# DOCKET NO. CP17-___-000

# RESOURCE REPORT NO. 13

## ENGINEERING AND DESIGN MATERIAL

## (GAS TREATMENT PLANT)

## PUBLIC

DOCUMENT NUMBER: USAI-PE-SRREG-00-000013-000-A

| RESOURCE REPORT NO. 13 – ENGINEERING AND DESIGN MATERIAL<br>SUMMARY OF FILING INFORMATION[1] | |
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| **Minimum Filing Requirements** | **Found in Section** |
| 1. Provide all the listed detailed engineering materials. (18 CFR § 380.12(o)) | |
| 2. Provide a detailed plot plan showing the location of all major components to be installed, including compression, pretreatment, liquefaction, storage, transfer piping, vaporization, truck loading/unloading, vent stacks, pumps, and auxiliary or appurtenant service facilities. (§ 380.12(O)(1)) | Appendix E.5 |
| 3. Provide a detailed layout of the fire protection system showing the location of fire water pumps, piping, hydrants, hose reels, dry chemical systems, high expansion foam systems, and auxiliary or appurtenant service facilities. (§ 380.12(O)(2)) | Appendix S.1, |
| 4. Provide a layout of the hazard detection system showing the location of combustible-gas detectors, fire detectors, heat detectors, smoke or combustion product detectors, and low temperature detectors. Identify those detectors that activate automatic shutdowns and the equipment that would shut down. Include all safety provisions incorporated in the plant design, including automatic and manually activated emergency shutdown systems. (§ 380.12(O)(3)) | Appendix S.6 |
| 5. Provide a detailed layout of the spill containment system showing the location of impoundments, sumps, subdikes, channels, and water removal systems. (§ 380.12(O)(4)) | Appendix S.3 |
| 6. Provide manufacturer's specifications, drawings, and literature on the fail-safe shut-off valve for each loading area at a marine terminal (if applicable). (§ 380.12(O)(5)) | Appendix Q.5 |
| 7. Provide a detailed layout of the fuel gas system showing all taps with process components. (§ 380.12(O)(6)) | Appendix E.5 |
| 8. Provide copies of company, engineering firm, or consultant studies of a conceptual nature that show the engineering planning or design approach to the construction of new facilities or plants. (§ 380.12(O)(7)) | Appendix T |
| 9. Provide engineering information on major process components related to the first six items above, which include (as applicable) function, capacity, type, manufacturer, drive system (horsepower, voltage), operating pressure, and temperature. (§ 380.12(O)(8)) | Appendix E, Appendix M |
| 10. Provide manuals and construction drawings for LNG storage tank(s). (§ 380.12(O)(9)) | Not Applicable |
| 11. Provide up-to-date piping and instrumentation diagrams. Include a description of the instrumentation and control philosophy, type of instrumentation (pneumatic, electronic), use of computer technology, and control room display and operation. Also, provide an overall schematic diagram of the entire process flow system, including maps, materials, and energy balances. (§ 380.12(O)(10)) | Appendix E.5 |
| 12. Provide engineering information on the plant's electrical power generation system, distribution system, emergency power system, uninterruptible power system, and battery backup system. (§ 380.12(O)(11)) | Appendix N |
| 13. Identify all codes and standards under which the plant (and marine terminal, if applicable) will be designed, and any special considerations or safety provisions that were applied to the design of plant components. (§ 380.12(O)(12)) | Appendix D |
| 14. Provide a list of all permits or approvals from local, state, Federal, or Native American groups or Indian agencies required prior to and during construction of the plant, and the status of each, including the date filed, the date issued, and any known obstacles to approval. Include a description of data records required for submission to such agencies and transcripts of any public hearings by such | Appendix C |

[1] Draft Preferred Submittal Format Guidance (FERC, April 2006). Available online at: http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=10997105.

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| **Minimum Filing Requirements** | **Found in Section** |
| agencies. Also provide copies of any correspondence relating to the actions by all, or any, of these agencies regarding all required approvals. (§ 380.12(O)(13)) | |
| 15. Identify how each applicable requirement will comply with 49 CFR part 193 and the National Fire Protection Association 59A LNG Standards. For new facilities, the siting requirements of 49 CFR part 193, subpart B, must be given special attention. If applicable, vapor dispersion calculations from LNG spills over water should also be presented to ensure compliance with the U.S. Coast Guard's LNG regulations in 33 CFR part 127. (§ 380.12(O)(14)) | Not Applicable |
| 16. Provide seismic information specified in Data Requirements for the Seismic Review of LNG facilities (NBSIR 84-2833, available from FERC staff) for facilities that would be located in zone 2, 3, or 4 of the Uniform Building Code Seismic Map of the United States. (§ 380.12(O)(15)) | Appendix I,<br>Appendix J |

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**Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant)**

| Agency | Comment Date | Comment | Response/Resource Report Location |
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| FERC | 12/14/2016 | Figures 13.1.3-1 and 13.1.3-2 in draft Resource Report 13 provide an overview of the Project site area. Clarify, as public information, the property line for the proposed GTP and the extent of land owned by the Project sponsor. | The proposed GTP facility pad is depicted on Figures 13.1.3-1 and 13.1.3-2. It is located on State-owned land. DNR has administratively reserved these lands for a North Slope gas treatment plant for the pipeline that delivers North Slope gas to tidewater. AGDC will include these lands in the State ROW Lease Application (AS 38.35). The Project intends on submitting the State ROW lease application coincident with the needs of the NEPA process and site control leading up to construction. Land status is depicted in RR8, Appendix B. |
| FERC | 12/14/2016 | Figure 13.1.3-2 in draft Resource Report 13 shows a Prudhoe Bay Unit Central Gas Facility adjacent to the Project site. Clarify, as public information, whether the adjacent Prudhoe Bay Unit Central Gas Facility is on leased property, and if so, identify the property line and the entity that leases the property. | The Prudhoe Bay Unit Central Gas Facility (CGF) is located on State-owned land under lease to BP, the Unit Operator. The CGF facility boundary is depicted on Figure 13.1.3-2. Land status is depicted in RR8, Appendix B. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, the flash points, LFLs, and UFLs for all ignitable Project fluids, including the ranges for each ignitable mixture. | Resource Report 11 Section 11.8.1 has been updated to include this information |
| FERC | 12/14/2016 | Any fluid that would be handled above its flashpoint could potentially be ignited upon release and could present a fire hazard. For preparation of the environmental document, indicate, as public information, whether the tri-ethylene glycol, Acid Gas Removal Unit (AGRU) solvents, and oils would be handled above their flashpoints. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, the maximum concentration of H2S in parts per million by volume (ppmv) and carbon dioxide (CO2) in molar percentage that would occur in the outdoor plant piping. | Resource Report 11 Section 11.8.1 has been updated to include this information. |
| FERC | 12/14/2016 | Provide, as public information, a description of the hazardous liquid spill containment system, confirming that all hazardous liquid vessels and piping would be provided with liquid spill containment. | Resource Report 13 Section 13.34 has been updated to include this information. |
| FERC | 12/14/2016 | Provide the dimensions and net usable volume of the liquid spill impoundments for the knock out drums, along with justification for the capacity of each of these impoundments, confirming that they would be adequate for the purpose. Provide a discussion of this knock out drum containment as public information. | Resource Report 13 Section 13.34 has been updated to include this information. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, for each impoundment that could contain hazardous fluid: | Resource Report No. 13 Section 13.34 has been updated to include this information. |
| FERC | 12/14/2016 | a. the impoundment name; | See above. |
| FERC | 12/14/2016 | b. materials of construction; | See above. |

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| FERC | 12/14/2016 | c. Project areas and fluids served; | See above. |
| FERC | 12/14/2016 | d. dimensions (in feet); | See above. |
| FERC | 12/14/2016 | e. net usable volume (in gallons); and | See above. |
| FERC | 12/14/2016 | f. a full description of the sizing spill, including the fluid type and vessel capacity. | See above. |
| FERC | 12/14/2016 | Draft Resource Report 13, section 13.13.1.6.1 indicates that secondary containment areas would be sized to contain precipitation from a 25-year, 24-hour rainfall event, in addition to 110 percent of the largest tank capacity. As public information, explain how this water would be removed. | Water would be removed from the containment areas by using a pump or pumps and disposed of in accordance with ADEC Disposal Permits. |
| FERC | 12/14/2016 | Draft Resource Report 13, section 13.1.17.8 indicates that a portable methanol system would be used. Provide the amount of methanol in this system and the location where it would be stored. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The building list in table 13.22.2-1 indicates that flammable fluid components would be located within enclosed buildings. Provide a comparison of the process building design and ventilation systems to the content of NFPA 59A (2001) sections 2.3.1 through 2.3.2.3. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | For the analysis, provide hourly weather data, in Excel format for at least 3 recent years, to support the selection of the ambient temperature, humidity, and wind speed for the hazard modeling. | A Meterological Data Report is included in Resource Report No. 13, Appendix H. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information: | See below. |
| FERC | 12/14/2016 | a. the weather station(s) used to select meteorological conditions for the hazard modeling; | A Meterological Data Report is included in Resource Report No. 13, Appendix H. |
| FERC | 12/14/2016 | b. the beginning and end dates of the weather data; | A Meterological Data Report is included in Resource Report No. 13, Appendix H. |
| FERC | 12/14/2016 | c. the temperature, humidity, and wind speed parameters selected for thermal radiation modeling; and | A Meterological Data Report is included in Resource Report No. 13, Appendix H. |
| FERC | 12/14/2016 | d. the temperature, humidity, and wind speed parameters selected for flammable and toxic vapor dispersion modeling. | A Meterological Data Report is included in Resource Report No. 13, Appendix H. |
| FERC | 12/14/2016 | For all hazardous fluids, provide details of all leakage sources used for hazard modeling, including the release temperature and pressure, and justification for the leakage sources selected (e.g. failure rate and criteria, cumulative risk and criteria, etc.). | A Hazard Analysis Report is included in Resource Report No. 13, Appendix H.3. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a list of the leakage sources used for hazard modeling including the following parameters: | Resource Report 11, Section 11.9.1 has been updated to include this information. A Hazard Analysis Report is included in Resource Report No. 13, Appendix H.3. |
| FERC | 12/14/2016 | a. leakage source scenario; | See above. |
| FERC | 12/14/2016 | b. plant location; | See above. |

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| FERC | 12/14/2016 | c. fluid type; | See above. |
| FERC | 12/14/2016 | d. source line diameter (inches) or vessel capacity; | See above. |
| FERC | 12/14/2016 | e. hole diameter (inches); | See above. |
| FERC | 12/14/2016 | f. duration of release; | See above. |
| FERC | 12/14/2016 | g. total mass flow rate (lb/hr); | See above. |
| FERC | 12/14/2016 | h. liquid rainout (percent); and | See above. |
| FERC | 12/14/2016 | i. any liquid de-inventory volumes between shutoff valves and isolation valves around the release. | See above. |
| FERC | 12/14/2016 | Draft Resource Report 13 section 13.13 indicates that hazard modeling would be provided with the FERC application. Be sure to provide hazard modeling analyses in the manner being done for the Liquefaction Plant, including: | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |
| FERC | 12/14/2016 | a. flammable vapor dispersion analysis for leakage sources of all ignitable fluids; | See above. |
| FERC | 12/14/2016 | b. toxic dispersion analysis for leakage sources of all toxic fluids, such as H2S -containing gas and propane; | See above. |
| FERC | 12/14/2016 | c. asphyxiant vapor dispersion analysis for leakage sources of CO2; | See above. |
| FERC | 12/14/2016 | d. overpressure analysis based on the flammable vapor dispersion results, considering ignition of flammable vapor in the confined or congested areas of the plant; | See above. |
| FERC | 12/14/2016 | e. jet fire analysis for leakage sources of all flammable and combustible fluids; and | See above. |
| FERC | 12/14/2016 | f. pool fire analysis for leakage sources of all flammable and combustible liquids. | See above. |
| FERC | 12/14/2016 | Provide all dispersion, overpressure, and jet fire modeling software files in a well-organized electronic format that clearly identifies the scenario being modeled in each case. Include pool fire modeling files as well, or for LNGFIRE3, provide printouts of the input/output files. | All software files will be provided directly to FERC staff |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a discussion of the ground surface roughness used in the hazard modeling. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, identification of the software used to model each hazardous scenario and the factor of safety applied to account for uncertainty in the model for each type of hazard. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a discussion of any assumptions used in the dispersion modeling, including how any fan equipment was considered to | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |

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| | | contribute to vapor dispersion modeling scenarios and why that account is reasonable or conservative. | |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a depiction of the maximum distance of flammable vapor dispersion, considering uncertainty in the model, for all flammable scenarios on generalized plot plans, identifying any property lines and onsite and offsite occupied building areas as well as the scale of the drawing. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a discussion of the exposure times considered for the toxic dispersion endpoints and the averaging times used in the toxic modeling. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a list of the maximum distances, considering uncertainty in the model, to all three AEGLs for all toxic dispersion scenarios. Also, provide a depiction of the maximum distances the AEGL-2 and AEGL-3 endpoints on generalized plot plans, identifying any property lines and onsite and offsite occupied building areas as well as the scale of the drawing. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |
| FERC | 12/14/2016 | If any of the three modeled AEGL distances extend to other property lines or onsite or offsite occupied building areas, provide, as public information, a discussion of the types of buildings and outdoor areas within the zones. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H |
| FERC | 12/14/2016 | Section 13.14.2.1 of draft Resource Report 13 states that the detection of flammable gases and toxic gases would use detectors specifically listed for the type of gas anticipated. Provide, as public information, an explanation of the toxic gas detection system, including which toxic gases would be provided with detection in buildings and outside of buildings. Also, consider the need for oxygen sensors within process buildings to detect potential releases involving asphyxiant gases or vapors, such as from nitrogen bottles or heated AGRU solvent components. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a depiction on a generalized plot plan of the results of leakage source dispersion modeling for the asphyxiant or oxygen deprivation potential of a CO2 release. Include identification of any property lines and onsite and offsite occupied building areas as well as the scale of the drawing. | Resource Report No. 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a discussion of: | Resource Report No. 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3. |

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| FERC | 12/14/2016 | a. the overpressure scenarios; | See above. |
| FERC | 12/14/2016 | b. obstacle density; | See above. |
| FERC | 12/14/2016 | c. confined or semi-confined areas (such as underneath the equipment platforms or within buildings); and | See above. |
| FERC | 12/14/2016 | d. any assumptions used in vapor cloud overpressure modeling. | See above. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a depiction on generalized plot plans of the maximum distances to the 1 psi overpressure level from the vapor cloud overpressure scenarios. Include identification of any property lines and onsite and offsite occupied building areas as well as the scale of the drawing. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H. |
| FERC | 12/14/2016 | For analysis, provide detailed thermal radiation result plots for thermal radiation from impoundment and jet fires, depicting the maximum extent of the 10,000, 3,000, and 1,600 Btu/ft2-hr level zones, and identifying: | Resource Report No. 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3. |
| FERC | 12/14/2016 | a. any plant property lines, including any easements within; | See above. |
| FERC | 12/14/2016 | b. the measurement scale of the drawing; and | See above. |
| FERC | 12/14/2016 | c. plant components within the zones, such as: | See above. |
| FERC | 12/14/2016 | i. equipment items; | See above. |
| FERC | 12/14/2016 | ii. hazardous liquid truck transfer stations; | See above. |
| FERC | 12/14/2016 | iii. occupied buildings or fixed duty work locations; | See above. |
| FERC | 12/14/2016 | iv. critical emergency equipment; and | See above. |
| FERC | 12/14/2016 | v. any other components that could exacerbate the hazard. | See above. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a depiction on a generalized plot plan of the distances to 1,600 Btu/ft2-hr from all ignitable fluid impoundments. Include identification of any property lines and onsite and offsite occupied building areas as well as the scale of the drawing. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3 |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a depiction on a generalized plot plan of the maximum distances to the 1,600 Btu/ft2-hr level from leakage source jet fires. Identify any property lines and onsite and offsite occupied building areas as well as the scale of the drawing. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3 |
| FERC | 12/14/2016 | Draft Resource Report 13, section 13.1.9 indicates that the fire protection system was not fully developed at the time of writing. Provide, as public information, an updated description of the fire protection system, and explain how indoor and outdoor equipment would be kept cool in a fire | During final design, a detailed evaluation would be performed to identify any fire protection requirements from vessels not protected by the fine mist water system. In the event that those vessels could be exposed to high heat loads, the design of the insulation and wrapping |

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| | | situation (including the outdoor liquid propane system). | systems would take those heat loads into account to ensure the insulation and wrapping would be able to protect the vessel appropriately. |
| FERC | 12/14/2016 | After completing the thermal radiation analysis, provide passive protection measures for any impoundment sump fires found to have potential to cause BLEVEs, pressure vessel bursts, or other significant cascading impacts. Consider the impacts from a 2-hour duration fire, unless the sizing spill would not produce that duration of a fire. Alternatively, provide modeling of the impacts, including any fragment travel distances. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3<br>The GTP's shutdown system, fine water mist system, hazard detection, and hazard control systems will be used to mitigate consequences in the unlikely event of a fire. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a detailed discussion of any measures, including spacing, which would prevent any potential BLEVEs or pressure vessel bursts due to thermal radiation impacts. Alternatively, provide a discussion of any possible impacts. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3<br>The GTP's shutdown system, fine water mist system, hazard detection, and hazard control systems will be used to mitigate consequences in the unlikely event of a fire. |
| FERC | 12/14/2016 | For preparation of the environmental document, provide, as public information, a discussion of any potential impacts and any mitigation needed to protect from impoundment thermal radiation levels and from vapor cloud overpressures to occupied building areas, above-ground impoundment walls, critical emergency equipment, and any other Project components that could exacerbate the initial hazard. | Resource Report 11, Section 11.9 has been updated to include this information. A Hazard Analysis Report is included in Resource Report 13, Appendix H.3<br>The GTP's shutdown system, fine water mist system, hazard detection, and hazard control systems will be used to mitigate consequences in the unlikely event of a fire. |
| FERC | 12/14/2016 | Draft Resource Report 13, section 13.5.8 indicates that the treated gas in the chillers would be at a pressure of over 2,000 psi. Provide consideration of the potential ramifications of a release of from this very high pressure system occurring underneath the supports for the propane accumulator, as shown on the Module No. 5B – Plans and Sections drawing in Appendix U.1. | During detailed design, an analysis would be performed to determine the design of the structural supports. If it is determined that a release from that high pressure, large diameter solid bore piping is credible, the supports would be designed appropriately to withstand that credible release. |
| FERC | 12/14/2016 | Draft Resource Report 13, section 13.4.4 states that the 2012 International Building Code specifies seismic design parameters that are based upon ASCE 7-05. That is not a correct statement. The 2012 International Building Code specifies seismic design parameters that are based upon ASCE 7-10. Please clarify or revise. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, table 13.4.4-1, indicates that the Site Class is C; however, it appears that the geotechnical report for the GTP site will not be submitted until the application version of Resource Report 13 is submitted. Please provide the technical data from other sources that was relied upon to assign the Site Class as C. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, table 13.4.4-1 and draft Resource Report 13, appendix C.2, section 2.7.13 | The Applicant will address this comment prior to the initiation of the EIS process. |

