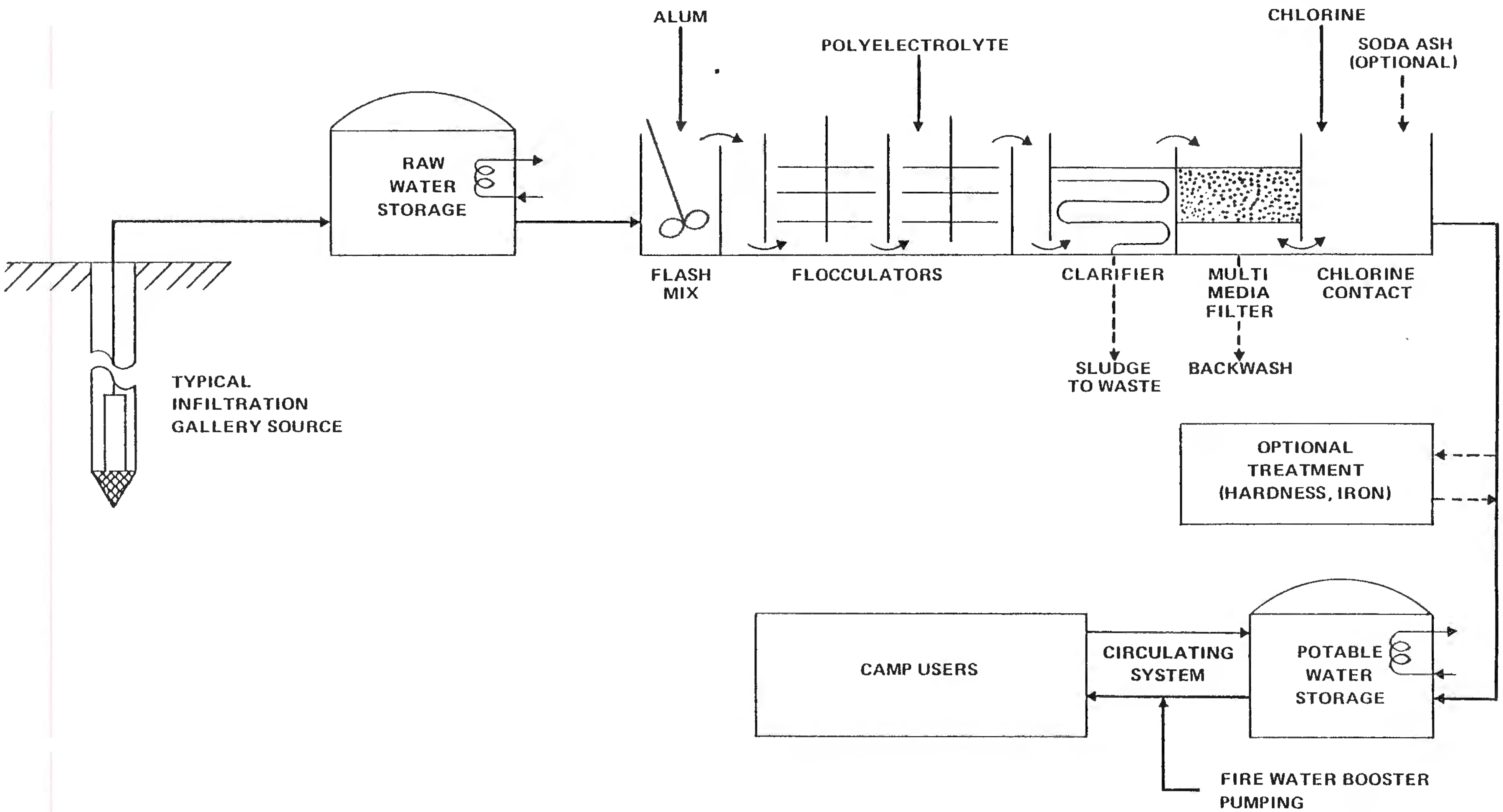


FIGURE Z-9.5-3-2

MAY, 1980

SIMPLIFIED FLOW DIAGRAM –
TYPICAL PHYSICAL-CHEMICAL TREATMENT PLANT

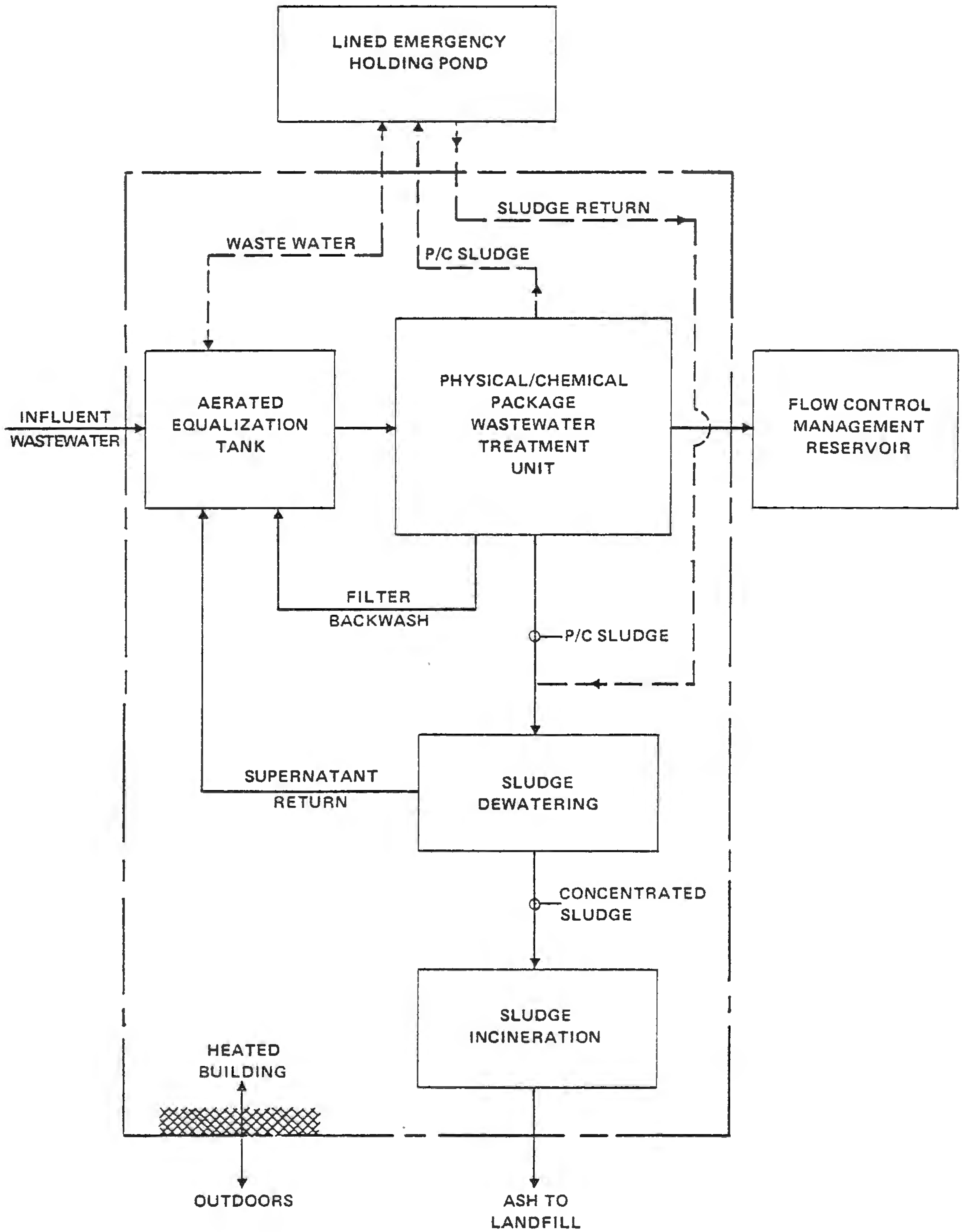


FIGURE Z-9.5-3-3

MAY, 1980

SIMPLIFIED FLOW DIAGRAM – TYPICAL BIOLOGICAL TREATMENT PLANT

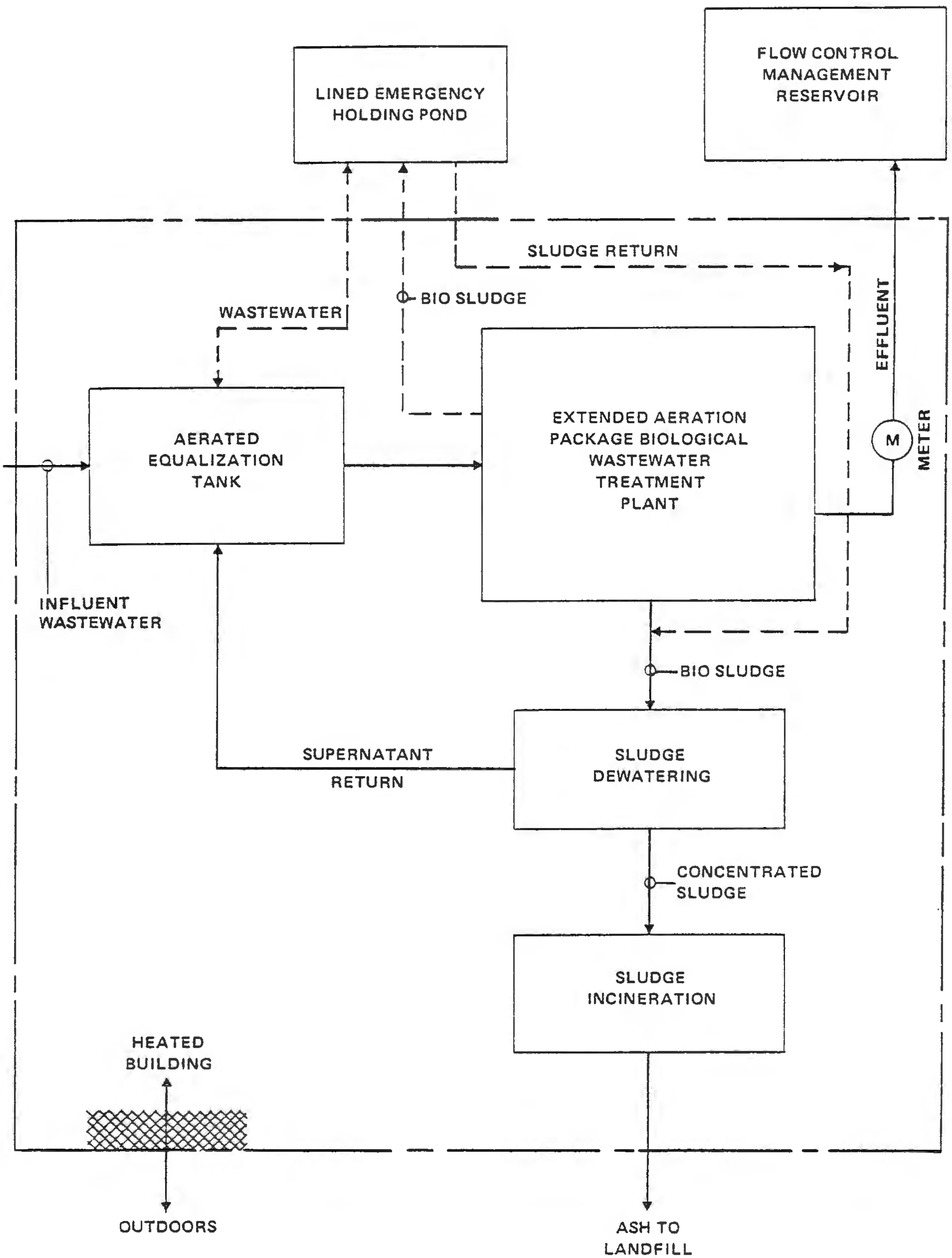


FIGURE Z-9.5-3-4

MAY, 1980

SOLID WASTE COLLECTION, PROCESSING, AND ULTIMATE DISPOSAL – PIPELINE CONSTRUCTION CAMPS

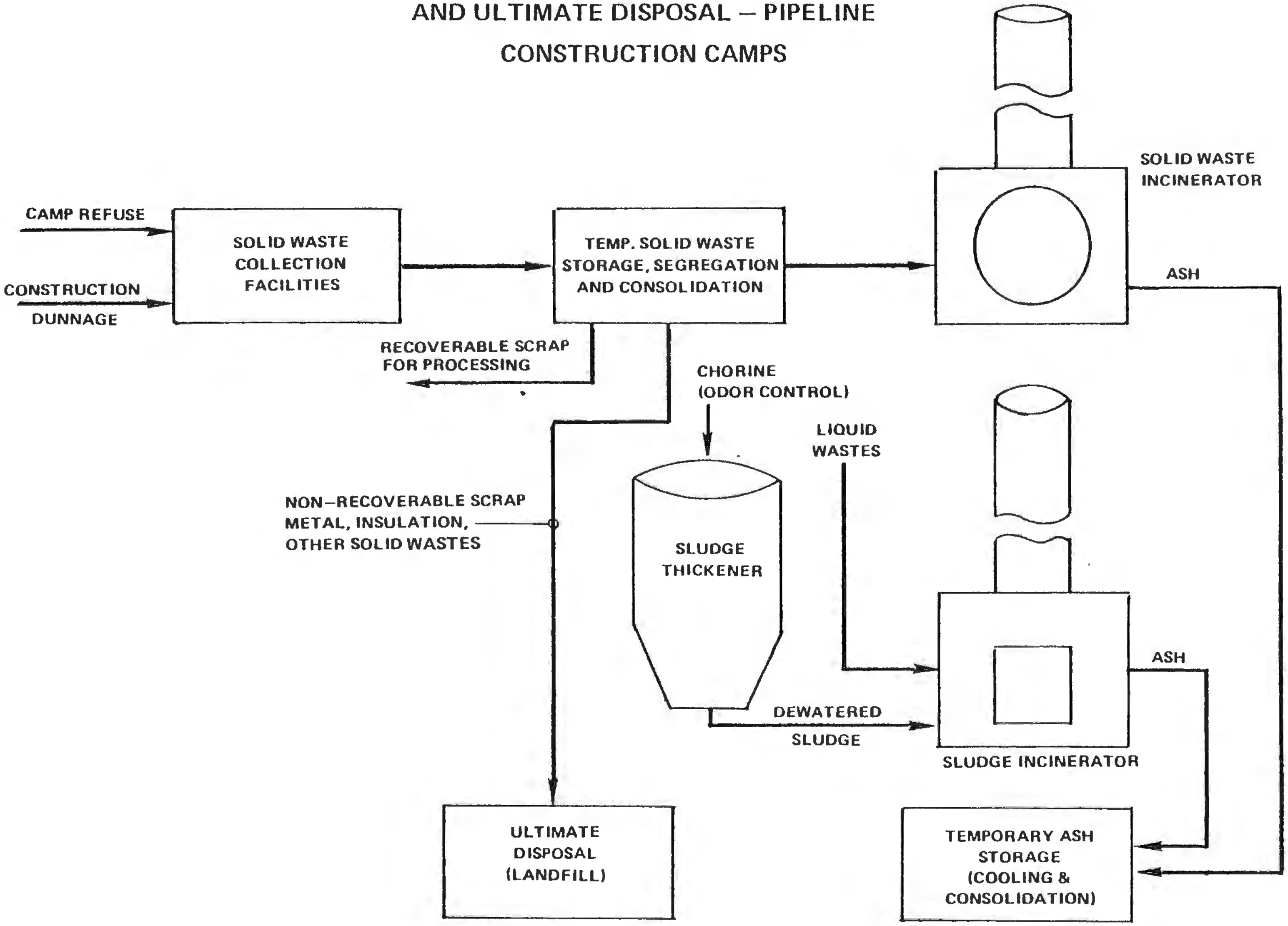


FIGURE Z-9.5-3-5

SOLID WASTE COLLECTION, PROCESSING, AND ULTIMATE DISPOSAL – COMPRESSOR STATION CONSTRUCTION CAMPS

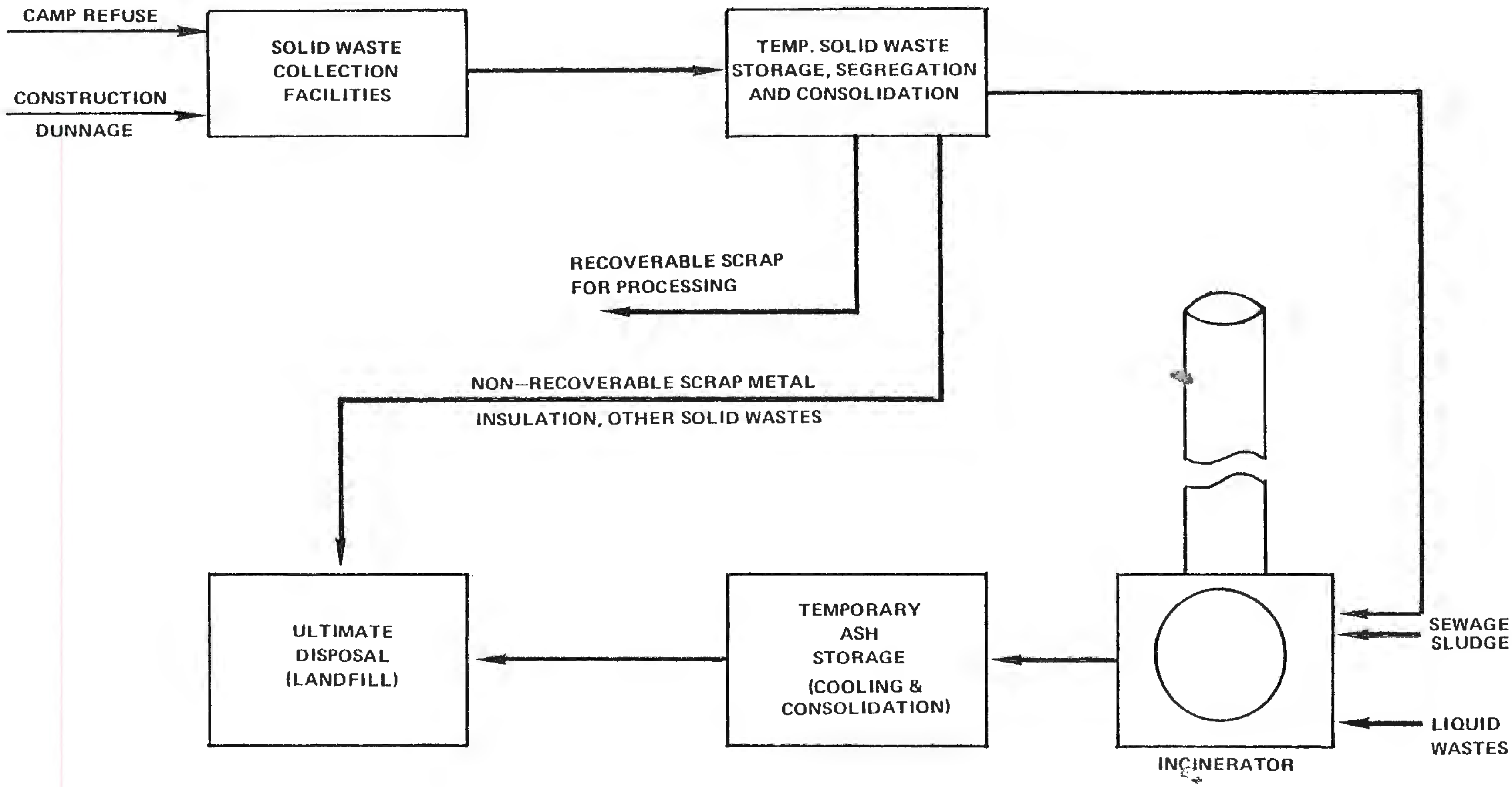


FIGURE Z-9.5-3-6

Table 3-1

PIPELINE CONSTRUCTION CAMP WATER SUPPLIES AND PROJECTED TREATMENT REQUIREMENTS

	PRINCIPAL WATER SUPPLY	
CAMP LOCATION	SOURCE	TREATMENT REQUIREMENTS
Franklin Bluffs	Sagavanirktok R. (I.G.)*	Filtration; Disinfection
