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31.0 COMPRESSOR STATIONS

31.1 INTRODUCTION

This section describes and discusses the design of the compressor stations that will be installed in the Alaska Segment of the Alaska Natural Gas Transportation System (ANGTS).

The number of compressor stations, configurations and locations are based on the hydraulic design criteria and adjustments for compatibility with surrounding land use and sensitive environmental areas.

To provide the initial capacity for the Alaska Segment of the ANGTS, compressor stations will be constructed at the same time as the pipeline. An example of a typical compressor station layout if shown in Figure 31-1.

31.2 CODES AND CRITERIA

31.2.1 Codes

- United States Code, Title 15 – Commerce and Trade, Chapter 15C – Alaska Natural Gas Transportation Act
- United States Code, Title 16 – Conservation (Fish and Wildlife Coordination Act of 1934, as amended)
- United States Code, Title 42 – Public Health and Welfare, Chapter 15B – Air Pollution Control (Clean Air Act)
- Code of Federal Regulations, Title 18 – Conservation of Power and Water Resources
- Code of Federal Regulations, Title 33 – Navigation and Navigable Waters
- Code of Federal Regulations, Title 40 – Protection of the Environment
- Code of Federal Regulations, Title 43 – Public Lands: Interior
- Code of Federal Regulations, Title 49 - Transportation of Natural and Other Gas by Pipeline
- Code of Federal Regulations, Title 50 – Wildlife and Fisheries
- Federal Energy Regulatory Commission conditional certificate of public convenience and necessity, issued on December 16, 1977, as such is finalized
- Federal Right-of-Way Grant for the Alaska Natural Gas Transportation System Alaska Segment Serial No. F-24538 (December 1, 1980), as such may be updated and/or amended from time to time.
- Alaska Statutes, Title 16 – Fish and Game
- Alaska Statutes, Title 38 – Public Lands

- Alaska Statutes, Title 46 – Water, Air, Energy and Environmental Conservation
- Alaska Administrative Code, Title 5 – Fish and Game
- Alaska Administrative Code, Title 6 – Alaska Coastal Management Program
- Alaska Administrative Code, Title 11 – Natural Resources
- Alaska Administrative Code, Title 18 – Environmental Conservation

31.2.2 Criteria

Compressor station location and design will be based on the following criteria:

- Minimal impacts on TAPS, adjacent or nearby facilities and minimal interference with routine operations of TAPS and/or private or public facilities within the immediate area.
- Reduce, minimize and/or eliminate visual impacts resulting from compressor station construction.
- Provide site-specific design in areas with soils of high thermal or hydraulic erosion potential if the area cannot be avoided.
- Minimize impacts to wetlands.
- Minimize impacts to fish habitat, especially key areas such as spawning and overwintering.
- Minimize impacts to areas of riparian vegetation.
- Avoid all known archaeological sites.
- Minimize impacts to sensitive wildlife areas.
- Maintain terrain stability and provide erosion control measures.
- Provide minimum surface area disturbance by limiting the extent of construction to the minimum dimensions required for safe and efficient conduct of the work.
- Minimize emission of air pollutants to the extent practicable.
- Minimize noise impacts to the extent practicable.

31.3 SITE SELECTION

Selection of a specific compressor site will consider local topography, geography, geology, environmental sensitivity, and compressor station configuration. Each site will minimize earthwork cut and fill and be located within easy access of major or public roadways where possible. Site specific setbacks from public roadways will be investigated during the detailed engineering phase of design.

Compressor stations may vary in size, depending on compression and refrigeration requirements. A typical station will require an area of approximately 25 acres adjacent to or close to the pipeline right-of-way (ROW). Chain link perimeter fencing will enclose the site to prevent wildlife from entering and for security purposes.

Compressor stations will be located above river flood zones on rock or thaw-stable gravel wherever possible. Foundations located on permafrost soils may require supplemental active or passive refrigeration.

31.3.1 Access Roads

Station access roads will tie into the public road system or other established roads where possible. Entrance to a typical compressor station site will be provided by one large gate in the perimeter fencing. The site will have other smaller personnel-gates as emergency exits.

31.3.2 Environmental Issues

Environmental considerations related to compressor station site selection consider biological and physical factors. A number of biological, physical, and civil field investigation programs were previously conducted to gather environmental data that is being incorporated into the design process. Additional biological, physical, and civil field investigation will be conducted as necessary to collect the data required for the design process.