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| | | appears to omit some relevant information and contain some errors. Specifically, the table does not indicate the Risk Category, the second row uses the term Impact Factor, and the fourth row indicates a value of 0.1.0 for 1.0-Second Spectral Response Acceleration. Please provide, clarify, or revise the following: | |
| FERC | 12/14/2016 | a. provide a row with the Risk Category; | See above |
| FERC | 12/14/2016 | b. clarify or revise if the Impact Factor should be the Seismic Importance Factor; and | See above |
| FERC | 12/14/2016 | c. clarify or revise if 0.1.0 should be 0.10. | See above |
| FERC | 12/14/2016 | Draft Resource Report 13, table 13.4.4-1 and draft Resource Report 13, appendix C.2, section 2.7.13 suggests a possible Seismic Importance Factor of 1.25. This would be equivalent to a Risk Category of III based on ASCE 7-10 table 1.5-2. Explain the rationale for selecting the Risk Category of III and equivalent Seismic Importance Factor of 1.25 and why a Risk Category of IV and equivalent Seismic Importance Factor of 1.5 was not selected. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, section 13.4.10.2 for the GTP indicates that the gas leaving the GTP would contain less than 4 ppmv H2S, but section 13.5.3 of draft Resource Report 13 for the Liquefaction Plant indicates that the GTP would achieve the LNG feed specification of less than 3 ppmv H2S. Explain this discrepancy. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | In Draft Resource Report 13, section 13.4.5.6 and draft Resource Report 13, appendix C.5, section 1.4.3.2, it is stated that the GTP design basic wind speed would be in accordance with ASCE 7 and would be 140 mph 3-second gust at 33 feet above ground. This may be equivalent to a Risk Category of II through IV based on ASCE 7-10 figures 26.5-1A and 26.5-1B. Clarify if the Risk Category of III is being used. If Risk Category III, explain the rationale for selecting the Risk Category of III and why a Risk Category of IV or higher wind speed (e.g., 10,000 year return period) was not selected. Note selecting a Risk Category of III instead of IV may impact the need for following enhanced protection requirements of Table 3 in ASTM E1996 per the Protection Requirements for Glazed Openings in ASCE 7-10 section 26.10.3.2. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, section 13.1.17.3 indicates that the Project would include equipment taller than 200 feet. Provide, as public information: | Resource Report 11, Section 11.1.1.5 has been updated to include this information. |
| FERC | 12/14/2016 | a. the distance to the nearest airport from the proposed GTP site; and | See above |
| FERC | 12/14/2016 | b. the FAA aeronautical study number for each Project component that would be tall enough to require FAA notification. | See above |

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| FERC | 12/14/2016 | Provide all information that was noted as to be provided or was missing from the PSFG list being used. Be sure to include: | See below. |
| FERC | 12/14/2016 | a. owner organizational structure [PSFG 1.25.3]; | An organizational chart is included in Appendix A.2. |
| FERC | 12/14/2016 | b. barometric pressure rate of change in inches Hg/h or mbar/h [PSFG 4.5.4]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | c. pressures in pounds per square inch absolute or pounds per square inch guage for any Resource Report 13 text items that provide pressure in only psi; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | d. Uninterruptible Power Source services capacity (battery duration) in hours [PSFG 4.27.10]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | e. discussion of the sendout metering overpressure safety system, isolation system, metering instrumentation and analysis of sendout [PSFG 5.12]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | f. flare sizing report and type of flares [PSFG 4.24.1 and 5.10]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | g. motor horse power and voltage on the equipment list [PSFG 8.1]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | h. control communication and sample conditioning for instrumentation [PSFG 9.4 and 9.6]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | i. communication for safety instrumentation [PSFG 10.3]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | j. clarification of alarm conditions on the cause and effect drawings in appendix U.5 [PSFG 10.6.2]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | k. emergency lighting plan [PSFG 11.3.4]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | l. layout drawing of manual emergency shut down locations [related to PSFG 14]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | m. discussion of any fuel gas odorant system and overpressure protection considerations [PSFG 12]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | n. hazard detection plan drawings for the Operations Center area [PSFG 14.5.1]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | o. descriptions of all fire extinguishing systems and locations, including portable and wheeled extinguishers [PSFG 16.1 and 16.4.1]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | p. specifications and operating conditions for the firewater pumps and discussion of the jockey pumps [PSFG 17]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | q. discharge conditions, activation, and any remote control capabilities for the fire water mist systems [PSFG 17.2]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | r. fire water Process and Instrumentation Diagrams for the mist systems [PSFG 17.4.1]; | The Applicant will address this comment prior to the initiation of the EIS process. |

| Resource Report No. 13<br>Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant) | | | |
|---|---|---|---|
| **Agency** | **Comment Date** | **Comment** | **Response/Resource Report Location** |
| FERC | 12/14/2016 | s. fire water piping plans [PSFG 17.4.2]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | t. camera layout plan [PSFG 19.7.2]; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | u. equipment specifications, including for insulation, valves, rotating equipment, storage tanks and vessels, heat exchangers, electrical, control system, and buildings [PSFG App M/T]; and | Resource Report 13, Appendix F, includes preliminary specifications for the GTP. In addition, a list of additional specifications to be developed in detailed design is included in Appendix F. |
| FERC | 12/14/2016 | v. description and list of shutoff valves [PSFG App S]. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Indicate whether the following have been conducted or provide a schedule for the following: | The Applicant will address this comment after the FEIS but prior to construction start. |
| FERC | 12/14/2016 | a. plant reliability, availability, and maintainability analysis; | The Applicant will address this comment after the FEIS but prior to construction start. |
| FERC | 12/14/2016 | b. road safety and reliability impact studies; | The Applicant will address this comment after the FEIS but prior to construction start. |
| FERC | 12/14/2016 | c. security threat and vulnerability studies; and | The Applicant will address this comment after the FEIS but prior to construction start. |
| FERC | 12/14/2016 | d. simultaneous operations studies. | The Applicant will address this comment after the FEIS but prior to construction start. |
| FERC | 12/14/2016 | Appendix A.1 provides an overall plan drawing of the process area equipment configuration. The areas that are within or outside of buildings are not immediately clear on this drawing. Provide an overall plot plan showing the arrangement of equipment items and including a method to easily distinguish the areas inside buildings from the areas outside, such as possibly using subtle shading of indoor building areas or using bolded lines to represent building walls. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The plan drawing of the Operations Center area, found in draft Resource Report 13, appendix A.1, shows propane use in this area, and section 13.1.17.12 indicates that diesel and gasoline storage tanks would be located in this area as well. Provide a spill containment and leakage source hazard modeling analysis for potential releases of hazardous fluids in the Operations Center area of the plant. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The GTP Architectural Design Basis in draft Resource Report 13, appendix C.4 indicates that the process module buildings would be liquid tight and designed to contain spills. Resource Report 13, appendix Q will address any hazardous liquid spill containment. Explain, as public information, how other liquid releases would be handled within the process buildings, including the capacity of the containment relative to the liquid inventory in the equipment. | The Applicant will address this comment prior to the initiation of the EIS process. |

**Resource Report No. 13**
**Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant)**

| Agency | Comment Date | Comment | Response/Resource Report Location |
|---|---|---|---|
| FERC | 12/14/2016 | Section 2.6.3.1 of the Design Basis in draft Resource Report 13, appendix C.2 indicates that flammable gas detectors would be located at all HVAC unit air intakes in and outside of process areas. Provide, as public information: | See below |
| FERC | 12/14/2016 | a. clarification on whether this applies to the Operations Center area as well; | Gas detection would not be provided for the operations center as it is located remotely away from the GTP process equipment |
| FERC | 12/14/2016 | b. a discussion of the alarm and shutdown actions would occur if flammable gas would be detected in a building ventilation air intake; and | Alarm and shutdown conditions would be developed in detailed design. |
| FERC | 12/14/2016 | c. a discussion of whether flammable gas detection would be provided for the air intakes of combustion equipment, as well as the alarm and shutdown actions that would occur if flammable gas was detected in the air intake of combustion equipment. | Gas detectors will be provided for the intakes of buildings and combustion equipment |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix C.5, section 2.1.1.5 should provide the seismic design criteria in a table such as that provided in draft Resource Report 13 table 13.4.4-1 and draft Resource Report 13, appendix C.2, section 2.7.13. The table should include values of SDS and SD1 and TL. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix C.5, section 2.1.1.11 should provide the temperature values for which self straining forces of structures are be determined. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix C.5, section 2.1.2.1 and 2.1.2.2 should provide the load combinations and factors for load combinations that consider self-straining forces of structures in combination with wind and seismic forces. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix D provides a pre-FEED list of codes and standards for the GTP. Many codes and standards commonly referenced were not included. Provide a revised list of codes and standards for the FEED design in Resource Report 13, appendix D and/or a reason for not including the specific codes and standards listed in attachment B. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix E.1 provides a list of permits and approvals that appear to cover both the LNG terminal and the GTP and is not specific about the applicability of regulations such as 49 CFR 192 and 49 CFR 193. Provide, as public information: | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | a. a list of permits and approvals intended only for the GTP; | Resource Report 11, Section 11.1.1 has been updated to include this information<br>The Project is currently in consultations with DOT PHMSA to determine applicability of PHMSA jurisdiction of the GTP. The results of the consultation will be filed with FERC staff when complete. |

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**Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant)**

| Agency | Comment Date | Comment | Response/Resource Report Location |
|---|---|---|---|
| FERC | 12/14/2016 | b. the results of consultation with the PHMSA, Occupational Safety and Health Administration, and U.S. Environmental Protection Agency on which federal regulations apply to the remote GTP, considering 49 CFR 192, 49 CFR 193, 29 CFR 1910.119, and/or 40 CFR 68; and | Resource Report 11, Section 11.1.1 has been updated to include this information.<br>The Project is currently in consultations with the listed federal agencies to determine applicability of jurisdiction of the GTP. The results of the consultation will be filed with FERC staff when complete. |
| FERC | 12/14/2016 | c. the results of consultation with the Department of Homeland Security on whether the Chemical Facility Anti-Terrorism Standards program would apply to the GTP. | Resource Report 11, Section 11.1.1 has been updated to include this information.<br>The Project is currently in consultations with DHS to determine applicability of jurisdiction of the GTP. The results of the consultation will be filed with FERC staff when complete. |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix G provided a HAZID review. Provide responses to the HAZID recommendations and a schedule for the Hazard and Operability Study of the FEED design. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The hazard detection drawing in draft Resource Report 13, appendix P.2 indicates which types of detectors would be located in each building. Additional information is needed to fully evaluate the layout of the hazard detection system. Provide a revised drawing that: | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | a. allows the reviewer to easily distinguish areas within buildings from areas outside; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | b. identifies the number of each type of detector in each building; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | c. differentiates toxic gas detectors from flammable gas detectors; | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | d. depicts the intended placement of flame detectors within buildings; and | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | e. depicts the intended placement of all hazard detectors that would be located outside of buildings (such as in the area of the liquid propane system). | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Table 2 of the Secondary Containment of Tanks Report in draft Resource Report 13, appendix Q provides a list of sizing spills from certain Project vessels. Pages 7 and 8 of 13 in this report explain that not all hazardous liquid vessels were considered to need containment. We recommend secondary containment for all hazardous liquid piping and vessels. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | a. Expand Table 2 to consider impoundment sizing spills for all hazardous liquid vessels (and associated hazardous liquid piping outside of the vessel impoundment collection area), including the propane accumulator, oil vessels, diesel day tank, hazardous liquid trucks at transfer stations, and any other vessels that would contain hazardous liquid. | The Applicant will address this comment prior to the initiation of the EIS process. |

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**Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant)**

| Agency | Comment Date | Comment | Response/Resource Report Location |
|---|---|---|---|
| FERC | 12/14/2016 | b. Provide calculations to support the maximum design liquid capacities of the hazardous liquid vessels in the revised Table 2. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Page 12 of 13 in the Secondary Containment of Tanks Report in draft Resource Report 13, appendix Q indicates that portable spill containment may be proposed for truck transfer areas. The design of the hazardous liquid truck transfer spill containment is not clear. Clarify this design, as public information, including the locations, construction materials, dimensions, and capacities. Also, include an explanation how the materials of construction would perform in a fire scenario. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The Secondary Containment of Tanks Report in draft Resource Report 13, appendix Q indicates that snow and ice filling the containment dikes was not considered. Provide a detailed and clear philosophy for handling snow volumes in the impoundment system, as public information, which explains: | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | a. how hazardous liquid spills into the areas under and around equipment would be assured to be directed to the impoundment at all times, including after large snowfalls; and | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | b. how the sizing spill volume in all of the hazardous liquid impoundments would be maintained available at all times. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The drawings in draft Resource Report 13, appendix U.1 provide plan and cross-section views of the spill containment impoundments listed in table 3 of the Secondary Containment of Tanks Report in draft Resource Report 13, appendix Q. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | a. Expand table 3 to include impoundments for all hazardous liquid sizing spills identified in the revised table 2. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | b. Provide cross-section drawings to represent the additional hazardous liquid impoundments not already included in draft Resource Report 13, appendix U.1. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | c. Provide a plan drawing of the overall hazardous liquid spill containment system, confirming that all hazardous liquid vessels and piping would be provided with liquid spill containment (except where a guillotine release from the liquid piping would not produce any liquid rainout). | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | d. Provide the slope of the floor for all portions of the impoundment system. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | e. Indicate the materials of construction for each portion of the impoundment system. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The layout drawings in draft Resource Report 13, appendix U.1 appear to show building walls intersecting vessels flare knock out drums. Clarify | The Applicant will address this comment prior to the initiation of the EIS process. |

| **Resource Report No. 13<br>Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant)** | | | |
|---|---|---|---|
| **Agency** | **Comment Date** | **Comment** | **Response/Resource Report Location** |
| | | whether these are structural intersections, rather than an open bay, and if intersections, explain how they would not compromise the vessel integrity over time. | |
| FERC | 12/14/2016 | The drawings in draft Resource Report 13, appendix U.1 show that the diesel storage tank containment dike and the AGRU solvent/tri-ethylene glycol containment dike would be formed by above-ground walls. Explain, as public information, how these walls would be protected from any impacts due to errant vehicles or mobile equipment. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | The index plot plan in draft Resource Report 13, appendix U.1 indicates that not all unit plot plans were provided. Provide a complete set of unit plot plans. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix U.3 provided Heat and Material Balance sheets for the Base Case in summer and winter. Provide the bounding design cases, in addition to the Base Case. | The Applicant will address this comment prior to the initiation of the EIS process. |
| FERC | 12/14/2016 | Draft Resource Report 13, appendix U.4 provided Piping and Instrumentation Diagrams that contained a majority of the information needed, but did not include items such as relief valve sizes and smaller line sizes. Provide Piping and Instrumentation Diagrams, ensuring that they contain all of the following information: | The Applicant will address this comment after the FEIS but prior to construction start. |
| FERC | 12/14/2016 | a. equipment tag number, name, size, duty, capacity and design conditions; | See above |
| FERC | 12/14/2016 | b. piping with line number, piping class spec, size and insulation; | See above |
| FERC | 12/14/2016 | c. LNG tank pipe penetration size or nozzle schedule; | See above |
| FERC | 12/14/2016 | d. piping spec breaks and insulation limits; | See above |
| FERC | 12/14/2016 | e. vent, drain, cooldown and recycle piping; | See above |
| FERC | 12/14/2016 | f. isolation flanges, blinds and insulating flanges; | See above |
| FERC | 12/14/2016 | g. valve type, in accordance with the piping legend symbol; | See above |
| FERC | 12/14/2016 | h. all control valves numbered; | See above |
| FERC | 12/14/2016 | i. all valve operator types and valve fail position; | See above |
| FERC | 12/14/2016 | j. instrumentation numbered; | See above |
| FERC | 12/14/2016 | k. control loops including software connections; | See above |
| FERC | 12/14/2016 | l. shutdown interlocks; | See above |
| FERC | 12/14/2016 | m. relief valves numbered, with set point; | See above |
| FERC | 12/14/2016 | n. relief valve inlet and outlet piping size; | See above |
| FERC | 12/14/2016 | o. car sealed valves and blinds; and | See above |
| FERC | 12/14/2016 | p. equipment insulation. | See above |

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**Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant)**

| Agency | Comment Date | Comment | Response/Resource Report Location |
|---|---|---|---|
| SOA | 12/14/2016 FERC letter | "the active layer … is 1-2 feet in depth" This value of 1-2 feet of active-layer depth is repeated in many locations, some with a footnote, "pending verification …." However, this depth is less than what is listed in most North Slope specifications. Moreover, these specifications were developed in the 1970s. Some evidence indicates that permafrost warming has increased the active layer in the intervening decades, and designs should account for the trends of the facility's design life of 30 years. The active layer depth can affect the stability of piles and pads. | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | Minimum Design Temperature - "The minimum metal (equipment) temperature used in the design of the GTP is -20F for equipment located inside a module and -50F for equipment located outside a module …." Consider the shut-down case at minimum ambient temperatures. How will gas cooled to -50F be moved through the facility? Many North Slope process facilities have some -50F components inside the modules or have a bypass rated to -50F. In some cases, recycling and blending to keep the feed above -20F is used. | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | "… unlike the GTP is plant, which is designed for a summer temperature of 55F, the propane condenser is designed for 65F …" The maximum ambient design temperatures might be low. What percentage of overage time are these based upon? The temperatures exceed 70F every year, and the ultimate maximum is about 80F. On the North Slope during summers, there is little day/night change in temperature and many production modules reach high temperatures. Coolers reach their maximum temperatures and need water sprinklers. | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | Grounding and Lightning Protection - Providing lightning protection per NFPA 780 will cost little money. In general, the production facilities on the North Slope do not have lightning rods, but TAPS NS facilities do. Given the huge consequences of a lightning strike at the plant and the low cost of a system, consider protecting per NFPA 780. | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | "Water from the Putuligayak Reservoir would … supply both process and camp water needs." - Lakes and streams in the area have SRBs. Some facilities with combined flow have experienced MIC, microbially induced corrosion. Consider completely separate water feeds for fire and potable use. Cost could be reduced for the potable pipe by making it out of less expensive materials and corrosion mitigation could be simplified. | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | Black Start - Given the size and importance of this facility, is the a single diesel generator for black start the correct choice? All restart activities depend upon this generator operating on demand. More redundancy might be advisable for the arctic. | The Applicant will address State of Alaska comments during required permitting activities. |

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**Agency Comments and Requests for Information Concerning Engineering and Design Material (Gas Treatment Plant)**

| Agency | Comment Date | Comment | Response/Resource Report Location |
|---|---|---|---|
| | | Consider that Alyeska has added more black start generators that were not in the original Strategic Reconfiguration design. | |
| SOA | 12/14/2016 FERC letter | Green House Gas (GHG) regulation and fugitive emissions - In the North Slope NGL plant or the Nikiski terminal, are anticipated regulations covering GHG emissions and fugitive emissions considered? These issues will have the least cost impact if they are considered early in design? Do they need to be considered? Do they belong in a resource report? | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | "The Fine Water Mist (FWM) would be provided …" - A fine water mist fire suppression system has been installed previously in the arctic, such as at the Alpine production facility. However, arctic production modules typically have purge regimes, where hydrocarbons are vented at high rates to keep levels below the lower explosive limits. If purge systems are used, large volumes of ambient air will be used. Purge systems and heating of arctic winter air in combination with water systems should be considered. | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | Green House Gas (GHG) regulation and fugitive emissions - In the North Slope NGL plant or the Nikiski terminal, are anticipated regulations covering GHG emissions and fugitive emissions considered? These issues will have the least cost impact if they are considered early in design? Do they need to be considered? Do they belong in a resource report? | The Applicant will address State of Alaska comments during required permitting activities. |
| SOA | 12/14/2016 FERC letter | Storage, Currents and Ice - The design current is listed as 4.1 knots. The net LNG production is listed as 2.6 mmscfd. The total storage volume is listed as 480,000 cubic meters. The Holding Mode and the Loading Mode are described. Design sustained wind speed is listed as 150 mph. However, this location has large tides, ice, inclement weather, and strong cross-shore currents. Is there any analysis or information on the allowable loading conditions or the likelihood of delay in loading due to weather? Is there is sufficient storage capacity to avoid shutting down the AKLNG process and pipeline? | The Applicant will address State of Alaska comments during required permitting activities. |