Happy Valley	Sagavanirktok R. (I.G.)	Filtration; Disinfection
Toolik	Murphy Lake (P.S.)	Filtration; Disinfection
Galbraith	Camp Creek (I.G.)	Filtration; Disinfection
Atigun	Atigun R. (I.G.)	Filtration; Disinfection
Chandalar	Dietrich R. (P.S.)	Filtration; Disinfection
Dietrich	Dietrich R. (I.G.)	Filtration; Disinfection
Coldfoot	Slate Creek (I.G.)	Filtration; Disinfection
Prospect Creek	Jim R. (I.G.)	Filtration; Disinfection
Old Man	Kanuti R. (I.G.)	Filtration; Disinfection
Five Mile	Well	Disinfection
Livengood	Well	Disinfection
Delta	Well	Disinfection
Knob Ridge	Well (tentative)	Disinfection

Table 3-1 (Continued)

CAMP LOCATION	SOURCE	TEMPORARY REQUIREMENTS
Tok	Well (tentative)	Disinfection
Northway	Well (tentative)	Disinfection

*I.G. - Infiltration Galleries
P.S. - Water Pumping Station

Table 3-2

TENTATIVE COMPRESSOR STATION CONSTRUCTION
CAMP WATER SUPPLIES AND TREATMENT REQUIREMENTS

	PRINCIPAL WATER SUPPLY	
CAMP LOCATION	SOURCE	TREATMENT REQUIREMENTS
C.S. 2	Sagavanirktok R. (I.G.)*	Filtration; Disinfection
C.S. 4	Ginger Lake (P.S.)	Filtration; Disinfection
C.S. 7	Well	Disinfection
C.S. 9	Well	Disinfection
C.S. 11	Well	Disinfection
C.S. 13	Well	Disinfection
C.S. 15	Well	Disinfection

*I.G. - Infiltration Galleries
P.S. - Water Pumping Station

4.0 DEMOBILIZATION AND SITE RESTORATION

4.1 DEMOBILIZATION OF CAMPS

It is currently planned that the temporary construction camp facilities will be removed and their sites rehabilitated at the end of their useful life. All salvageable buildings, equipment, and materials will be disassembled and transported to the most convenient urban center to be sold. Typically, items to be salvaged are:

- Housing modules
- Prefabricated shops, warehouses, and utility buildings