The avoidance or reduction of impacts to endangered species habitat is of primary importance. The migration ranges, migration routes, and seasonal use areas of mammals, water birds, and raptors are being considered based on available biological data. Data from other previously completed and available biological investigations will be verified and incorporated into the design process.

31.4 STATION STRUCTURES AND PIPING

31.4.1 Design Analysis

Design loading criteria for station structures, piping and pressure vessels will be established. The final design will consider the following types of loading as applicable:

- dead
- live
- snow
- wind pressure
- seismic activity
- maintenance
- hydrotest
- vibration
- thermal
- operating
- transport
- vehicle equipment
- pressure(internal & external)
- erection

The impacts of compressor stations on air quality will be determined utilizing computer modeling techniques to estimate the atmospheric dispersion of equipment emissions. These results are used to develop designs that are in accordance with the National Ambient Air Quality Standards for the contaminants emitted.

The gas turbine drivers for the main gas compressor and propane refrigeration compressors will utilize dry low emission (DLE) combustion technology to reduce NOx and CO emissions.

31.4.2 Site Preparation

Preparation of the station sites will include:

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

Corrugated galvanized metal pipe will be used for under-drains, trench drains, and culverts. Culverts will be insulated in permafrost areas.

31.4.3 Foundation Design

Foundations will be designed to prevent thawing where permafrost is present.

As required, sites will be protected from permafrost degradation by using 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. Some buildings may be elevated above a gravel pad on steel pile foundations incorporating an insulated floor. This allows ambient air to circulate in the air space between the bottom of the structure and the ground surface, which will prevent heat from transferring 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. Buildings and equipment will be supported on ad-freeze piles, steel piles or insulated gravel pads. Properly designed foundation systems in the permafrost will prevent "frost jacking" and settlement of the structures. Foundation systems will incorporate passive or active refrigeration where necessary to prevent thawing the permafrost.

31.4.4 Buildings

The buildings will provide a heated, efficient working environment for personnel and equipment. The extreme climatic conditions at the various sites and the short building season are important design considerations. The use of pre-engineered and prefabricated modular buildings will be maximized. With the exception of the compressor buildings and the warehouse building, all other buildings will likely be shop erected on steel skids and shipped to the site as modules. The gas compressor building and propane compressor buildings may be stick-built on concrete foundations as the height and width of the buildings exceeds the module shipping limitations.

All buildings will have thermal insulation of at least R20.

31.4.5 Emergency Quarters

Although the facilities will be designed for unmanned operation, there will be occasions when operating and maintenance personnel will be on site.

Facilities will be provided for the overnight accommodation of a small number of personnel. The facilities will provide a sleeping area and basic living accommodations. In the event of failure of the main station gas turbine generator, a small diesel generator will provide emergency power.

31.4.6 Potable Water

Depending on the station location, water will be provided from a well or will be delivered by a tank truck to a storage tank. Well water will be pumped through a media filter to a holding tank for on-demand distribution.

31.4.7 Piping

Piping that is located within a building will be routed to accommodate equipment operation, piping support requirements and operations and maintenance access. The distribution systems will be grouped on common pipe supports. Much of the large diameter high-pressure gas piping outside of the buildings will be buried and insulated. All underground piping will be coated with a suitable coating. Acoustic lagging will be applied to any aboveground high-pressure gas piping outside of the buildings.

31.4.8 Wastewater System

The proposed wastewater system will consist of low-volume flush toilets, urinals, showers, and wash basins. Wastewater will be collected in a wastewater storage tank fitted with level indication. Wastewater will be hauled to the nearest wastewater treatment facility.

31.5 COMPRESSION STATION EQUIPMENT

31.5.1 Compressors

Compression will be provided by 35,000 to 45,000 hp (ISO) dry low emission (DLE) gas turbine-powered, single-stage centrifugal compressors with dry gas seals. An acoustical enclosure will be provided over the gas turbine assembly for noise and fire control. The enclosure will be ventilated with fans for cooling and to ensure that any gas leakage will be quickly vented before a combustible mixture develops. An automatic fire suppression system will be provided for extinguishing any fires.

A unit control panel will be supplied with each turbine compressor unit.

31.5.2 Refrigeration

The compressor discharge gas is cooled in propane refrigeration trains. The gas leaving the compressor is split into multiple chiller trains. The gas is chilled in kettle-type heat exchangers. The gas is on the tube side while propane is boiling on the shell side. The refrigeration cycle is based on a two-stage system with the second stage acting as an economizer flash drum. This provides increased propane refrigeration efficiency.