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## ACRONYMS AND ABBREVIATIONS

| Abbreviation | Definition |
|---|---|
| **Abbreviations for Units of Measurement** | |
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| ACFM | actual cubic feet per minute |
| bbl./ (cubic meters) | barrels cubed |
| bbl. /h (cubic meters/h) | barrels per hour/cubed per hour |
| BSCFD | billion standard cubic feet per day |
| BTU/SCF | british thermal unit/standard cubic feet |
| g | Acceleration |
| gpm/usgpm | gallons per minute/United States gallons per minute |
| gr/100 SCF | grams per 100 standard cubic feet |
| Hg | inches mercury |
| HP | high pressure |
| Kg | kilogram |
| kV | kilovolt |
| kVA | kilovolt Ampere |
| kW | kilowatts |
| Lb | pounds |
| LP | low pressure |
| mA | milliampere |
| mbar | millibar |
| MMTPA | million metric tons per annum |
| MMSCFD | million standard cubic feet per day |
| mol% | molecular percent |
| mph | miles per hour |
| MW | megawatts |
| MWt | megawatt thermal |
| Ppmv | parts per million/volume |
| Psia | pounds per square inch absolute |
| Psig | pounds per square inch gauge |
| Psi | pounds per square inch |
| SCFM | standard cubic feet per minute |
| Sf | square feet |
| ST | short tons |
| VAC | volts alternating current |
| **Other Abbreviations** | |
| § | section or paragraph |
| AAAQS | Alaska Ambient Air Quality Standards |
| AAC | Alaska Administrative Code |

| Abbreviation | Definition |
|---|---|
| ADEC | Alaska Department of Environmental Conservation |
| ADNR | Alaska Department of Natural Resources |
| AGA | American Gas Association |
| AGDC | Alaska Gasline Development Corporation |
| AGRU | Acid Gas Removal Unit |
| API | American Petroleum Institute |
| AMS | Alarm Management System |
| ANSI | American National Standards Institute |
| ATWS | Additional Temporary Workspace |
| BL | boundary limit |
| BLM | United States Department of the Interior, Bureau of Land Management |
| CCR | Central Control Room |
| CCTV | Closed-Circuit Television |
| C.F.R. | Code of Federal Regulations |
| CGF | Central Gas Facility |
| $CH_4$ | methane |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| CS | Control System |
| CSA | Canadian Standards Association |
| CTM | Custody Transfer Meter |
| DC | Direct Current |
| ECMS | Electrical Control and Management System |
| EG | ethylene glycol |
| EOCs | Emergency Operations Centers |
| EPA | United States Environmental Protection Agency |
| EPC | Engineering, Procurement, and Construction |
| ERP | Emergency Response Plan |
| ESD | Emergency Shut Down (System) |
| FACP | Fire Alarm Control Panel |
| FCC | Federal Communications Commission |
| FDH | Facility Data Historian |
| FEMA | United States Department of Homeland Security, Federal Emergency Management |
| FERC | United States Department of Energy, Federal Energy Regulatory Commission |
| FERC Plan | FERC Erosion Control, Revegetation, and Maintenance Plan |
| FERC Procedures | FERC Wetland and Waterbody Construction and Mitigation Procedures |
| FGTL | Fuel Gas Transfer Line |
| F&G | Fire and Gas |
| FGDS | Fire and Gas Detection System |
| FWM | Fine Water Mist |
| GPBFD | Greater Prudhoe Bay Fire Department |

| Abbreviation | Definition |
|---|---|
| GT | gas turbine |
| GTP | Gas Treatment Plant |
| HART | Highway Addressable Remote Transducer |
| HC | hydrocarbon |
| $H_2S$ | hydrogen sulfide |
| HDMS | Hazard Detection and Mitigation System |
| HHV | Higher Heating Value |
| HMI | Human/Machine Interface |
| HSE | Health, Safety and Environmental |
| HVAC | Heating, Ventilation, and Air Conditioning |
| IAMS | Instrument Assets Management System |
| ICS | Incident Command System |
| ICSS | Integrated Control and Safety System |
| ISO | International Organization for Standardization |
| KO Drum | Knock-Out Drum |
| LER | Local Equipment Room |
| LIMS | Laboratory Information Management Systems |
| LIR | Local Instrument Room |
| LLC | Limited Liability Company |
| LNG | liquefied natural gas |
| LNGC | liquefied natural gas carrier |
| LSS | Load Sharing System |
| LHV | Lower Heating Value |
| LP | Low Pressure |
| MAC | Manual Alarm Call |
| Mainline | 42-inch-diameter Natural Gas Pipeline from the Gas Treatment Plant to the Liquefaction Facility |
| MAOP | Maximum Allowable Operating Pressure |
| MCC | Motor Control Centers |
| MCE | Maximum Considered Earthquake |
| MDEA | methyl-diethanolamine |
| MFS | Module Fabrication Sites |
| MSL | mean sea level |
| MLBV | Mainline block valve |
| MP | Milepost |
| NA | Not Applicable |
| NFPA | National Fire Protection Association |
| NGA | Natural Gas Act |
| NIMS | National Incident Management System |
| NPDES | National Pollutant Discharge Elimination Systems |
| NRTL | Nationally Recognized Testing Laboratories |

| Abbreviation | Definition |
|---|---|
| NSB | North Slope Borough |
| NTP | Notice to Proceed |
| OBE | Operating Basis Earthquake |
| OPC | OLE for Process Control |
| OTS | Operator Training Simulator |
| O&M | Operations and Maintenance |
| OSHA | Occupational Safety and Health Administration |
| OU | Operating Unit |
| PA/GA | Public Address and General Alarm System |
| PBTL | Prudhoe Bay Gas Transmission Line |
| PBU | Prudhoe Bay Unit |
| PCS | Process Control System |
| PDCS | Power Distribution Control System |
| PF | Participation Factor |
| PFD | Process Flow Diagram |
| P&ID | Process and Instrumentation Diagram |
| PIV | Post Indicating Valves |
| PLC | Programmable Logic Controller |
| PIMS | Process Information Management Systems |
| PMS | Power Management System |
| PSD | Process Shutdown |
| PSV | Pressure Safety Valve |
| PTTL | Point Thomson Gas Transmission Line |
| PTU | Point Thomson Unit |
| PWTS | Potable Water Treatment System |
| RAM | Reliability, Availability and Maintainability |
| RCRA | Resource Conservation and Recovery Act |
| RFC | Ready for Commissioning |
| RIE | Remote Instrument Enclosure |
| R.O. | Reverse Osmosis |
| SCADA | Supervisory Control and Data Acquisition Systems |
| SCT | Systems Completion Team |
| SIF | Safety Instrumented Function |
| SIL | Safety Integrity Level |
| SIS | Safety Instrumented System |
| SOE | Sequence of Events |
| SSE | Safe Shutdown Earthquake |
| SPCC | Spill Prevention, Control, and Countermeasure |
| TBD | To Be Determined |
| TEG | tri-ethylene glycol |
| TGDU | Treated Gas Glycol Dehydration Unit |

| Abbreviation | Definition |
|---|---|
| UEHM | Upstream Health Monitoring Systems |
| UIC | Underground Injection Control |
| UL | Underwriters' Laboratories |
| UPS | Uninterruptible Power Source |
| U.S. | United States |
| U.S.C. | United States Code |
| USFWS | United States Fish and Wildlife Service |
| VoIP | Voice-Over Internet Protocol |
| VSM | vertical support members |
| WHR | Waste Heat Recovery |
| WHRU | Waste Heat Removal Unit |
| WSR | Wild and Scenic Rivers |

# 13.0 RESOURCE REPORT NO. 13– ENGINEERING AND DESIGN MATERIAL

## 13.1 GENERAL BACKGROUND AND PROJECT MANAGEMENT

The Alaska Gasline Development Corporation (Applicant) plans to construct one integrated liquefied natural gas (LNG) Project (Project) with interdependent facilities for the purpose of liquefying supplies of natural gas from Alaska, in particular from the Point Thomson Unit (PTU) and Prudhoe Bay Unit (PBU) production fields on the Alaska North Slope (North Slope), for export in foreign commerce and for in-state deliveries of natural gas.

The Natural Gas Act (NGA), 15 U.S.C. § 717a(11) (2006), and Federal Energy Regulatory Commission (FERC) regulations, 18 Code of Federal Regulations (C.F.R.) § 153.2(d) (2014), define “LNG terminal” to include “all natural gas facilities located onshore or in State waters that are used to receive, unload, load, store, transport, gasify, liquefy, or process natural gas that is ... exported to a foreign country from the United States.” With respect to this Project, the “LNG Terminal” includes the following: a liquefaction facility (Liquefaction Facility) in Southcentral Alaska; an approximately 807-mile gas pipeline (Mainline); a gas treatment plant (GTP) within the PBU on the North Slope; an approximately 63-mile gas transmission line connecting the GTP to the PTU gas production facility (PTU Gas Transmission Line or PTTL); and an approximately 1-mile gas transmission line connecting the GTP to the PBU gas production facility (PBU Gas Transmission Line or PBTL). All of these facilities are essential to export natural gas in foreign commerce and will have a nominal design life of 30 years.

These components are shown in Resource Report No. 1, Figure 1.1-1, as well as the maps found in Appendices A and B of Resource Report No. 1. Their proposed basis for design is described as follows.

The new Liquefaction Facility would be constructed on the eastern shore of Cook Inlet just south of the existing Agrium fertilizer plant on the Kenai Peninsula, approximately 3 miles southwest of Nikiski and 8.5 miles north of Kenai. The Liquefaction Facility would include the structures, equipment, underlying access rights, and all other associated systems for final processing and liquefaction of natural gas, as well as storage and loading of LNG, including terminal facilities and auxiliary marine vessels used to support Marine Terminal operations (excluding LNG carriers [LNGCs]). The Liquefaction Facility would include three liquefaction trains combining to process up to approximately 20 million metric tons per annum (MMTPA) of LNG. Two 240,000-cubic-meter tanks would be constructed to store the LNG. The Liquefaction Facility would be capable of accommodating two LNGCs. The size of LNGCs that the Liquefaction Facility would accommodate would range between 125,000–216,000-cubic-meter vessels.

In addition to the Liquefaction Facility, the LNG Terminal would include the following interdependent facilities:

- Mainline: A new 42-inch-diameter natural gas pipeline approximately 807 miles in length would extend from the Liquefaction Facility to the GTP in the PBU, including the structures, equipment, and all other associated systems. The proposed design anticipates up to eight compressor stations; one standalone heater station, one heater station collocated with a compressor station, and six cooling stations associated with six of the compressor stations; four meter stations; 30 Mainline block valves (MLBVs); one pig launcher facility at the GTP meter station, one pig receiver facility at the Nikiski meter station, and combined pig launcher and receiver facilities at each of the compressor stations; and associated infrastructure facilities.

Associated infrastructure facilities would include additional temporary workspace (ATWS), access roads, helipads, construction camps, pipe storage areas, material extraction sites, and material disposal sites.

Along the Mainline route, there would be at least five gas interconnection points to allow for future in-state deliveries of natural gas. The approximate locations of three of the gas interconnection points have been tentatively identified as follows: milepost (MP) 441 to serve Fairbanks, MP 763 to serve the Matanuska-Susitna Valley and Anchorage, and MP 807 to serve the Kenai Peninsula. The size and location of the other interconnection points are unknown at this time. None of the potential third-party facilities used to condition, if required, or move natural gas away from these gas interconnection points are part of the Project. Potential third-party facilities are addressed in the Cumulative Impacts analysis found in Appendix L of Resource Report No. 1;

- GTP: A new GTP and associated facilities in the PBU would receive natural gas from the PBU Gas Transmission Line and the PTU Gas Transmission Line. The GTP would treat/process the natural gas for delivery into the Mainline. There would be custody transfer, verification, and process metering between the GTP and PBU for fuel gas, propane makeup, and byproducts. All of these would be on the GTP or PBU pads;

- PBU Gas Transmission Line: A new 60-inch natural gas transmission line would extend approximately 1 mile from the outlet flange of the PBU gas production facility to the inlet flange of the GTP. The PBU Gas Transmission Line would include one-meter station on the GTP pad; and

- PTU Gas Transmission Line: A new 32-inch natural gas transmission line would extend approximately 63 miles from the outlet flange of the PTU gas production facility to the inlet flange of the GTP. The PTU Gas Transmission Line would include one-meter station on the GTP pad, four MLBVs, and pig launcher and receiver facilities—one each at the PTU and GTP pads.

Existing State of Alaska transportation infrastructure would be used during the construction of these new facilities including ports, airports, roads, railroads, and airstrips (potentially including previously abandoned airstrips). A preliminary assessment of potential new infrastructure and modifications or additions to these existing in-state facilities is provided in Resource Report No. 1, Appendix L. The Liquefaction Facility, Mainline, and GTP would require the construction of modules that may or may not take place at existing or new manufacturing facilities in the United States.

Resource Report No. 1, Appendix A, contains maps of the Project footprint. Appendices B and E of Resource Report No. 1 depict the footprint, plot plans of the aboveground facilities, and typical layout of aboveground facilities.

Outside the scope of the Project, but in support of or related to the Project, additional facilities or expansion/modification of existing facilities would be needed to be constructed. These other projects may include:

- Modifications/new facilities at the PTU (PTU Expansion project);

- Modifications/new facilities at the PBU (PBU Major Gas Sales [MGS] project); and
- Relocation of the Kenai Spur Highway.

### 13.1.1 Project Facilities

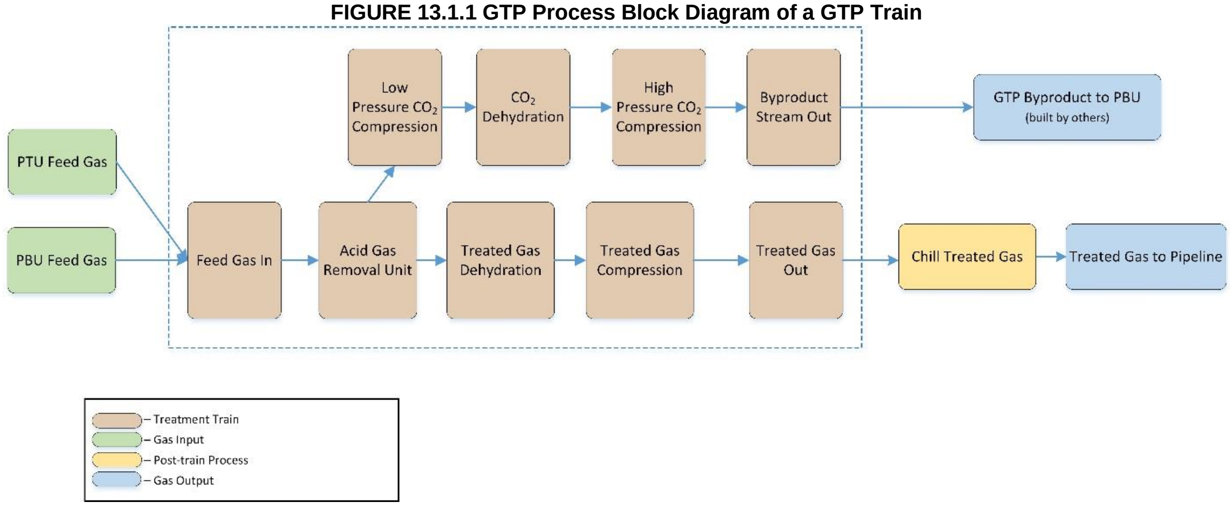
To produce up to 20 MMTPA of LNG, the Liquefaction Facility would be designed to process an average stream day rate of 2.7 billion standard cubic feet per day (BSCF/D)[b] of feed gas and would be able to accommodate compositions of natural gas received from the pre-treatment facilities. The proposed design for the GTP consists of three parallel treatment trains, each sized to process approximately 1.3 BSCFD of sour feed gas. The process removes the majority of carbon dioxide ($CO_2$) and hydrogen sulfide ($H_2S$) from the sour feed gas to the specification of the Liquefaction Facility, and most of the water to a dew point specification for the Mainline. The treated gas then would be compressed in stages and routed to a natural gas chilling unit. The chilling unit uses propane refrigerant to cool the gas. After refrigeration, the natural gas would be delivered to the Mainline at pressures up to 2,075 psig for delivery to the Liquefaction Facility.

The GTP would include facilities in each treatment train to collect the $CO_2$ and $H_2S$ removed from the natural gas. The $CO_2$/$H_2S$ stream also would contain water and some hydrocarbons. The $CO_2$/$H_2S$ stream from each train would be compressed and treated to remove water. The $CO_2$/$H_2S$ stream from each train would be combined into a single stream (GTP Byproduct) that would be sent to the PBU.

As discussed in the following sections, the water removed from both the natural gas and the Byproduct streams would be injected at the GTP site through Class 1 industrial wells located on the GTP Pad.

A block diagram depicting the GTP treatment process is provided in Figure 13.1.1

**FIGURE 13.1.1 GTP Process Block Diagram of a GTP Train**



### 13.1.2 Location

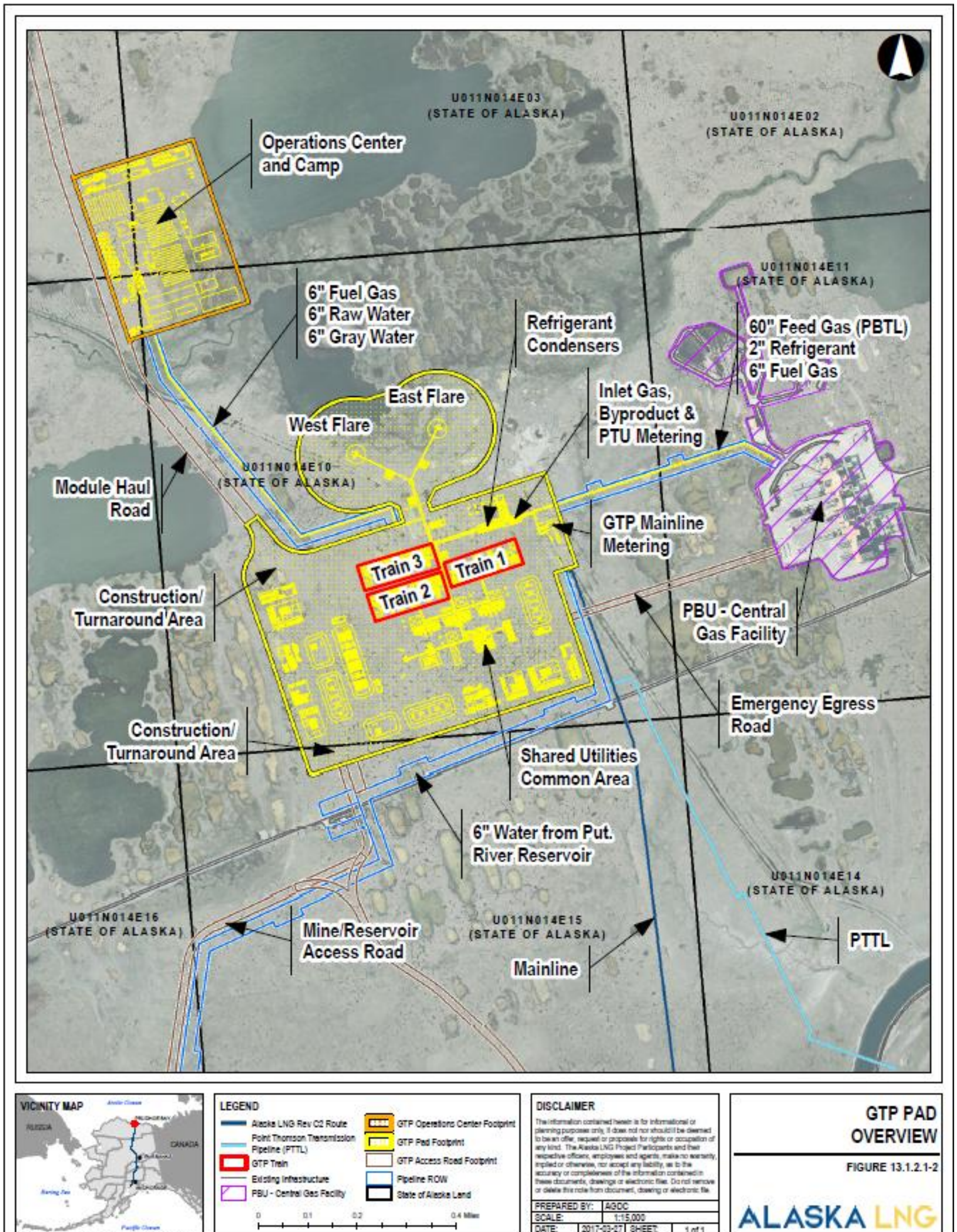
#### 13.1.2.1 Owned and Leased Property Boundaries, Options, Easements, and Rights Of Way With Reference to Site Location Maps and Drawings in Appendix 13.A.1

The GTP wouldtreat natural gas received from the PBU and the PTU. The proposed GTP would be located in the PBU near the Beaufort Sea coast (Refer to Figure 1.1-1 in Resource Report No. 1). Figure 13.1.2.1-1 provides a general overview of the GTP and associated facilities. Figure 13.1.2.1-2 provides details of the GTP Pad, and appendices A.1 and E.6 provide more detailed plot plans of the facility. The GTP would be located in the PBU, which is located on state land within the North Slope Borough (NSB) and is designated for oil and natural gas development.