- Power generation equipment
- Water supply and treatment equipment
- Sewage treatment equipment
- Solid waste incinerators and associated equipment
- Fuel storage tanks and dispensing equipment
- Distribution pumps and equipment
- Fencing material
- Kitchen appliances and equipment
- Furniture and recreation equipment
- Laundry equipment
- Laboratory and first aid equipment
- Recoverable scrap metal

Unsalvageable and undesireable manmade material and debris will be removed and transported to acceptable disposal sites.

4.2 RESTORATION OF SITES

Areas which have been graded, filled, or otherwise disturbed during development of the temporary facilities or in the course of the construction of the permanent facilities will be restored to satisfactory conditions at the end of their usefulness. Such restoration efforts will leave the affected area physically stable and minimally change the topography or drainage patterns until native vegetation reclaims the disturbed area. Restoration measures will include:

- Grading of areas to a stable geometry
- Installation of permanent erosion control structures
- Reestablishment of natural drainage patterns
- Redistribution of stripped material
- Revegetation of disturbed areas
- Reestablishment of native plant species
- Treatment of areas designated as being critically visual

Revegetation will consist of both temporary and permanent measures. Temporary revegetation will consist of measures controlling erosion or siltation during construction of the permanent facilities. Permanent revegetation measures will be specified for slope stabilization and restoration. Permanent revegetative measures will be implemented in order to minimize erosion and visual impact and to enhance the reestablishment of native vegetation. Revegetation measures will include the following:

- Surface preparation of areas to be revegetated, leaving soil in a rough and friable condition.
- Fertilizer will be applied at suitable rates contingent on soil type and condition. Fertilizer mixes will be designed to add the required nutrients to the soil to promote hardy stand establishment.
- Temporary seeding will be used when the surface will be disturbed in the future. Fast establishing grasses will be used for temporary seeding.

- Permanent seeding will be used for final revegetation. Selected permanent seed mixes may consist of perennial grasses chosen for their similarity to native grasses and suitability to the climate.

- Surface protection will be applied, where needed, to retain moisture, dissipate raindrop energy, and hold the seed in place.