The control system is essentially based on level and pressure controllers. The liquid propane flow from the accumulator to the economizer flash drum and then to the chiller is based on forward level control. The pressure controllers are installed on the propane condenser and in the economizer flash drum vapor line to the propane compressor.

The propane compressor operation is controlled by temperature control on the chilled gas exiting the chiller.

Propane makeup will be provided from 2 on-site storage bullets.

31.5.3 Electric Generators

The power supply for the compressor stations will be obtained from natural gas fired gas turbine generators (GTG) with rated output of approximately 2MW each. In the event that one of the two GTG units fails or during maintenance, the other GTG unit will be able to carry the full load of the compressor station.

In the case that both GTG units shut down, two standby diesel-generator sets rated at approximately 100 kW each will supply power to the living quarters as well as to the GTG unit's lube oil heating and pre-lube systems.

31.5.4 Inlet scrubber

An inlet scrubber will be designed to remove entrained liquids through a blowdown connection to a cyclone separator that separates the liquids from any remaining gas.

31.5.5 Space Heating

Space heating for buildings will be electric element (baseboard and elevated fan and radiant) or a circulating heating medium such as a glycol solution. The method of space heating selected will be established during the detailed design.

31.6 STATION SUPPORT SYSTEMS

31.6.1 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 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. There will be manually operated switches to test the operation of the transfer scheme without affecting the normal source of power to the essential loads.

The local control panel and instrumentation will be compatible with the station central control system and the associated remote terminal units.

31.6.2 Control

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. A local programmable logic controller (PLC) based station control panel (SCP) controls the compressor station. The SCP will be capable of monitoring and controlling all the critical station functions and accepting control set points from the Supervisory Control and Data Acquisition System (SCADA) when the station is in "remote" mode or from the station human-machine interface (HMI) when the station is in "local" mode.

The station PLC will also be used to provide safety shutdown functions for the compressor station.

31.6.3 Emergency Shutdown System (ESD)

An ESD will be provided at each compressor station to safely isolate, depressure and bypass station piping and shut down major equipment. An uninterruptable power supply (UPS) will be provided for the ESD system to keep the system operable during primary power outages.

31.6.4 Blowdown and Flare System

Each compressor station will be provided with a blowdown and flare system for emergency and routine venting of station piping and flaring of propane. The flare system will receive hydrocarbon vapors from vents and relief valves

31.6.5 Fuel Gas Conditioning, Metering and Regulation

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

A fuel gas supply system regulates the pressure, temperature and flow of clean, dry fuel gas to the gas generator. The fuel gas supply system will typically be comprised of a filter, fuel gas heater, flow meter, regulators isolation valves, vent valve, and gas chromatograph.

31.6.6 Fire and Gas Detection System

Fire and gas detectors will be located within station buildings containing natural gas piping and equipment. The number of sensors and their locations will be in accordance with applicable codes and standards.

The gas detectors will operate when subjected to abnormal flammable gas concentrations and will utilize diffusion sampling or continuous sample draw principles.

The fire detectors will be ultraviolet, infrared, or thermal type sensors capable of detecting incipient fire conditions. An uninteruptable power supply (UPS) will be provided to power the system during a main power outage.

31.6.7 Fire Protection

An Inergen or equivalent extinguishing system will provide fire protection in the gas turbine enclosures. Each of the fire protection systems will be designed to provide a concentration of fire suppressant to the affected area. Within seconds after actuation, the discharging system will flood the affected area.

The fire protection system will include automatic controls to shut down the turbine enclosure ventilation fans, close the supply and the return dampers in the ducts, initiate warning alarms, and initiate preset time delays prior to the discharge of fire suppressant. Manual discharge controls will also be provided in or near each protected zone. Annunciation will be provided at entrances to areas where the fire suppressant has been discharged.

31.6.8 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 the latest edition of standards and codes.

Each station will have its own power generation and distribution system. Starting emergency power for the GTG units will be supplied by a (black-start) generator.

31.6.9 Communications

Station gas compressor unit and refrigeration system controls utilize PLC’s operating with a centralized SCADA system. Station information and operational displays are shown on local desktop PCs utilizing interactive HMI software that is continuously polling data from the station, unit, and chiller control PLCs. All necessary station control information from gas compressor and chiller units is collected in the station PLC via a remote I/0 link and sent to a remote telemetry unit (RTU) that manages bi-directional communication with the SCADA system.