Granular material would be placed to a specific thickness to stabilize the footprint of the road and create a trafficable surface. The Operations Center Pad would be separate from the GTP Pad, and would include area for the Integrated Construction and Operations Camp along with some construction laydown area. Approximately 1,100 acres would be required for construction of the GTP and approximately 710 acres for operations.

**FIGURE 13.1.2.1-1 GTP Facilities Overview**

**FIGURE 13.1.2.1-2 GTP Pad Overview**



Access roads and module haul roads would be constructed to provide access to the site and to transport modules from the dock location to the GTP. Construction would involve both widening of existing roads and construction of new roads. To construct granular roads, the route would be surveyed, staked, and cleared as necessary. Work would be completed according to permits and requirements to avoid additional impacts. During construction, restrictions/limitations would be put in place to avoid damaging the tundra outside of the pad and road footprint and communicated to the construction teams during Project kickoff and tailgate meetings.

### 13.1.3 Owner, Principal Contractors, and Operator

#### 13.1.3.1 Owner of the Facilities with reference to the Organizational Structure in Appendix 13.A.2

The entity or entities that would own the Project facilities has yet to be determined. AGDC is currently the sole applicant. A preliminary organization chart is included in Appendix 13.A.2.

#### 13.1.3.2 Principal Contractors Identified for Design, Engineering, Procurement, and Construction of the facilities with reference to any preliminary Construction Workforce Organizational Chart or Work Breakdown Structure (if available) in Appendix 13.A.3*

The engineering and design presented in Resource Report 13 GTP has been prepared by AECOM. The principal Engineering, Procurement & Construction (EPC) contractor(s) have not yet been selected.

#### 13.1.3.3 Operating Company of the Facilities with reference to a preliminary Operating Workforce Organizational Chart in Appendix 13.A.4

The entity or entities that would operate the Project facilities has yet to be determined. A Workforce Organization Chart will be developed during the Final Design Phase.

### 13.1.4 Feed and Sendout Products

#### 13.1.4.1 Natural Gas Pipeline(s) Sending Out To

The GTP would send natural gas to the Mainline. The Mainline is a new 42-inch-diameter natural gas pipeline approximately 804 miles in length that would extend from GTP to the Liquefaction Facility.

#### 13.1.4.2 Natural Gas Pipelines Feeding From

The GTP and associated facilities would receive natural gas from the PBU by way of the PBTL and from the PTU by way of the PTTL.

The PBTL would be an approximately 1-mile, 60-inch-diameter aboveground pipeline to transport natural gas from the PBU Central Gas Facility (CGF) to the GTP, with an average stream day rate of 2.8 billion standard cubic feet per day (BSCFD), a peak capacity of 4.0 BSCFD[b] and a maximum allowable operating pressure (MAOP) of 720 pounds per square inch gauge (psig).

The PTTL would be an approximately 62.5-mile, 32-inch-diameter aboveground pipeline. The PTTL design includes an average stream day rate of 865 million standard cubic feet per day (MMSCFD), a peak capacity of 920 MMSCFD[b], and an MAOP of 1,150 psig.

#### 13.1.4.3 Fractionation Product Pipelines Sending Out To

Not applicable to the GTP.

#### 13.1.4.4 Liquefaction Product Shipped To

Not applicable to the GTP.

### 13.1.5 Project Schedule

It is to be requested that FERC issue authorization to site, construct, and operate the Project no later than late 2018, with construction scheduled to commence late 2019. It is anticipated that construction and commissioning of the facilities would take approximately eight years to complete. Construction activities would be divided into phases. The first phase is planned to last from 2019–2025 and would include construction related to the first LNG and GTP trains, marine facilities, Mainline, PBTL, and PTTL, resulting in first production of LNG. After 2024, the installation of the remaining Project facilities needed for full production would take place. The proposed Project schedule is included in Appendix 13.A.5.

## 13.2 SITE INFORMATION

### 13.2.1 Site Conditions

The GTP is planned to be located within the PBU on the North Slope of Alaska, approximately 2,000 feet west of the existing CGF. The GTP would accept feed gas from the PBU and from the PTU to produce a treated gas stream that does not require further $H_2S$ or $CO_2$ removal at the Liquefaction Facility at Southcentral Alaska (Nikiski). The plant would have multiple interfaces with the PBU and PTU that have been integrated into its design.

The GTP would consist of three processing trains, common utility systems, two 100-percent-capacity flare sets, inlet/outlet metering, and a construction laydown area. The entrance to the facility would be located at the northwest corner of the pad. This road would serve as the main access/egress for the plant and module delivery road for construction. Road turnouts would be constructed to accommodate the multi-purpose use. A road would also be constructed to connect the GTP with the nearby CGF. Because the primary road should be used for nearly all entrance and exits, this road would serve as a potential means of egress and moving smaller equipment.

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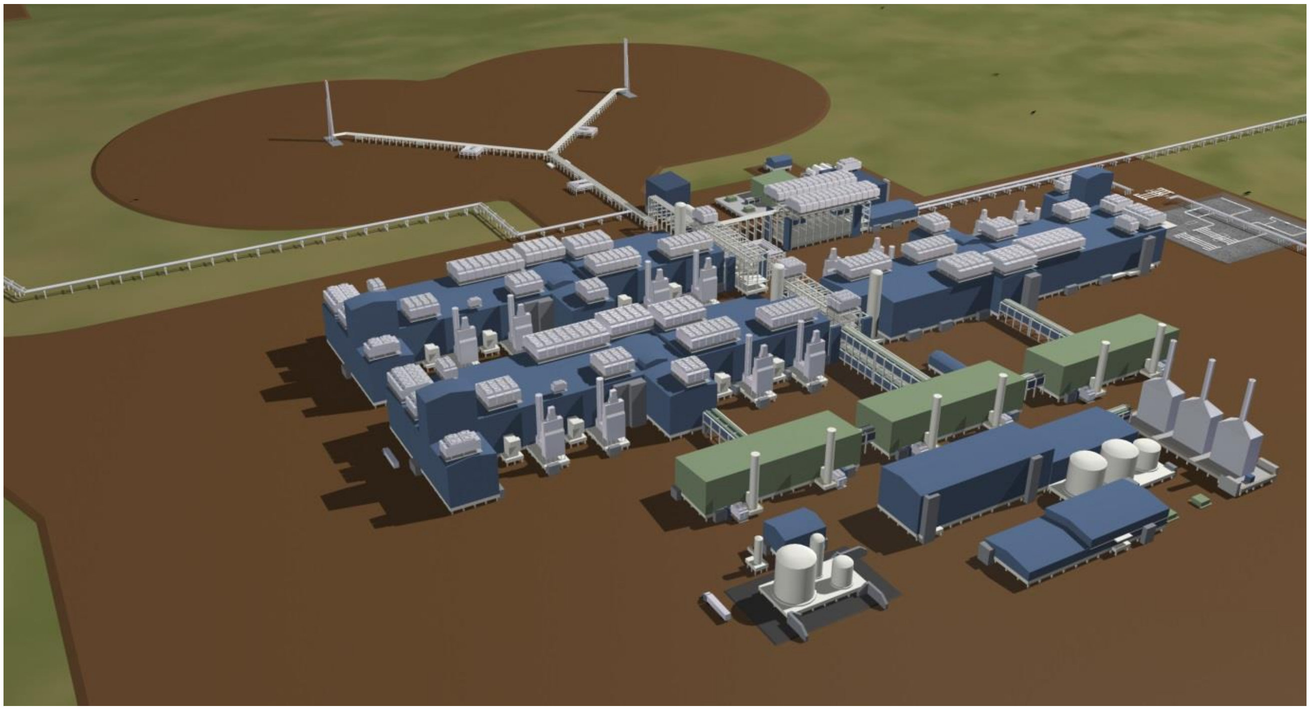
[b] Average stream day rate denotes the weighted 12-month average of monthly stream day rate values. Stream day rate represents the physical capacity of the facility at a particular ambient condition and does not account for planned or unplanned downtime (assume 100 percent uptime).

Additionally, a granular haul road would enter the pad near the southwest corner. The control building would be located immediately adjacent to this road to facilitate a central entrance/check-in point. Because this would be an occupied building, it would be designed and constructed as a blast-resistant structure per the overpressure and dispersion scenarios analyzed.

Figure 13.2.1-1 shows a 3-D rendering of the GTP and Operations Center depicting the major components of the facility.

**FIGURE 13.2.1-1 3D Rendering Model of GTP**



The Grid Layout to the Alaska North Slope NAD83 U.S. Survey for the GTP is included in the Gas Treatment Plant Site Plan (USAG-EC-LDLAY-00-001004-000) included in Appendix 13.A.1.

#### 13.2.1.1 Elevation reference, North American Vertical Datum of 1988 (NAVD88) or National Geodetic Vertical Datum of 1929 (NGVD29)

The site is relatively flat at an average elevation of approximately 30 feet above mean sea level (MSL) with an active layer (seasonal thaw cycles allowing plant growth) from 1–2 feet in depth.

Elevations are relative to the North American Vertical Datum (NAVD) 88.

#### 13.2.1.2 Marine Platform Elevation, ft

Not applicable to the GTP.

#### 13.2.1.3 LNG Storage Tank Inner Tank Bottom Elevation, ft

Not applicable to the GTP.

#### 13.2.1.4 Process Areas Foundation Elevation, ft

GTP Pad process area elevation: 30 feet +/- MSL.

#### 13.2.1.5 Impoundment Floor Elevation, ft

Not applicable to the GTP.

#### 13.2.1.6 Utilities Foundation Elevation, ft

GTP Pad utilities area elevation: 30 feet +/- MSL.

#### 13.2.1.7 Buildings Foundation Elevation, ft

GTP Pad buildings area elevation: 30 feet +/- MSL.

#### 13.2.1.8 Roads Elevation, ft

Roads would be constructed of competent granular fill only (i.e., no overburden) with a minimum thickness of 5 feet as required to stabilize the footprint of the road. Actual thicknesses are determined by topography and slope requirements, which are generally considerably thicker than the minimum.

Primary road elevations are provided in the following list:

- Emergency road elevation, high point: 31 feet above MSL;
- Module haul road elevation, high point: 31 feet MSL; and
- Granular haul road elevation, high point: 38 feet above MSL.

### 13.2.2 Shipping Channel

#### 13.2.2.1 Channel Width, ft

Not applicable to the GTP.

#### 13.2.2.2 Channel Depth, ft

Not applicable to the GTP.

#### 13.2.2.3 Berth Depth, ft

Not applicable to the GTP.

#### 13.2.2.4 Tidal Range Elevations, ft

Not applicable to the GTP.

#### 13.2.2.5 Channel Current (normal, maximum), knots

Not applicable to the GTP.

### 13.2.3 Climactic Conditions

#### 13.2.3.1 Temperature Design Basis (minimum, average, maximum), °F

The minimum metal (equipment) design temperature used in the design of the GTP is -20 °F for equipment located inside a module and -50° F for equipment located outside a module, based on review of climate data.

The maximum ambient temperature used in the design of the facility is 82 °F, based on review of climate data.

#### 13.2.3.2 Barometric Pressure Design Basis (minimum, average, maximum), inches mercury (Hg)

The barometric pressure used for the design of the facility is 29.8 inches mercury (Hg) (1,009.1 mbar).

#### 13.2.3.3 Barometric Pressure Rate of Increse Design Basis (minimum, average, maximum), inHg/h

Not applicable to the GTP.

#### 13.2.3.4 Barometric Pressure Rate of Decrease Design Basis (minimum, average, maximum), inHg/hr

Not applicable to the GTP.

#### 13.2.3.5 Prevailing Wind with Seasonal Wind Rose or Charts with 16 Radial Directions and Wind speeds, mph

The prevailing wind directions at the GTP are East-North-East.

#### 13.2.3.6 Rain Fall Fates Design Basis (100-year return period, 50-year return period, 10-year return period), inches per hour

Annual average precipitation is 4.26 inches (1/50 year). The design (1-hour period) precipitation is 0.4 inch (1/50 year).

#### 13.2.3.7 Snow Fall Rates Design Basis (100-year return period, 50-year return period, 10-year period), inches per hour

Average annual snowfall is 33.1 inches (1/50 year).

#### 13.2.3.8 Frost Line Depth, ft

The active layer of permafrost is 1 to 2 feet with varying depth.

#### 13.2.3.9 Visibility Frequency and Distances, No. fog alerts per year, visibility ft

Not applicable to the GTP.

#### 13.2.3.10 Lightinig Strike Frequency, No. per year

Not applicable to the GTP.

### 13.2.4 Geotechnical Conditions

#### 13.2.4.1 Groundwater Conditions

To be determined in detailed design.

#### 13.2.4.2 Soil/Rock Layer Description

The proposed GTP area consists of silty soil with continuous permafrost and occasional ice lenses. Permafrost refers to soils frozen for two or more years and is described as continuous when the majority of ground surface (e.g., greater than 80 percent) is underlain by permafrost.

The three process trains, flares, and operation center would be constructed on individual granular pads. The fill requirements for each pad are based on the following considerations:

- Sufficient thickness to stabilize the footprint of the pad; and
- Thickness designed to avoid damage to or thawing of the permafrost.

Pads would be constructed of granular material placed in lifts and compacted as overlays (embankments) on the tundra. Organic cover would not be removed. Pads would be at least 5 feet thick.

Pads would be oriented to minimize snow drifting where practicable, which involves the long axis of a pad approximately parallel to the prevailing wind direction to minimize the end area (sail) exposed to the wind.

Consideration would be given to snow removal during the pad layout design. Access to the tundra would be provided at several pad locations for equipment to push snow onto the tundra in a manner to minimize any granular material displacement onto the tundra. Pipe racks should be laid out so that push distances are relatively short.

The pad design would consider existing topography and hydrology to minimize granular material requirements, maintain natural drainage patterns, to the extent practical, and minimize water ponding. The design would also consider the required turn radius that would accommodate the largest vehicles accessing or exiting the facility.

Flood surges, ice run-up, and erosion would be considered when designing pads near rivers or coastal shorelines.

Pads constructed with frozen granular material would not be considered seasoned (stable) until at least one summer season has passed for thawing and draining to occur. Frozen embankments, even if compacted, may subside 15-20 percent upon thawing. Pads may be initially overbuilt or rebuilt after settlement has occurred.

#### 13.2.4.3 Geotechnical Cross Sections

The site is relatively flat at an average elevation of approximately 30 feet above mean sea level (MSL) with an active layer (seasonal thaw cycles allowing plant growth) from 1 to 2 feet in depth. Unsuitable material would be removed from the area where granular material for the pad or roads would be placed without disturbance to the tundra outside the limits of construction.

Active layer and permafrost boundary locations vary in the vicinity of lakes, ponded water, snow storage, and where local conditions modify the thermal requirements. In situations like these, the depth of active layer would be determined by actual field measurements.

For design purposes, the bottom of the active layer would be as follows:

- Undisturbed tundra: 3 feet below the surface;
- Disturbed tundra or pond up to 3 feet in depth: 6 feet below the surface;
- Established granular pad (5 feet thick): 6 feet below the pad surface; and
- New granular pad (5 feet thick) in place less than two years: 8 feet below the pad surface.

#### 13.2.4.4 Soil and Rock Parameters

The Project location area consists of silty soil with continuous permafrost and occasional ice lenses. Permafrost refers to soils frozen for two or more years and is described as continuous when the majority of ground surface (e.g., greater than 80 percent) is underlain by permafrost. The site is relatively flat at an average elevation of approximately 30 feet above MSL with an active layer (seasonal thaw cycles allowing plant growth) from 1–2 feet in depth.

There is no specific geotechnical data available for the current design of foundations and support systems for the GTP Pad. Historical borehole data has been used to compile the basis for pile foundation design detailed in the Criteria for Pile Foundation Design (USAG-EC-NSZZZ-00-000001-000) included in Appendix 13.F.1.

Additional geotechnical investigations for the GTP Pad would be conducted during detailed design of the Project to progress geohazard screening (e.g., ice lenses) and support design for adfreeze pile, dynamic foundations, and other structures.

#### 13.2.4.5 Granular Material Mine

The PUT 23 mine is currently the primary granular resource in the vicinity of the GTP site, but is expected to be nearly depleted at the time of GTP construction, so a new granular material mine would be required. A geotechnical investigation was conducted in April 2015 that characterized a new granular material resource sufficient for construction in both quantity and quality. Findings from this investigation are detailed in the GTP Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

The location of the recommended mine is on the north side of the Putuligayuk River approximately 3 miles southwest of the GTP Pad such that granular material haul distance is minimized due to the scale of the projected haul size.

#### 13.2.4.6 Foundations and Piles

The predominant foundation system used on the North Slope is adfreeze piles, which would serve as the basis for the GTP design. All structures, excluding the slab on grade warehouse, would be supported by adfreeze piles, which are round, closed-end pipe piles placed in a pre-drilled hole with a sand/water slurry backfill.

The adfreeze pile system achieves strength when the slurry freezes in the annular space between the pile and the exposed native soil in the boring, and the capacity generated from this bond strength is a factor of the following considerations:

- Pile diameter;
- Pile material;
- Slurry density;
- Slurry quality;
- Ice content of the native in-situ condition;
- Installed slurry temperatures;
- Ground temperatures;
- Temperature cycles; and
- Load duration.

The pile diameters would range from 12-inch to 48-inch with the largest quantity being the 12-inch pile size. The proposed estimate for pile quantities is approximately 4,650 piles for a total of 23,500 short tons. Additional information on foundation design would be available in a later stage of the Project upon the completion of a site-specific geotechnical investigation. The heaviest modules are of particular interest along with those with rotating equipment requiring dynamic analysis.

The connection between the piles and the module legs would be a direct connection to a single pile, or in cases of high shear or axial load, a foundation frame system support of multiple piles. Adfreeze pile material shall meet the requirements American Petroleum Institute (API) 5L or approved equal.

Appendix 13.F.1 includes the Criteria for Pile Foundation Design (USAG-PG-NSZZZ-00-00001-000), which presents preliminary criteria for the design of foundations for modules, buildings, tanks, pipe racks, pipe supports, and other structures.

Additional details regarding machinery foundations/supports, module base plate/pile cap plate connections, concrete specification, and other general foundation design considerations are provided in the Structural Design Basis (USAG-EC-NBDES-00-000001-000) included in Appendix 13.B.5.

#### 13.2.4.7 Roads

Approximately 6 miles of new road would be constructed and approximately 2.2 miles would be upgraded for the module haul to the GTP Site Pad. The road upgrades would be as necessary to transport the GTP modules (9,000-ton not-to-exceed weight), which would include widening of the section to 100–125 feet, achieving sufficient bearing capacity, and increasing the road thickness if required.

All upgrades and new roads would be constructed of granular fill only (i.e., no overburden) with a sufficient thickness to stabilize the footprint of the road. The road embankments are assumed to be at a 2:1 slope considering this is the typical angle of repose for granular material and maximum gradient suitable for transportation.

The entrance to the GTP would be located at the northwest corner of the pad. This road serves as the main access/egress for the plant and module delivery road for construction. A road is also provided to connect the GTP with the nearby CGF. Because the primary road would be used for nearly all entrance and exits, this road would serve as a potential means of egress and moving smaller equipment. Additionally, a granular material haul road enters the pad near the southwest corner.

The Project Civil Basis of Design (USAG-EC-CBDES-00-000001-000) included in Appendix 13.B.3 provides design considerations for the following:

- Haul Roads;
- Access Roads;
- Road Crossings; and
- Ice Roads.

##### 13.2.4.7.1 Existing Road Upgrade

The existing main road from West Dock to PBU's K-Pad would be upgraded to facilitate module transport (width, bearing pressure, curvature, and potentially increasing thickness) and provide access to the new staging area prior to the location where the new road diverges to the GTP.

The existing road has previously been used to transport modules weighing more than 5,000 short tons and is an average of 45-feet wide and 5-feet thick. The road expansion would go to the north due to the pipelines paralleling the southern edge and module turnouts would be provided as needed to allow traffic flow during module delivery.

- Curvature: 1,000 feet radius; and
- Length: 2.2 miles.

#### 13.2.4.7.2 Module Haul Main Access Road

The new module haul road would diverge to the GTP at approximately 1.2 miles northeast of K-Pad where a caribou crossing would be leveraged to bridge over the pipelines paralleling the southern edge of K-Pad Road. The road would be designed and constructed to facilitate module transport (width, bearing pressure, and curvature) and would lead to the Operations Center and GTP Pad at the northwest corner.

- Curvature: 1,000 feet radius; and
- Length: 2.1 miles.

#### 13.2.4.7.3 Granular Material Haul/Water Reservoir Road

Another road would be constructed to the GTP Pad near the southwest corner because it is the closest location to the granular material mine and water reservoir. This road would be designed to accommodate the high volume of heavy duty trucks required to haul the millions of cubic yards of granular material needed to construct the GTP. To enter the facility on the southwest corner, a built-up granular material intersection would be required over a 60-inch pipeline on each side of a road that parallels the southern edge of the pad. The primary design strategy of this bridge is to facilitate safe transport during difficult trucking conditions. It would be a two-way traffic bridge with heavy-duty guardrails leading the trucks up the approaching abutments safely. Because the bridge would need to maintain cross-traffic for PBU's service road between the pipelines, a granular material bridge would be used to elevate crossings from all four directions. The granular material compaction, pipeline casings, and thickness above casings would be sufficient to accommodate the large granular material hauling units that would be expected to be used.

- Curvature: 200 feet radius; and
- Length: 3.1 miles.

#### 13.2.4.7.4 Central Gas Facility (CGF) Road

A road primarily intended as a second avenue for emergency access/egress with the opportunity for small equipment travel, if needed, would be connected to the CGF. The road would enter/exit the pad at the opposite corner as the primary road, which is ideal for emergency egress given a scenario that shuts down the primary road. The granular material haul road could function as an egress route from the GTP pad; however, the road would dead-end at the Put River. This road may connect to existing PBU roads at the spine road or drill site 15 south of the reservoir.

- Curvature: Not applicable (NA) (this road is a straight connection to the CGF Pad); and
- Length: less than 1 mile.

Plan and elevation drawings for the emergency road are included in Appendix 13.E.9.

## 13.3 NATURAL HAZARD DESIGN CONDITIONS

### 13.3.1 Seismic

There are no known active fault lines north of the Brooks Range including the North Slope, where the GTP would be located. Thus, the initial approach to develop seismic design requirements for structures, systems, and components at the GTP would be to apply the 2012 International Building Code, which specifies that seismic design parameters be based upon ASCE 7-05. Table 13.3.1 provides the seismic design criteria for the GTP.

TABLE 13.3.1

**GTP Seismic Design Criteria**

| **Earthquake** | | **Unit** | **Source** |
|---|---|---|---|
| Site Class | C | | Source 1 |
| Impact Factor | 1.25 | | Source 1 |
| 0.2-Second Spectral Response Acceleration (Ss) | 0.26 | g | Source 2 |
| 1.0-Second Spectral Response Acceleration (S1) | 0.1.0 | g | Source 2 |
| Seismic Design Category | B | | Source 1 |

Source 1: IBC 2012 – This parameter is used to calculate the wind load on the structures as part of the structural design at Limit States
Source 2: http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html
Source 3: http://tapseis.anl.gov/documents/docs/feis/volume7/3.12-3.pdf

#### 13.3.1.1 Maximum Considered Earthquake Design Philosophy

The Maximum Considered Earthquake (MCE) Spectrum and Design Response Spectrum were developed using the generic code procedures as (not site-specific) outlined in Section 11.4 of the Standard ASCE 7-10 for a soil class representative of the anticipated subsurface soils at the site. A site-specific analytical approach may be considered in detailed design to reduce the conservatism associated with generic code-based Spectra.

Systems Designed to Operating Basis Earthquake, Operating Base Earthquake (OBE)

No systems would be designed to Operating Basis Earthquake (OBE) because OBE is specific to the FERC Seismic Design Guidelines and Data Submittal Requirements, which have been determined not to be applicable to the GTP.

#### 13.3.1.2 Systems Designed to Safe Shutdown Earthquake (SSE)

No systems would be designed to Safe Shutdown Earthquake (SSE) because SSE is specific to the FERC Seismic Design Guidelines and Data Submittal Requirements, which have been determined not to be applicable to the GTP.

#### 13.3.1.3 Ground Motion Detection: Identify Systems That Alarm and Shutdown

Not applicable to the GTP.

### 13.3.2 Design Wind Speed, mph

The wind speeds for the facility would be applied in accordance with ASCE 7 requirements. The design basic wind speed is 140 miles per hour (mph) (three-second gust wind speed at 33 feet above ground).

### 13.3.3 Hurricane Design Force mph or Storm Category

Not applicable to the GTP.

### 13.3.4 Storm Surge Height, Feet

Not applicable to the GTP.

### 13.3.5 Description of Foundations and Supports

The predominant foundation system used on the North Slope is adfreeze piles, which would serve as the basis for the GTP design. All structures, excluding the slab on grade warehouse, would be supported by adfreeze piles that are round closed-end pipe piles placed in a pre-drilled hole with a sand/water slurry backfill. The adfreeze pile system achieves strength when the slurry freezes in the annular space between the pile and the exposed native soil in the boring, and the capacity generated from this bond strength is a factor of the following:

- Pile diameter;
- Pile material;
- Slurry density;
- Slurry quality;
- Ice content of the native in-situ condition;
- Installed slurry temperatures;
- Ground temperatures;
- Temperature cycles; and
- Load duration.

The pile diameters would range from 12-inch to 48-inch with the largest quantity being the 12-inch pile size. The proposed design estimate for pile quantities is approximately 4,650 piles for a total of 23,500 short tons. Additional information on foundation design would be available in a later stage of the Project upon the completion of a site-specific geotechnical investigation. The heaviest modules would be of particular interest along with those with rotating equipment requiring dynamic analysis. The connection between the piles and the module legs would be a direct connection to a single pile, or in cases of high shear or axial load, a foundation frame system support of multiple piles. Adfreeze pile material would meet the requirements API 5L or approved equal.

Appendix 13.F.1 includes the Criteria for Pile Foundation Design (USAG-PG-NSZZZ-00-00001-000), which presents preliminary criteria for the design of foundations for modules, buildings, tanks, pipe racks, pipe supports, and other structures.

Additional details regarding machinery foundations/supports, module base plate/pile cap plate connections, concrete specification, and other general foundation design considerations are provided in the Structural Design Basis (USAG-ECNBDES-00-000001-000) included in Appendix 13.B.5.

Typical foundation drawings are included in Appendix 13.J.2 as listed in the subsequent table.

TABLE 13.21.2-1

**Typical Foundation Drawings**

| Drawing Number | Description |
|---|---|
| USAG-EC-NDPIL-10-000002-001 | Typical Pile Concept Details |
| USAG-EC-NDCPT-10-000001-001 | Typical Module Details (Sheet 001) |
| USAG-EC-NDCPT-10-000001-002 | Typical Module Details (Sheet 002) |

## 13.4 MARINE FACILITIES

Not Applicable to the GTP

## 13.5 FEED GAS

The GTP would accept feed gas from the PBU and from the PTU to produce a treated gas stream that would not require further $H_2S$ or $CO_2$ removal at the Liquefaction Facility at Southcentral Alaska (Nikiski). The GTP would have multiple interfaces with the PBU and PTU that have been an integral part to its proposed state of design.

### 13.5.1 Feed Gas Design

During peak winter operation, the GTP is designed to process approximately 3.9 BSCFD of blended feed gas containing 11 molecular percent (mol%) $CO_2$ and 81 parts per million/volume (ppmv) of $H_2S$ and deliver 3.3 BSCFD of treated gas containing less than 50 ppmv $CO_2$ and 4 ppmv $H_2S$ to the Mainline at a maximum delivery pressure of 2,075 psig. Minimum summer capacity is designed for about 2.9 BSCFD.

The extraction of $CO_2$ and $H_2S$ from the raw feed gas would produce a $CO_2$-rich stream containing approximately 99-percent $CO_2$ with the remainder $H_2S$ and hydrocarbons that would be compressed, dehydrated, and returned to the PBU at 4,000 psig. Custody transfer and fiscal allocation of the feed gas from the PTU and PBU would be accomplished via ultrasonic-type custody transfer meters (CTMs). Document USAG-EC-LDEQL-5A-001001-001, Appendix 13.E.6 provides details of the Inlet Gas Metering Station module location and layout for the GTP. The inlet/outlet check metering would be located on a granular material pad on the east side of the facility. This location provides simple pipeline access to the neighboring CGF and separates it from the process area.

Process flow diagrams included in Appendix 13.E.2 provide details of the GTP interface with the PBU and PTU feed gas pipelines.

| Drawing Number | Description |
|---|---|
| USAG-EC-PDPFD-50-000609-001 | Process Flow Diagram – GTP Interface |
| USAG-EC-PDPFD-50-000609-002 | Process Flow Diagram – PTU Interface |

Table 13.5.1-1 provides a summary of the design conditions of the GTP interfaces with the PTU and CGF.

TABLE 13.5.1-1

**GTP Interface Design Conditions**

| | **Winter** | **Summer** | **Upstream Design Conditions** |
|---|---|---|---|
| Ambient temperature (for Process Design) | 20 °F | 55 °F | |
| Boundary limit (BL) operating pressure CGF feed gas at CGF | 580–620 psig | 580–620 psig | MAOP = 720 psig |
| BL operating temperature CGF feed gas at CGF | 40 °F (average 45 °F) | 80 °F (average 55 °F) | -40 °F (minimum)<br>90 °F (maximum) |
| BL pressure PTU feed gas at GTP | 650–1050 psig | 650–1050 psig | MAOP = 1,130 psig |
| BL temperature PTU feed gas at GTP | -2 °F | +70 °F | -50 °F (minimum) at minimum flow winter condition |

The PTU gas would be sent through an inlet Knock-out (KO) Drum to allow any liquids that may form in the PTTL to drop out of the natural gas stream before entering the processing trains. The natural gas from the PBU would be combined with the natural gas flow from PTU and then sent to the GTP process trains. The inlet facilities would be located on the northeast corner of the GTP Pad as detailed in the Process and Utilities Plot Plan (USAG-EC-LDLAY-00-001005-001) included in Appendix 13.A.1.

#### 13.5.1.1 Feed Gas Batter Limit Operating and Design Flow Rate Capacities (minimum, normal, maximum), MMscfd

The PBTL would be an approximately 1-mile, 60-inch-diameter aboveground pipeline to transport natural gas from the PBU CGF to the GTP, with an average stream day rate of 2.9 billion standard cubic feet per day (BSCFD), a peak capacity of 4.0 BSCFD [c] and a MAOP of 720 psig.

[c] Average stream day rate denotes the weighted 12-month average of monthly stream day rate values. Stream day rate represents the physical capacity of the facility at a particular ambient condition and does not account for planned or unplanned downtime (assume 100 percent uptime).

The PTTL would be an approximately 62.5-mile, 32-inch-diameter aboveground pipeline. The PTTL design includes an average stream day rate of 865 MMSCFD[d], a peak capacity of 920 MMSCFD[e], and an MAOP of 1,150 psig.

#### 13.5.1.2 Feed Gas Battery Limit Design Pressures (minimum, normal, maximum), psig

Pressure of the feed gas from the PTU would be approximately 665 psi at the battery limits of the GTP and the PTTL. Pressure of the feed gas from the PBU would be approximately 587 psi at the battery limits of the GTP and the PBTL.

The MAOP at the inlet of the GTP would be 720 psig.

The minimum inlet pressure at the GTP would be 580 psig.

#### 13.5.1.3 Feed Gas Battery Limit Operating and Design Temperatures (minimum, normal, maximum), °F

Pressure of the feed gas from the PTU would be approximately -2 °F at the battery limits of the GTP and the PTTL. Pressure of the feed gas from the PBU would be approximately 39 °F at the battery limits of the GTP and the PBTL.

The design temperature of the GTP at the custody transfer meter from the PBTL is -50 °F/150 °F.

#### 13.5.1.4 Feed Gas Operating and Design Inlet Gas Compositions (minimum/lean/light, normal/design/average, maximum/rich/heavy), %-vol and/or parts per million (ppm)

Table 13.5.1-2 provides the expected feed gas composition considered for the design of the GTP.

TABLE 13.5.1-2

**Expected Feed Gas Composition**

| Component | Feed to GTP (Design Basis) |
|---|---|
| $H_2S$ | 81 ppmv |
| $CO_2$ | 10.9798 mol% |
| Nitrogen | 0.681 mol% |
| Methane ($CH_4$) | 81.0927 mol% |
| Ethane | 5.131 mol% |
| Propane | 1.7571 mol% |
| i-Butane | 0.1191 mol% |
| n-Butane | 0.1562 mol% |
| i-Pentane | 0.033 mol% |
| n-Pentane | 0.0308 mol% |

[d] Variability due to changes in in-state gas interconnection points over 30-year design life.

[e] Average stream day rate denotes the weighted 12-month average of monthly stream day rate values. Stream day rate represents the physical capacity of the facility at a particular ambient condition and does not account for planned or unplanned downtime (assume 100 percent uptime).

TABLE 13.5.1-2

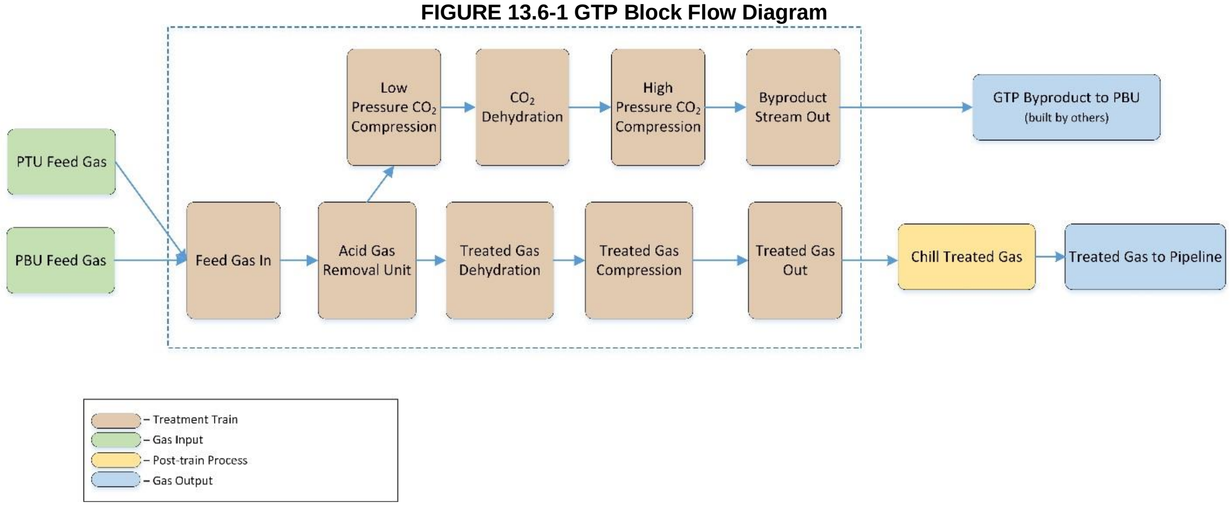
**Expected Feed Gas Composition**

| Component | Feed to GTP (Design Basis) |
|---|---|
| 2-Methylpentane | 0.0015 mol% |
| n-Hexane | 0.0031 mol% |
| Methylcyclopentane | 0.0012 mol% |
| Benzene | 0.0005 mol% |
| Cyclohexane | 0.0007 mol% |
| n-Heptane | 0.0025 mol% |
| Methylcyclohexane | 0.0009 mol% |
| Toluene | 0.0001 mol% |
| n-Octane | 0.0008 mol% |
| Water | 0 mol% |

## 13.6 FEED GAS PRETREATMENT

The GTP would consist of a three-train system with each train producing nominally up to 1.1 BSCFD of treated gas to the Mainline. Each process train would have the dedicated common systems listed below and as depicted in Figure 13.6-1.

**FIGURE 13.6-1 GTP Block Flow Diagram**



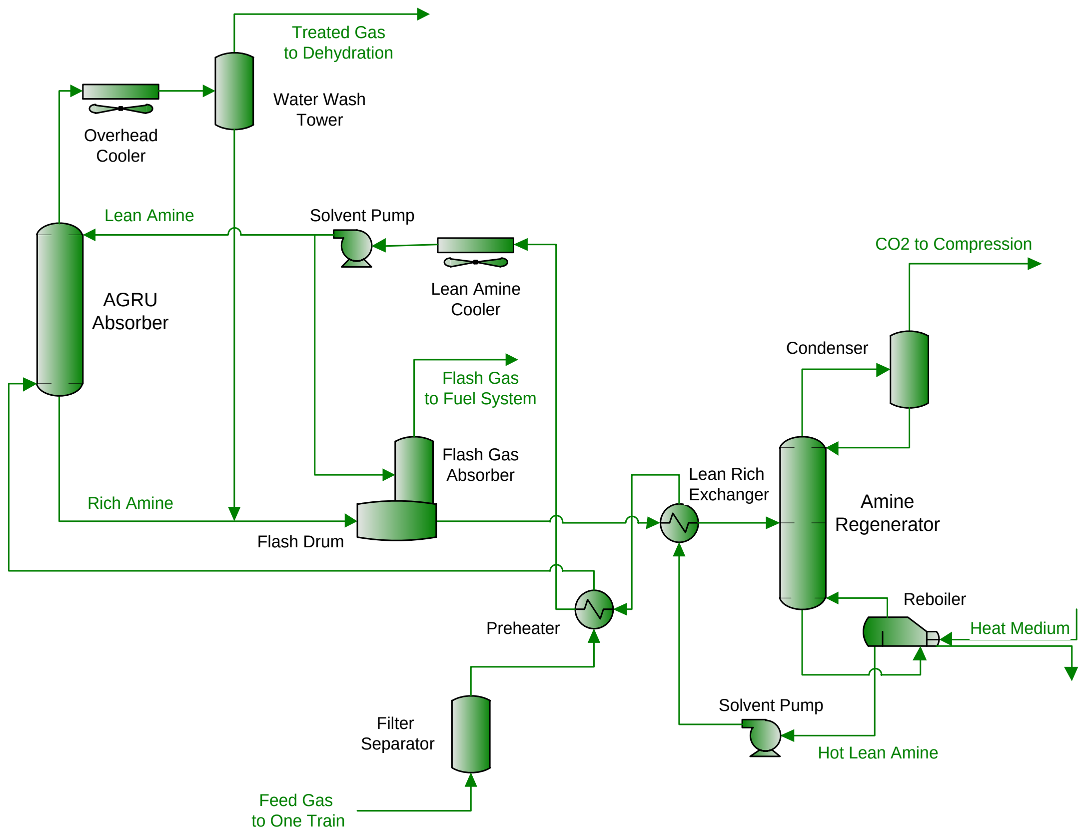

### 13.6.1 Acid Gas Removal Design

There would be one Acid Gas Removal Unit (AGRU) per train. The purpose of the AGRU would be to absorb $CO_2$ and $H_2S$ from the feed gas by counter-current contact in a packed absorber tower with an aqueous amine solvent (formulated methyl-diethanolamine [MDEA] solvent).

The acid gas-rich solvent would be regenerated by heat stripping and the cooled lean solvent would be recirculated to the absorber tower. The solvent heating would be the primary process energy load for the

Process Heat Medium Loop. Three parallel AGRU trains would be required to treat the volume of gas fed to the GTP. A simplified sketch of the AGRU for one train is shown in Figure 13.6.1-1.

**FIGURE 13.6.1-1 AGRU Process Schematic**




The sour gas feed would enter the AGRU after exiting the Inlet Metering Facilities and would first flow through the Filter Separator, which removes solid particles and liquid mist.

The purpose of the Filter Separator would be to protect the AGRU from unanticipated contamination in the feed gas that could cause undesirable effects (e.g., foaming, degradation). Because of the very large volume of gas fed to each AGRU train, two 50-percent filter separators would be required and would be installed in parallel.