Each compressor station has its own local area network (LAN) comprised of an Ethernet logical topology with TCP/IP protocol and 10BaseT hardware connected via a hub. This equipment includes:

- Station Control PLC (SCP)
- Station HMI

- Turbine Unit Control PLC (UCP)
- Unit HMI
- Multiple Chiller Unit PLC's
- Gas Turbine Generator Unit PLC's

The compressor station is designed for remote unattended independent operation with critical parameters continuously monitored. SCADA communication is achieved via a satellite link.

If difficulties occur with SCADA communications, compressor station and turbine units can also be operated locally. Any new set points will be updated in the SCADA system and on the station HMI.

31.7 LIST OF FIGURES

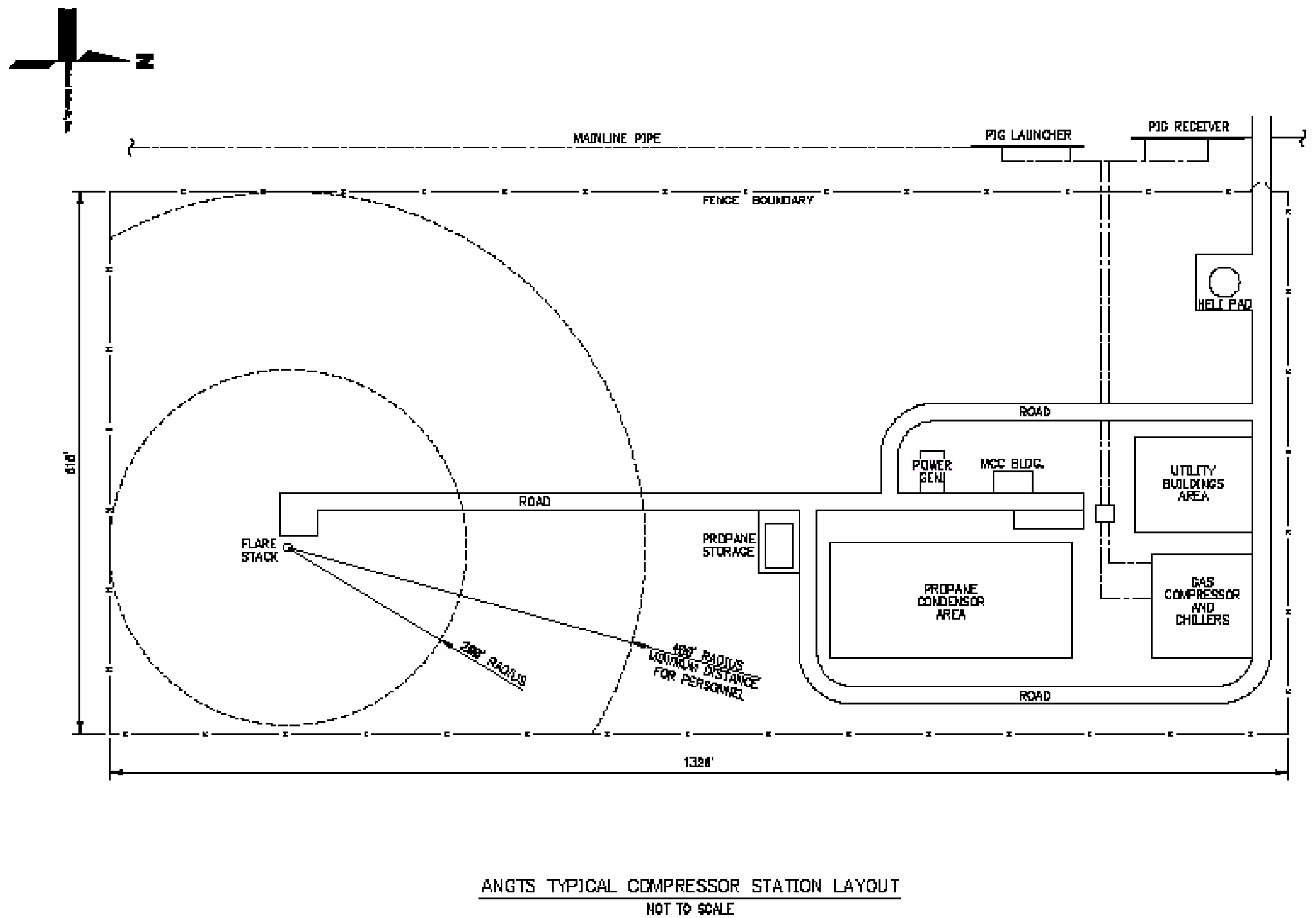

Figure 31-1 ANGTS Typical Compressor Station Layout