The gas from the AGRU Filter Separator would then flow to a Preheater where it would be heated by cross-exchange with warm, lean amine before entering the AGRU Absorber. Warming the inlet gas would be done to improve reaction kinetics for acid gas removal within the Absorber.

The warm, sour gas from the Preheater would enter the bottom of the AGRU Absorber where it would flow upward contacting a formulated MDEA solvent in counter-current flow through a series of packed beds where the amine removes $CO_2$ and $H_2S$ from the gas. The warm and now water-saturated, sweet overhead gas would then be fed to the AGRU Absorber Overhead Cooler to condense as much water as possible from the saturated stream. This serves two purposes: 1) it would minimize water losses from the AGRU system and in turn would lower water makeup requirements, and 2) it would minimize water content of the sweet gas before it is further dehydrated to meet treated gas specifications, lowering the overall load on the TGDU.

The cooled stream (now gas and condensed water) would be sent to the AGRU Water Wash Tower. The Water Wash Tower would provide a water wash section, which consists of three valve trays, to ensure minimal amine losses with the treated gas. The gas stream exiting the top of this separator, which is water-saturated and sweet, would be fed to the Treated Gas Dehydration Unit.

Cooled, lean amine would be fed to the top of the packed section of the Absorber. After counter-current contacting with the gas, the acid gas-rich amine would exit the bottom of the packed section into the sump of the Absorber. The sump below the packed beds in the Absorber would provide at least three minutes of surge volume for the rich amine. The warm, rich amine would be drawn off the bottom of the Absorber and would enter the AGRU Solvent Flash Drum. Most of the soluble hydrocarbon gases are flashed and recovered from the solvent entering the AGRU Solvent Flash Drum, treated with a small slipstream of amine in the AGRU Flash Gas Absorber to lower the acid gas content, and sent to the fuel gas system.

Rich amine solvent from the Flash Drum would be heated in the AGRU Lean/Rich Exchanger and would enter the Regenerator column above two packed beds. The rich solvent liquid would flow down through the packed beds where it would contact steam (generated in the reboiler) in counter-current flow for stripping of the $CO_2$ and $H_2S$ from the solvent. The stripped acid gas would mix with flash vapors from the rich solvent inlet and the combined stream would flow up to the reflux section of the column. This section contains three valve trays that would allow washing of the acid gas to minimize amine losses in the tower overhead. The hot, water-saturated acid gas from the Regenerator would feed the AGRU Solvent Regenerator Condenser, where the acid gas stream would be cooled and water condensed for return to the Regenerator as reflux.

When the stripped amine reaches the chimney tray below the packed section of the Regenerator, it would flow by gravity out of the Regenerator to six parallel AGRU Solvent Reboilers. In the kettle-type reboiler exchangers, pressurized water heat medium would flow through the tube-side to heat the solvent and boil a portion of the water in the solvent to generate the stripping steam required for regenerating the rich solvent fed to the AGRU Solvent Regenerator.

The stripping steam exits the top of the shell-side of the kettle and would be returned to the Regenerator below the chimney collection tray under the packed beds for proper distribution. The hot regenerated amine, which would then be lean, would flow over a weir maintaining a liquid level above the exchanger tubes, would exit the bottom of the shell-side of the kettle and then would flow back to the bottom of the AGRU Solvent Regenerator by gravity.

The bottom of the Regenerator would provide surge volume for the lean amine, from where it would be pumped by the AGRU Lean Solvent Booster Pump to the Lean/Rich Exchangers, Feed Gas Preheater, and Lean Solvent Cooler and then pumped by the Lean Amine Circulation Pumps to the AGRU Absorber.

Detailed Process Flow Diagrams (PFDs) and Process and Instrumentation Diagrams (P&IDs) for the AGRU are included in Appendix 13.E.2 and 13.E.5, respectively. Heat and Material Balance for winter and summer are provided in Appendix 13.E.4.

Process design conditions for the AGRU are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

#### 13.6.1.1 Acid Gas Removal System Type

Amine

#### 13.6.1.2 Acid Gas Removal Operating and Design Inlet Flow Rate Capacities (minimum, normal, maximum), MMscfd

| | TABLE 13.6.1-1<br><br>**Acid Gas Removal Operating and Design Inlet Flow Rate Capacities (MMscfd)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 3921.4 | TBD |
| **Summer** | TBD | 3439.4 | TBD |

#### 13.6.1.3 Acid Gas Removal Operating and Design Inlet Gas Compositions (Minimum/Lean/Light, Normal/Design/Average, Maximum/Rich/Heavy), Parts Per Million (ppm)

Gas compositions are detailed in the Heat and Material Balance documents included in Appendix 13.E.4. Refer to information for streams referenced below:

Winter: Stream 609005 in Heat and Material Balance document USAG-EC-PDPFD-50-000609-100

Summer: Stream 609005 in Heat and Material Balance document USAG-EC-PDPFD-50-000609-200

#### 13.6.1.4 Acid Gas Removal Operating and Design Inlet Pressures (Minimum, Normal, Maximum), psig

| | TABLE 13.6.1-2<br><br>**Acid Gas Removal Operating and Design Inlet Pressures (psig)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 570.0 | 720 |
| **Summer** | TBD | 571.1 | 720 |

#### 13.6.1.5 Acid Gas Removal Operating and Design Inlet Temperatures (Minimum, Normal, Maximum), °F

| | TABLE 13.6.1-3<br><br>**Acid Gas Removal Operating and Design Inlet Temperatures (°F)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 27.1 | TBD |
| **Summer** | TBD | 75.7 | TBD |

#### 13.6.1.6 Acid Gas Removal Operating and Design Outlet Flow Rate Capacities (Minimum, Normal, Maximum), MMscfd

| | TABLE 13.6.1-4<br><br>**Acid Gas Removal Operating and Design Outlet Flow Rate Capacities (MMscfd)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 3485.7 | TBD |
| **Summer** | TBD | 3057.0 | TBD |

#### 13.6.1.7 Acid Gas Removal Operating and Design Outlet Gas Compositions (Minimum/Lean/Light, Normal/Design/Average, Maximum/Rich/Heavy), ppm

Gas compositions are detailed in the Heat and Material Balance documents included in Appendix 13.E.4. Refer to information for streams referenced below:

Winter: Stream 662001 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-102

Summer: Stream 662001 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-202

#### 13.6.1.8 Acid Gas Removal Operating and Design Outlet Pressures (Minimum, Normal, Maximum), Psig

| | TABLE 13.6.1-5<br><br>**Acid Gas Removal Operating and Design Outlet Pressures (psig)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 542.5 | 720 |
| **Summer** | TBD | 544.0 | 720 |

#### 13.6.1.9 Acid Gas Removal Operating and Design Outlet Temperatures (Minimum, Normal, Maximum), °F

| | TABLE 13.6.1-6<br><br>Acid Gas Removal Operating and Design Outlet Temperatures (°F) | | |
| --- | --- | --- | --- |
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 80 | TBD |
| **Summer** | TBD | 80 | TBD |

#### 13.6.1.10 Acid Gas Disposal Operating and Design Compositions, ppm

Gas compositions are detailed in the Heat and Material Balance documents included in Appendix 13.E.4. Refer to information for streams referenced below:

Winter: Stream 662009 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-102

Summer: Stream 662009 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-202

#### 13.6.1.11 Acid Gas Disposal Operating and Design Pressures (Minimum, Normal, Maximum), Psig

| | TABLE 13.6.1-7<br><br>Acid Gas Disposal Operating and Design Pressures (psig) | | |
| --- | --- | --- | --- |
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 13.0 | TBD |
| **Summer** | TBD | 13.0 | TBD |

#### 13.6.1.12 Acid Gas Disposal Operating and Design Outlet Temperatures (Minimum, Normal, Maximum), °F

| | TABLE 13.6.1-8<br><br>Acid Gas Disposal Operating and Design Temperatures (°F) | | |
| --- | --- | --- | --- |
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 79.7 | TBD |
| **Summer** | TBD | 79.7 | TBD |

#### 13.6.1.13 Acid Gas Removal Startup and Operation

System is designed for start up and continued operations. Final details to be determined in detailed design.

##### 13.6.1.13.1 Normal Startup and Operation

System is designed for start up and continued operations. Final details to be determined in detailed design.

#### 13.6.1.13.2 Regeneration Startup and Operation

Not applicable to the GTP.

### 13.6.1.14 Acid Gas Removal Shutdown

System is designed for safe shut down. Final details to be determined in detailed design.

### 13.6.1.15 Acid Gas Removal Piping, Vessel, and Equipment Design and Specifications

Piping, vessels, and equipment design and specifications are shown on the P&IDs included in Appendix 13.E.5, the equipment list in Appendix 13.M.3, and the data sheets in Appendix 13.M.4. Final details will be provided in detailed design.

### 13.6.1.16 Acid Gas Removal Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.6.1.16.1 Hydrogen Sulfide Removal/Disposal

Section 13.6.1 provides details for the $H_2S$ removal process from raw feed gas in the AGRU.

#### 13.6.1.16.2 Carbon Dioxide Removal/Disposal

Section 13.6.1 provides details for the $CO_2$ removal process from raw feed gas in the AGRU. Section 13.6.6 provides details for the $CO_2$ disposal process.

### 13.6.1.17 Acid Gas Removal Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix F.3. Final details will be provided in detailed design.

### 13.6.1.18 Acid Gas Removal Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

### 13.6.1.19 Acid Gas Removal Other Safety Features

To be identified in detailed design, as necessary.

### 13.6.2 Mercury Removal Design

Mercury adsorber beds are installed at the LNG facility. Not applicable to the GTP.

#### 13.6.2.1 Mercury Specifications, ppm

Not applicable to the GTP.

#### 13.6.2.2 Mercury Removal Type

Not applicable to the GTP.

#### 13.6.2.3 Mercury Removal Operating and Design Inlet Flow Rate Capacities (Minimum, Normal, Maximum), lb/hr

Not applicable to the GTP.

#### 13.6.2.4 Mercury Removal Operating and Design Inlet Gas Compositions (Minimum/Lean/Light, Normal/Design/Average, Maximum/Rich/Heavy), ppm

Not applicable to the GTP.

#### 13.6.2.5 Mercury Removal Operating and Design Inlet Pressures (Minimum, Normal, Maximum), psig

Not applicable to the GTP.

#### 13.6.2.6 Mercury Removal Operating and Design Inlet Temperatures (Minimum, Normal, Maximum), °F

Not applicable to the GTP.

#### 13.6.2.7 Mercury Removal Operating and Design Outlet Flow Rate Capacities (Minimum, Normal, Maximum), lb/hr

Not applicable to the GTP.

#### 13.6.2.8 Mercury Removal Operating and Design Outlet Gas Compositions (Minimum/Lean/Light, Normal/Design/Average, Maximum/Rich/Heavy), ppm

Not applicable to the GTP.

#### 13.6.2.9 Mercury Removal Operating and Design Outlet Pressures (Minimum, Normal, Maximum), psig

Not applicable to the GTP.

#### 13.6.2.10 Mercury Removal Operating and Design Outlet Temperatures (Minimum, Normal, Maximum), °F

Not applicable to the GTP.

#### 13.6.2.11 Mercury Removal Startup and Operation

Not applicable to the GTP.

#### 13.6.2.12 Mercury Removal Isolation Valves, Drains, and Vents

Not applicable to the GTP.

##### 13.6.2.12.1 Mercury Removal Disposal

#### 13.6.2.13 Mercury Removal Shutdown

Not applicable to the GTP.

#### 13.6.2.14 Mercury Removal Piping, Vessel, and Equipment Design and Specifications

Not applicable to the GTP.

#### 13.6.2.15 Mercury Removal Basic Process Control Systems

Not applicable to the GTP.

#### 13.6.2.16 Mercury Removal Safety Instrumented Systems

Not applicable to the GTP.

#### 13.6.2.17 Mercury Removal Relief Valves and Discharge

Not applicable to the GTP.

#### 13.6.2.18 Mercury Removal Other Safety Features

Not applicable to the GTP.

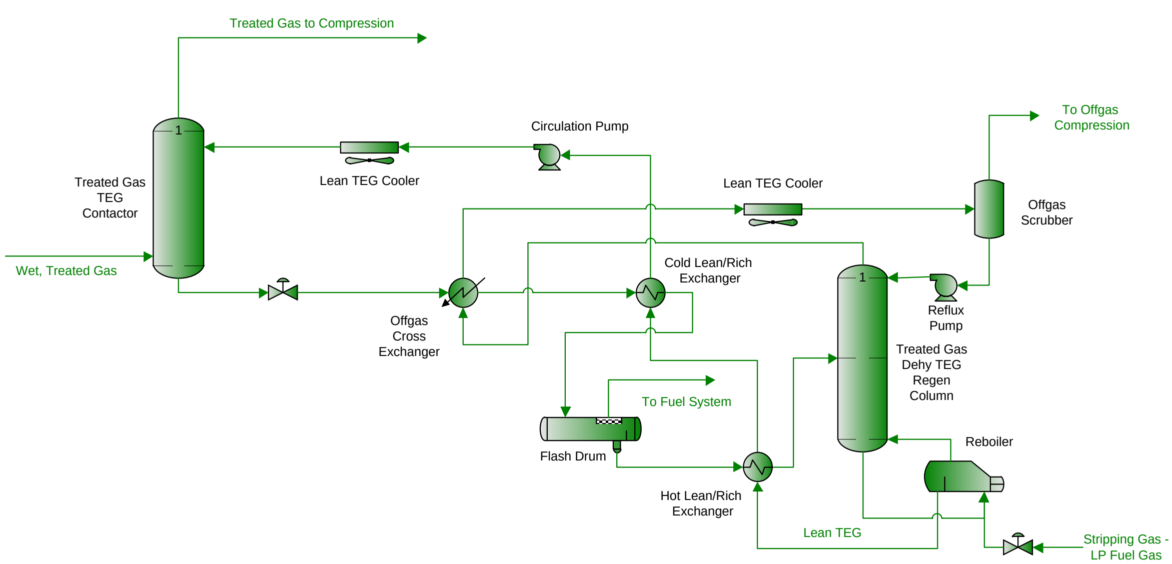
### 13.6.3 Water Removal Design

There would be one Treated Gas Dehydration Unit per train. The purpose of the TGDU is to remove water from the water-saturated treated gas exiting the AGRU to prevent hydrate formation in the Treated Gas Chillers and the Mainline.

The TGDU would absorb water from the feed gas by contacting it with TEG in a packed bed contactor. Figure 13.5.6-1 shows a simplified process sketch of the TGDU. One contactor is provided in each process train. Gas would enter the bottom of the Contactor through a vane distributor to allow even distribution before flowing up through the packed bed where it would contact lean TEG in counter current flow. Cooled lean TEG would enter at the top of the packed section of the tower. Rich TEG, loaded with water, would be collected below the packing and drawn off the contactor sump for regeneration. The dry, sweet gas would leave the top of the column and flows to Treated Gas Compression.

The rich TEG from the contactor would be regenerated in its dedicated TGDU Regeneration Unit in each process train.

**FIGURE 13.5.6-1 TGDU Process Schematic**




Regeneration heat would be supplied by electric Reboilers in each unit; stripping gas would be used in the TEG regeneration to ensure that a sufficiently lean TEG concentration is achieved to meet the maximum water/MMSCF specification for the treated gas. The vapor from the offgas scrubber would go to the TGDU Offgas Compressor, which would send the TGDU offgas vapor (primarily stripping gas and water) to the Fuel Gas Dehydration unit for treatment.

Detailed PFDs and P&IDs for the TGDU are included in Appendix 13.E.2 and 13.E.5, respectively. Heat and Material Balance for winter and summer are provided in Appendix 13.E.4.

Process design conditions for the TGDU are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

#### 13.6.3.1 Water Specifications, ppm

Design: < 0.07 lb $H_2O$/MMscfd

Maximum: < 0.1 lb $H_2O$/MMscfd

#### 13.6.3.2 Dehydration System Type

Tri-ethylene glycol (TEG) packed bed contactor.

#### 13.6.3.3 Dehydration Operating and Design Inlet Flow Rates (Minimum, Normal, Maximum), lb/hr

| | TABLE 13.6.3-1<br>**Dehydration Operating and Design Inlet Flow Rates (lb/hr)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 2,255,030 | TBD |
| **Summer** | TBD | 1,977,651 | TBD |

#### 13.6.3.4 Dehydration Operating and Design Inlet Compositions Capacities (Minimum, Normal, Maximum), ppm

Gas compositions are detailed in the Heat and Material Balance documents included in Appendix 13.E.4. Refer to information for streams referenced below:

Winter: Stream 662001 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-102

Summer: Stream 662001 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-202

#### 13.6.3.5 Dehydration Operating and Design Inlet Pressures (Minimum, Normal, Maximum), psig

| | TABLE 13.6.3-2<br>**Dehydration Operating and Design Inlet Pressures (psig)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 542.5 | TBD |
| **Summer** | TBD | 544.0 | TBD |

#### 13.6.3.6 Dehydration Operating and Design Inlet Temperatures (Minimum, Normal, Maximum), °F

| | TABLE 13.6.3-3<br>**Dehydration Operating and Design Inlet Temperatures (°F)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 80.0 | TBD |
| **Summer** | TBD | 80.0 | TBD |

### 13.6.3.7 Dehydration Operating and Design Outlet Flow Rates (Minimum, Normal, Maximum), lb/hr

| | TABLE 13.6.3-4<br>**Dehydration Operating and Outlet Flow Rates (lb/hr)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 2,251,545 | TBD |
| **Summer** | TBD | 1,974,600 | TBD |

### 13.6.3.8 Dehydration Operating and Design Outlet Gas Compositions (Minimum/Lean/Light, Normal/Design/Average, Maximum/Rich/Heavy), ppm

Gas compositions are detailed in the Heat and Material Balance documents included in Appendix 13.E.4. Refer to information for streams referenced below:

Winter: Stream 661001 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-103

Summer: Stream 661001 in Heat and Material Balance document USAG-EC-PDPFD-10-000662-203

### 13.6.3.9 Dehydration Operating and Design Outlet Pressures (Minimum, Normal, Maximum), psig

| | TABLE 13.6.3-5<br>**Dehydration Operating and Design Outlet Pressures (psig)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 538.5 | TBD |
| **Summer** | TBD | 540.0 | TBD |

### 13.6.3.10 Dehydration Operating and Design Outlet Temperatures (Minimum, Normal, Maximum), °F

| | TABLE 13.6.3-6<br>**Dehydration Operating and Design Outlet Temperatures (°F)** | | |
|---|---|---|---|
| | **Minimum** | **Nomal** | **Maximum (Design)** |
| **Winter** | TBD | 81.5 | TBD |
| **Summer** | TBD | 81.5 | TBD |

### 13.6.3.11 Regeneration Gas Operating and Design Flow Rates (Minimum/Lean/Light, Normal/Design/Average, Maximum/Rich/Heavy), lb/hr

Not applicable to the GTP.

#### 13.6.3.12 Regeneration Gas Operating and Design Temperatures To/From Adsorber (Minimum, Normal, Maximum), °F

Not applicable to the GTP.

#### 13.6.3.13 Regeneration Gas Operating and Design Pressures To/From Adsorber (Minimum, Normal, Maximum), psig

Not applicable to the GTP.

#### 13.6.3.14 Dehydration and Regeneration Startup and Operation

Not applicable to the GTP.

#### 13.6.3.15 Dehydration and Regeneration Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.6.3.16 Dehydration and Regeneration Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.6.3.17 Dehydration and Regeneration Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.6.3.18 Dehydration and Regeneration Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.6.3.19 Dehydration and Regeneration Other Safety Features

Final details will be provided in detailed design.

### 13.6.4 Treated Gas Compression Unit

The purpose of the Treated Gas Compression unit would be to compress and cool the treated gas received from the TGDC prior to entering the Mainline.

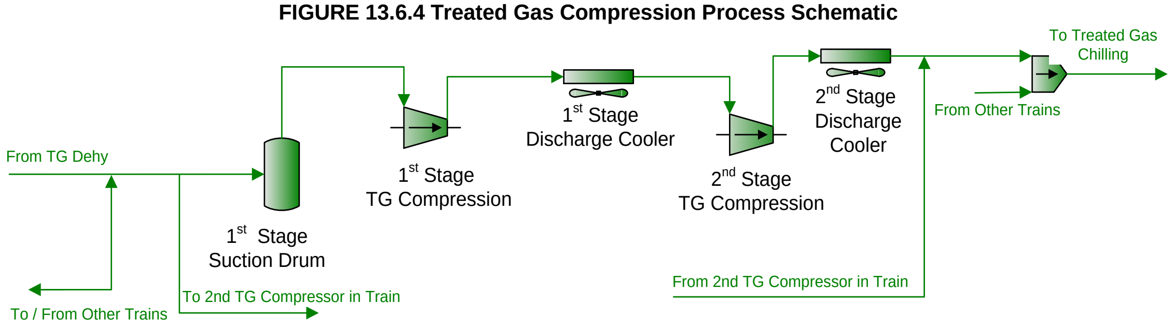
Three trains of Treated Gas Compression, one located in each gas processing train, are required to compress the sweet, dry gas from the TGDU to a pressure sufficient for feeding into the Mainline (see Figure 13.6.4). Each of the three trains would contain two Treated Gas Compressors, denoted within the trains as Unit 1 and Unit 2.

In each compressor, the treated gas would be compressed in two stages, with the compressor being driven by a gas turbine. Each Treated Gas Compressor would be designed to deliver 2,075 psig to the metering station at full plant capacity. An aerial cooler would be provided on each compressor interstage and discharge to remove the heat of compression and reduce the downstream gas chilling duty.

Treated gas from the three AGRU/TGDU trains would be manifolded together upstream of the Treated Gas Compressors such that gas from any train could go to any compressor. This would provide operating flexibility to use the additional 20 percent of available compression capacity and would allow the GTP to run at full capacity even when one of the Treated Gas Compressors is down.

The Treated Gas Compression turbines would be equipped with waste heat recovery (WHR) to provide heat to the AGRU reboilers. Supplemental firing in the gas turbine exhausts would be used during start-up and normal operation to increase the available heat to meet the AGRU reboiler requirements.

**FIGURE 13.6.4 Treated Gas Compression Process Schematic**




Detailed PFDs and P&IDs for the treated gas compression Unit are included in Appendix 13.E.2 and 13.E.5, respectively. Heat and Material Balance for winter and summer are provided in Appendix 13.E.4

Process design conditions for the treated gas compression Unit are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

### 13.6.5 Treated Gas Chilling Unit

The purpose of the Treated Gas Chilling Unit would be to lower the temperature of the treated gas from the Treated Gas Compression Unit to less than 32 °F to protect the permafrost near the buried Mainline.

Chilling of the combined treated gas from the three processing trains would be accomplished in two 50-percent Treated Gas Chillers, before entering the pipeline at approximately 2,025[f] psig and 30 °F (see Figure 13.6.5), thus providing some margin below the temperature specification.

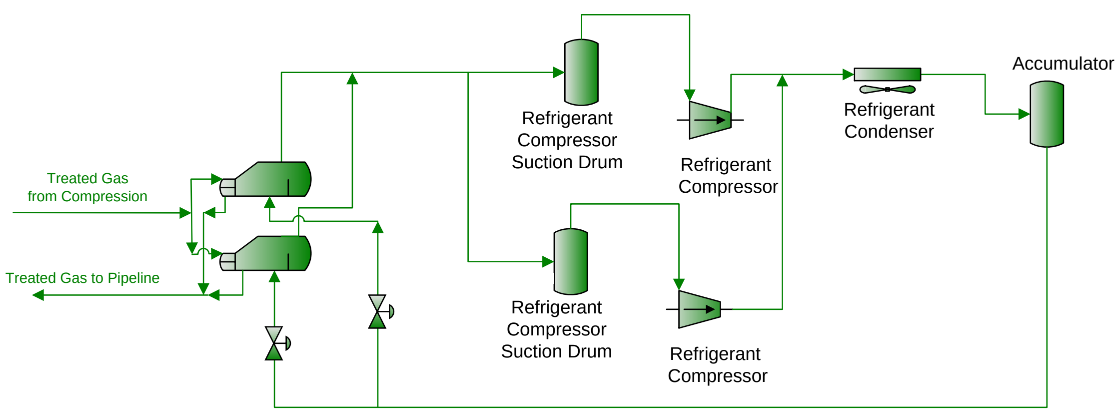
[f] 2,025 psig is approx. 98 percent of 2075 psig, Mainline MAOP. The actual delivery pressure to the mainline would be less than 2,075 psig to avoid spurious shutdowns by the pipeline overpressure protection system(s).

When the ambient temperature falls below 10 °F during the winter, the upstream air coolers can achieve the pipeline specification without further chilling, and the propane refrigeration unit can be put on standby or shut down.

Propane Refrigerant to the Treated Gas Chillers would be provided by two 50-percent motor-driven Refrigeration Compressor units, which are tied together with common suction and discharge headers. A single accumulator serves both compression systems. The propane Refrigerant Condenser is a single air cooled exchanger that would serve both refrigeration compression systems. Propane has been selected as the refrigerant because it has favorable refrigeration properties, is a well-established technology, and is readily available at the North Slope.

Unlike the majority of the GTP plant, which is designed for a summer ambient temperature of 55 °F, the propane condenser is designed for 65 °F ambient air. This allows propane condensing at the maximum expected ambient air temperature without dead-heading the propane compressors, allowing continued operation at reduced capacity. A capacity check has been performed for the refrigerant system at an ambient temperature of 85 °F to ensure the plant would remain on-stream.

**FIGURE 13.6.5 Treated Gas Chilling and Propane Refrigeration Process Schematic**




Detailed PFDs and P&IDs for the treated gas chilling Unit are included in Appendix 13.E.2 and 13.E.5, respectively. Heat and Material Balance for winter and summer are provided in Appendix 13.E.4.

Process design conditions for the treated gas chilling unit are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

### 13.6.6 $CO_2$ Compression Unit

The purpose of the $CO_2$ Compression Unit is to compress the AGRU Regenerator overhead to the specified target pressure for $CO_2$ Injection.

The GTP would include three trains of $CO_2$ compression. Each of the three trains would contain two $CO_2$ compressors, denoted within the trains as Unit 1 and Unit 2. Each compressor would have four stages of compression in two separate casings.

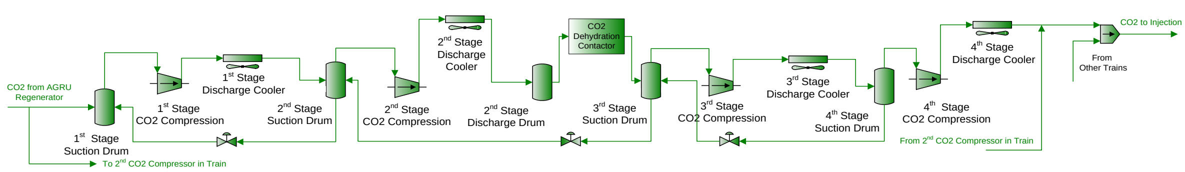
In each train, the $CO_2$-rich acid gas (about 750 ppmv $H_2S$) would be compressed in multiple stages in two-body compressor strings[g]. In each $CO_2$ Compressor, the two bodies would be on a single shaft that together would be driven by one gas turbine. The lower stages would be used to compress the wet $CO_2$-rich acid gas from the AGRU Regenerator overhead pressure to a pressure of approximately 515 psig, before sending the stream to dehydration.

After dehydration, the $CO_2$ would be returned to the remaining high stages of compression, located in the second compressor body. The dry $CO_2$ from the $CO_2$ Dehydration Contactor would be compressed to 4,000 psig, a pressure sufficient for delivery to the CGF.

A common header would be provided on the suction side of the first compressor body, between the AGRU Regenerator Reflux Drum and the Unit 1 and 2 $CO_2$ Compression 1st Stage KO Drums, to allow all compressors to receive $CO_2$ from any of the processing trains. The inclusion of common headers would improve GTP processing capacity by allowing all processing trains to continue to operate at full rate when a single compressor is shut down.

The $CO_2$ Compression turbines would also be equipped with WHR to provide heat to the AGRU reboilers. Supplemental firing in the gas turbine exhausts would be used during start-up and normal operation to increase the available heat to meet the AGRU reboiler requirements. Figure 13.6.6 shows a simplified process schematic of the $CO_2$ compression unit.

**FIGURE 13.6.6 $CO_2$ Compression Process Schematic**




Detailed PFDs and P&IDs for the $CO_2$ compression unit are included in Appendix 13.E.2 and 13.E.5, respectively. Heat and Material Balance for winter, summer, and rating cases are provided in Appendix 13.E.4

Process design conditions for the $CO_2$ compression unit are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

[g] The preliminary compressor selection is yet to be confirmed as the final design choice.

### 13.6.7 $CO_2$ Dehydration

The purpose of $CO_2$ Dehydration is to remove water from the water-saturated $CO_2$ exiting the AGRU Regenerator to prevent hydrate formation or liquid water dropout in the $CO_2$ injection lines.

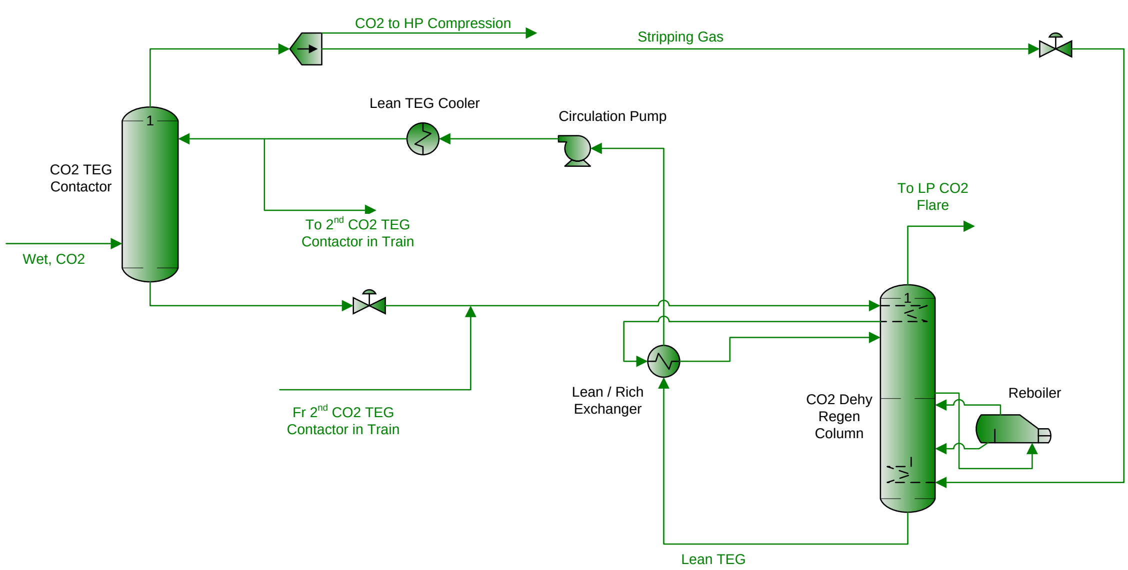
The $CO_2$ Dehydration Unit, shown in Figure 13.6.7 for one train, would absorb water from the acid gas by contacting with TEG in a packed bed contactor before the third stage of $CO_2$ compression.

Two 20-percent contactors would be provided in each process train. Gas would enter the bottom of the Contactors through a vane distributor to allow even distribution before flowing up through the packed bed and contacting the lean TEG in counter-current flow. Cooled lean TEG would enter at the top of the packed section of each tower. Rich TEG, loaded with water, would be collected in the contactor sump and let down for regeneration. The dry, acid gas would leave the top of the column to go to the third stage of compression.

The rich TEG from the contactors would be regenerated in three identical dedicated 40-percent $CO_2$ Dehydration Regeneration systems, one serving the two 20-percent contactors located in each train.

Regeneration heat would be supplied by electric Reboilers in each unit; stripping gas would be used to ensure a sufficiently lean TEG concentration is met to achieve the water/MMSCF specification for the $CO_2$.

**FIGURE 13.6.7 $CO_2$ Dehydration Process Schematic**




Detailed PFDs and P&IDs for the $CO_2$ dehydration unit are included in Appendix 13.E.2 and 13.E.5, respectively. Heat and Material Balance for winter and summer are provided in Appendix 13.E.4.

Process design conditions for the $CO_2$ dehydration unit are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

### 13.6.8 Treated Gas Specifications, Range of Conditions: Composition, Molecular Weight, HHV, LHV

Table 13.6.8-1 shows the range of treated natural gas specifications to the battery limits of the Mainline.

TABLE 13.6.8-1

**Treated Gas Specifications**

| **Parameter** | **Units** | **Minimum Spec** | **Maximum Spec** | **Design** |
|---|---|---|---|---|
| $CO_2$ | ppmv | - | 50 | 15 |
| $H_2S$ | ppmv | - | 4 | 2 |
| Total Sulfur | gr/100 SCF | - | 1 (Notes 1) | 1 |
| Water Content | lb $H_2O$/MMSCF | - | less than 0.1 (Note 3) | less than 0.07 |
| Cricondentherm | °F | - | -10.0 °F | -- |
| Delivery Pressure | psig | 1,100 | 2,075 | 2,075 (Note 2) |
| Delivery Temperature | °F | 25 | 32 | 30 |

TABLE 13.6.8-1

**Treated Gas Specifications**

| Parameter | Units | Minimum Spec | Maximum Spec | Design |
|---|---|---|---|---|

**Notes:**

1. Measured on an elemental sulfur basis.
2. Based on a Mainline MAOP of 2,075 psig. The actual delivery pressure to the Mainline is less than 2,075 to avoid spurious shutdowns by the pipeline overpressure protection system(s).
3. 0.1 lb/MMSCF correspond to a -45 °F hydrate point at contactor pressure and -40 °F at pipeline pressure. This is required to prevent hydrate formation in the GTP fuel gas system.

## 13.7 NATURAL GAS LIQUIDS (NGL) REMOVAL, STORAGE, AND DISPOSITION

Not applicable to the GTP.

## 13.8 HEAVIES/CONDENSATES REMOVAL, STORAGE, AND DISPOSITION

Not applicable to the GTP.

## 13.9 LIQUEFACTION SYSTEM

Not applicable to the GTP.

## 13.10 LNG PRODUCT TRANSFER TO STORAGE

Not applicable to the GTP.

## 13.11 LNG STORAGE TANKS

Not applicable to the GTP.

## 13.12 VAPOR HANDLING

Not applicable to the GTP.

## 13.13 LNG PUMPS

Not applicable to the GTP.

## 13.14 LNG TRUCKING

Not applicable to the GTP.

## 13.15 LNG VAPORIZATION

Not applicable to the GTP.

## 13.16 HEAT TRANSFER FLUID (HTF) SYSTEMS

### 13.16.1 HTF Storage Design

Not applicable to the GTP.

#### 13.16.1.1 Number of HTF Trucks, No. per Year

Not applicable to the GTP.

#### 13.16.1.2 HTF Truck Capacities, gal

Not applicable to the GTP.

#### 13.16.1.3 Number of HTF Storage Tanks, Operating and Spare

Not applicable to the GTP.

#### 13.16.1.4 HTF Operating and Design Storage capacities, gal

Not applicable to the GTP.

#### 13.16.1.5 HTF Operating and Design Storage Pressures (minimum, normal, maximum), psig

Not applicable to the GTP.

#### 13.16.1.6 HTF Operating and Design Storage Temperatures (minimum, normal, maximum), °F

Not applicable to the GTP.

#### 13.16.1.7 HTF Operating and Design Residence Times, minutes

Not applicable to the GTP.

#### 13.16.1.8 HTF System Startup and Operation

Not applicable to the GTP.

#### 13.16.1.9 HTF System Isolation Valves, Drains, and Vents

Not applicable to the GTP.

#### 13.16.1.10 HTF System Basic Process Control Systems

Not applicable to the GTP.

#### 13.16.1.11 HTF System Safety Instrumented Systems

Not applicable to the GTP.

#### 13.16.1.12 HTF System Relief Valves and Discharge

Not applicable to the GTP.

#### 13.16.1.13 HTF System Other Safety Features

Not applicable to the GTP.

### 13.16.2 HTF Heating System Design

The purpose of Heat Medium Systems is to provide two heat medium loops that would be used to service the gas turbine unit. The Building Heat Medium System would provide heat for storage tanks, various liquid drums, and all building heat. The Process Heat Medium System would use pressurized water to supply heat to the AGRU Reboilers.

Each AGRU Train would have a dedicated Process Heat Medium System to supply heat to the AGRU Reboilers. Heat would be supplied to the pressurized water by gas turbine exhaust WHR and supplemental firing as needed in the Treated Gas and $CO_2$ Compression turbine exhausts. Heat Medium would be supplied at 380 °F to the AGRU Reboilers and would return at approximately 300 °F.

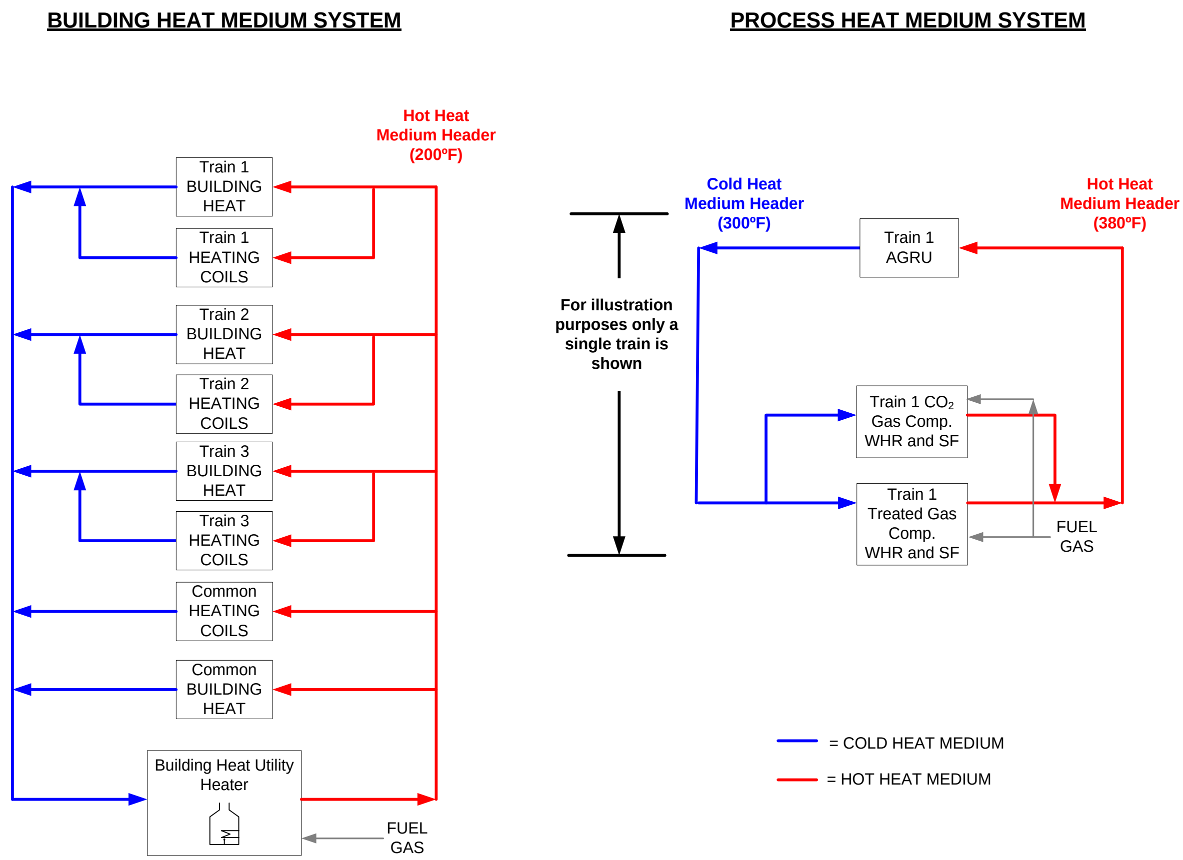
Building Heat Medium System heat would be supplied by 3 x 50 percent dedicated fired heaters. Heat Medium would be supplied at 200 °F and returns from the users at approximately 80 °F. A 60/40 weight percent ethylene glycol (EG)/water solution was selected for use in the Building heat medium system because of superior cold weather performance.

The Building Heat Medium system would require a high degree of reliability to protect personnel and equipment from typical North Slope low temperatures; this requirement drives the sparing philosophy and the need to have the system’s electrical loads tied to the Essential Power Source. The Operations Centers would use a standalone conventional Propylene Glycol/Water system separate from the Building Heat Medium system.

#### 13.16.2.1 HTF Distribution List and Usage Requirement by Equipment, gpm

Figure 13.16.2.1 provides a simplified schematic of the Heat Medium System for the GTP.

**FIGURE 13.16.2.1 Heat Medium System Process Schematic**




PFDs and P&IDs for the GTP heat medium system are included in Appendix 13.E.2 and13. E.5, respectively.

### 13.16.2.2 Heating Source

Process heating sources: Treated Gas Compressor Recovery Units and $CO_2$ Compression Heat Recovery Units.

Building heating soruces: Building Heat Medium Utility Heaters.

### 13.16.2.3 HTF Heaters Type

Treated Gas Compressor Heat Recovery Unit: Horizontal Tube Arrangement with Vertical Exhaust Flow

$CO_2$ Compression Heat Recovery Unit: Horizontal Tube Arrangement with Vertical Exhaust Flow

Building Heat Medium Utility Heater: Fired Heater

### 13.16.2.4 Number of HTF Heaters, Operating and Spare

For each Train, there are two (2) Treated Gas Compressor Heat Recovery Units with two (2) operating and no spares during normal operation, two (2) $CO_2$ Compression Heat Recovery Units with two (2) operating and no spares during normal operation, and three (3) Building Heat Medium Utility Heaters with two (2) operating and one (1) 50% spare during normal operation.

### 13.16.2.5 HTF Heaters Operating and Design Heat Duty/Rate each (minimum, rated, maximum), MMBtu/hr

**TABLE 13.16.2-1**

**HTF Heaters Operating and Design Heat Duty/Rate each (MMBtu/hr)**

| | Minimum | Nomal | Maximum (Design) |
|---|---|---|---|
| **Treated Gas Compressor Heat Recovery Unit** | TBD | 362 | TBD |
| **CO2 Compression Heat Recovery Unit** | TBD | 268 | TBD |
| **Building Heat Medium Utility Heater** | TBD | 225 | TBD |

### 13.16.2.6 HTF heaters operating and design pressures (minimum, normal, maximum), psig

**TABLE 13.16.2-2**

**Heaters Operating and Design Pressures (psig)**

| | Minimum | Nomal | Maximum (Design) |
|---|---|---|---|
| **Treated Gas Compressor Heat Recovery Unit** | TBD | 330 | 425 |
| **$CO_2$ Compression Heat Recovery Unit** | TBD | 334 | 425 |
| **Building Heat Medium Utility Heater** | TBD | 272 | 380 |

### 13.16.2.7 HTF Heaters Operating and Design Inlet Temperatures (minimum, normal, maximum), °F

**TABLE 13.16.2-3**

**Heaters Operating and Design Inlet Temperatures (°F)**

| | Minimum | Nomal | Maximum (Design) |
|---|---|---|---|
| **Treated Gas Compressor Heat Recovery Unit** | -50 | 300 | 450 |
| **CO2 Compression Heat Recovery Unit** | -50 | 300 | 450 |
| **Building Heat Medium Utility Heater** | TBD | 80 | 250 |

### 13.16.2.8 HTF Heaters Operating and Design Outet Temperatures (minimum, normal, maximum), °F

**TABLE 13.16.2-4**

**Heaters Operating and Design Outlet Temperatures (°F)**

| | Minimum | Nomal | Maximum (Design) |
|---|---|---|---|
| **Treated Gas Compressor Heat Recovery Unit** | -50 | 380 | 450 |
| **$CO_2$ Compression Heat Recovery Unit** | -50 | 380 | 450 |
| **Building Heat Medium Utility Heater** | TBD | 200 | 250 |

### 13.16.2.9 HTF Pumps Type

Centrifugal

### 13.16.2.10 Number of HTF Pumps, Operating and Spare

Process Heat Medium Pump: 2 Operating, 1 Spare

Building Heat Medium Pump: 2 Operating, 1 Spare

### 13.16.2.11 HTF Pumps Operating and Design Suction pressures (minimum/NPSH, normal/rated, maximum), psig

**TABLE 13.16.2-5**

**HTF Pumps Operating and Design Suction pressures (psig)**

| | Minimum/NPSH | Nomal/Rated | Maximum (Design) |
|---|---|---|---|
| **Process Heat Medium Pump** | TBD | 235 | TBD |
| **Building Heat Medium Pump** | TBD | 50 | TBD |

### 13.16.2.12 HTF Pumps Operating and Design Discharge pressures (minimum, normal/rated, maximum/shutoff), psig

**TABLE 13.16.2-6**

**HTF Pumps Operating and Design Discharge pressures (psig)**

| | Minimum | Nomal/Rated | Maximum/Shutoff |
|---|---|---|---|
| **Process Heat Medium Pump** | TBD | 352 | TBD |
| **Building Heat Medium Pump** | TBD | 278 | TBD |

### 13.16.2.13 HTF Pumps Operating and Design Flow Rate Capacities (minimum, normal/rated, maximum), gpm

**TABLE 13.16.2-7**

**HTF Pumps Operating and Design Flow Rate Capacities (gpm)**

| | Minimum | Nomal/Rated | Maximum |
|---|---|---|---|
| **Process Heat Medium Pump** | TBD | 27530 | TBD |
| **Building Heat Medium Pump** | TBD | 10712 | TBD |

### 13.16.2.14 HTF Pumps Operating and Design Densities (minimum, normal, maximum), specific gravity

**TABLE 13.16.2-8**

**HTF Pumps Operating and Design Densities (Specific Gravity)**

| | Minimum | Nomal/Rated | Maximum |
|---|---|---|---|
| **Process Heat Medium Pump** | TBD | .919 | TBD |
| **Building Heat Medium Pump** | TBD | 1.08 | TBD |

### 13.16.2.15 HTF System Startup and Operation

System is designed for startup and normal operations. Final details to be determined in detailed design.

### 13.16.2.16 HTF System Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

### 13.16.2.17 HTF System Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

### 13.16.2.18 HTF System Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.16.2.19 HTF System Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.16.2.20 HTF System Other Safety Features

Final details will be provided in detailed design.

### 13.16.3 Cooling Medium Design

The purpose of the Cooling Medium System is to provide coolant to machinery, e.g., turbine-driven compressor units and the turbine generator sets, and a few select process cooling services with small duties. Pumps in higher temperature services may also require seal cooling. A 60/40 weight percent EG/Water mixture would be used as cooling medium.

Each of the three gas treating trains would have its own dedicated cooling medium circulation loop, with no shared common equipment or cross-ties between the trains.

In the train cooling medium systems, the cooling medium is supplied at 77 °F and would return to be cooled at approximately 120 °F. The supply temperature was reduced to support the process cooling needs.

A common Cooling Medium System would be also provided to supply coolant to the Refrigeration Compressors. In the common cooling medium system, the cooling medium would be supplied at 90 °F and would return to be cooled at approximately 120 °F.

PFDs and P&IDs for the GTP cooling medium system are included in Appendix 13.E.2 and 13.E.5, respectively.

### 13.16.4 Building Heat Medium System Design

There would be one building heat medium system located in the common utility area. The purpose of the building heat medium system would be to provide heat for freeze protection for process buildings, storage tanks, liquid drums, and air coolers as required to prevent equipment damage (during both normal and off-case operations) and to facilitate equipment maintenance. It would use a mixture of water and glycol in a closed loop system as the heat medium, which is heated by fired heaters. This system would not heat the Operations Center buildings.

## 13.17 BTU ADJUSTMENT

Not applicable to the GTP.

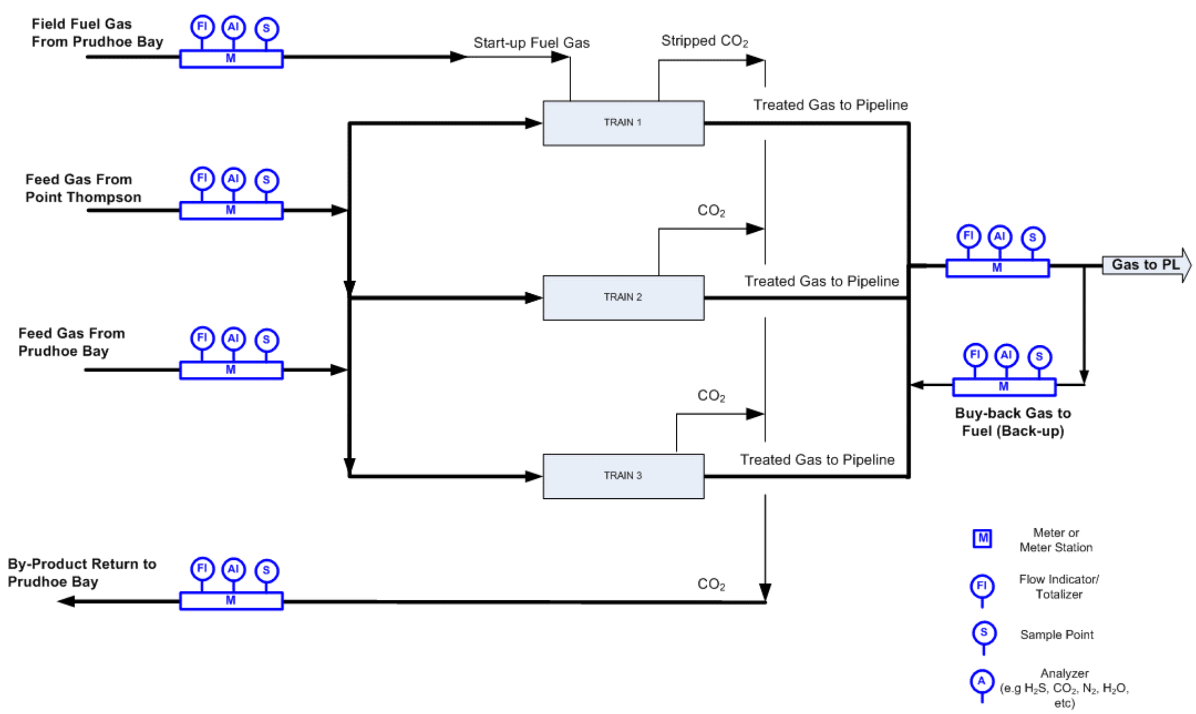
## 13.18 SENDOUT METERING SYSTEM

### 13.18.1.1 Sendout Metering Design

Treated gas from the three GTP trains would be combined and sent through a 42-inch common header to the Treated Gas Metering Station.

The Mainline Treated Gas Metering Station is considered a "Verification Meter" and would be designed following the same design standards and specifications as the feed gas CTMs (from the PBU and PTU). This meter would be located at the GTP Pad although it would be considered part of the Mainline. Figure 13.18.1.1 shows a block diagram for the metering facilities for the GTP.

**FIGURE 13.18.1.1 Metering Flow Diagram**




The GTP fuel gas system can be supplemented with gas from the buy-back line from the Mainline. There is normally no flow from the buy-back line, although the line and corresponding filter are sized to supply the entire GTP fuel gas demand in the event that fuel gas from the GTP is unavailable.

The $CO_2$ byproduct, buy-back, and GTP fuel gas meters are considered "Process Meter(s)" with no provisions for on-line proving and no sparing.

Details for the GTP interface and battery limits with the Mainline, buy-back fuel gas line, and $CO_2$ byproduct return to Prudhoe Bay are included in Process Flow Diagram USAG-EC-PDPFD-50-000609-001 included in Appendix 13.E.2.

#### 13.18.1.2 Sendout Operating and Design Flow Rate Capacities (minimum, normal, maximum), MMscfd

Maximum flowrate of treated gas to the Mainline would be 3.9 BSCFD during peak winter operation.

#### 13.18.1.3 Sendout Operating and Design Pressures (minimum, normal, maximum), psig

The maximum delivery pressure of treated gas to the Mainline would be 2,075 psig.

Minimum delivery pressure of treated gas to the Mainline is 1,100 psig.

#### 13.18.1.4 Sendout Operating and Design Temperatures (minimum, normal, maximum), °F

The maximum normal temperature of treated gas to the Mainline is 30 °F.

#### 13.18.1.5 Pipeline Operating and Design Flow Rate Capacities (minimum, normal, maximum), MMscfd

**TABLE 13.16.4-1**

**Pipeline Operating and Design Flow Rate Capacities (MMscfd)**

| | Minimum | Nomal | Maximum (Design) |
|---|---|---|---|
| **Winter** | TBD | 3307.2 | TBD |
| **Summer** | TBD | 2877.2 | TBD |

#### 13.18.1.6 Pipeline Operating and Design Pressures (minimum, normal, maximum), psig

**TABLE 13.16.4-2**

**Pipeline Operating and Design Pressues (psig)**

| | Minimum | Nomal | Maximum (Design) |
|---|---|---|---|
| **Winter** | TBD | 2080.1 | TBD |
| **Summer** | TBD | 2079.4 | TBD |

#### 13.18.1.7 Pipeline Operating and Design Temperatures (minimum, normal, maximum), °F

**TABLE 13.16.4-3**

**Pipeline Operating and Design Temperatures (°F)**

| | Minimum | Nomal | Maximum (Design) |
|---|---|---|---|
| **Winter** | TBD | 28.8 | TBD |
| **Summer** | TBD | 30.0 | TBD |

#### 13.18.1.8 Sendout Metering System Startup and Operation

System is designed for startup and normal operations. Final details to be determined in detailed design.

#### 13.18.1.9 Sendout Metering System Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.18.1.10 Sendout Metering System Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.18.1.11 Sendout Metering System Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.18.1.12 Sendout Metering System Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.18.1.13 Sendout Metering System Other Safety Features

Final details will be provided in detailed design.

## 13.19 FUEL GAS

### 13.19.1 Fuel Gas Design

The fuel gas system would supply gas to the Operations Center via transfer line from the GTP. The fuel gas system would supply fuel gas to the gas turbines, supplemental firing for WHRUs, fired heaters, and flare system purges. Fuel gas would also be used as blanketing gas for a variety of equipment that either requires a higher pressure or a lower oxygen content than the nitrogen blanketing gas.

The Fuel Gas System would be composed of an HP fuel gas system and a LP fuel gas system. The HP fuel gas system would draw sweetened dehydrated gas after the TGDU, upstream of treated gas compression. The LP fuel gas would be supplied from the HP system, supplemented by dehydrated AGRU flash gas, TGDU flash gas, and spent TGDU stripping gas. All fuel gas would be metered as it enters the distribution headers.

The fuel gas is distributed, depending on user requirements, to the following systems:

- HP Fuel Gas: gas turbines, Treated Gas Dehydration stripping gas; and

- LP Fuel Gas: supplemental firing fuel gas for WHRUs, flare purging and pilots, Building Heat Medium Utility Heaters, tank blanketing, operations camp.

The purpose of the HP fuel gas system would be to provide fuel to the Treated Gas and $CO_2$ Compressor and Power Generation gas turbines. In addition, it would be used as stripping gas for the TGDU Regen Column. The normal HP fuel gas source would be from the Treated Gas Dehydration Contactor overhead without compression; however, HP fuel gas could also be taken, in order of preference, from downstream of the Treated Gas Compressors or from Mainline buy-back when the pressure at the Treated Gas Dehydration Contactor is insufficient to satisfy requirements of all of the turbine users.

Flash gas from the AGRU flash drum, TGDU flash gas, and TGDU spent stripping gas would be used to supplement the common LP fuel gas system. All three streams would be water-saturated, which necessitates dehydration of these streams. The LP fuel gas treatment system would consist primarily of an inlet cooler, scrubber, TEG Contactor, and Dehydrated Gas KO Drum. Additional treatment may be necessary (pending verification during a later stage of the Project) to meet the treated fuel gas dew point and hydrate specifications.

The purpose of the LP Fuel Gas System would be to provide fuel to fired heaters and supplemental firing burners, and gas for flare purging and blanketing. Pre-heating of the HP Fuel Gas would not be necessary prior to pressure let-down to supply LP fuel gas.

The initial and black-start supply of fuel gas would be taken from the PBU Startup Fuel Gas. A fuel gas line from the PBU Startup Fuel Gas Supply line would be used to provide fuel gas requirements until an AGRU train is up and running.

A bath heater would be included on the buy-back gas line upstream of the pressure let-down into the fuel gas system.

The GTP fuel gas system is shown in the following Utility Flow Diagrams and Piping and Instrumentation Diagrams included in Appendix 13.E.3 and 13.E.5, respectively.

TABLE 13.19.1

**Drawings Showing Piping and Equipment Layout**

| Drawing Number | Description |
|---|---|
| USAG-EC-PDUFD-50-000965-070 | Utility Flow Diagram – Fuel Gas System Common System |
| USAG-EC-PDUFD-10-000965-072 | Utility Flow Diagram – Fuel Gas System Process Train |
| USAG-EC-PDUFD-10-000966-073 | Utility Flow Diagram – LP Fuel Gas Treating |
| USAG-EC-PDZZZ-50-000965-075 | P&IDs – Fuel Gas System Common System |
| USAG-EC-PDZZZ-10-000965-076 | P&IDs – Fuel Gas System Process Train |
| USAG-EC-PDZZZ-10-000966-077 | P&IDs – LP Fuel Gas Treating – Inlet |
| USAG-EC-PDZZZ-10-000966-078 | P&IDs – LP Fuel Gas Treating – Contactor |

#### 13.19.1.1 Fuel Gas Sources

High Pressure Fuel Gas Source: Dehydrated sweet gas from the Treated Gas Compressor suction line.

Low Pressure Fuel Gas Source: Dehydrated off-gas from the TGDU and treated flash gas from the AGRU Solvent Flash Drum, supplemented by HP Fuel Gas.

Backup source: A 6-inch Fuel Gas Transfer Line (FGTL) from the CGF provides fuel gas for "black start" operation, where the GTP is not producing any fuel, or needs assistance in a start-up. Buyback gas from the Mainline is another backup source.

#### 13.19.1.2 Fuel Gas Specifications

Fuel gas specifications for the High Pressure, Low Pressure and Backup fuel gas sources are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

Detailed stream compositions for each fuel gas source are included in the Heat and Material Balances provided in Appendix 13.E.4.

#### 13.19.1.3 Fuel Gas Distribution List and Requirement by Equipment, MMscfd

Fuel gas demand flowrates for the fuel gas systems are detailed in Table 13.19.1.3.

TABLE 13.19.1.3

**Fuel Gas System Demand**

| User | Fuel Service | Flow rate (MMscfd) |
|---|---|---|
| Building Heat Medium Utility Heater – fuel gas | LP | 13.8 |
| AGRU Solvent Storage Tank – blanketing | LP | Intermittent |
| AGRU Fresh Solvent Storage Tank – blanketing | LP | |
| TEG Makeup Storage Tank - blanketing | LP* | Intermittent |
| Drain Drums – for blanketing | LP* | 0.06 |
| HP and LP flare header purge | LP | 0.8 |
| Treated Gas Dehydration Stripping Gas | HP | 3.6 |
| Supplemental Firing in WHRs | LP | |
| • Treated Gas | | 22.7 |
| • $CO_2$ | | 17.2 |
| Turbines – fuel gas | HP | |
| • Power Generators (Main) | | 44.0 |
| • Treated Gas Compressor driver | | 42.3 |
| • $CO_2$ Gas Compressor driver | | 29.4 |
| Buyback Gas Bath Heater | LP | Minimal |
| *Choice of blanketing gas (LP fuel gas vs. N2) will be further evaluated. | | |

#### 13.19.1.4 Fuel Gas Operating and Design Flow Rate Capacities (minimum, normal/rated, maximum), lb/hr

The rated operating flow rate of HP fuel gas is 218,157 lb/hr during peak winter operation; the flow rate during minimum summer capacity is 201,431 lb/hr.

The rated operating flow rate of LP fuel gas is 140,191 lb/hr during peak winter operation; the flow rate during minimum summer capacity is 92,599 lb/hr.

#### 13.19.1.5 Fuel Gas Operating and Design Pressures (minimum, normal/rated, maximum), psig

The operating pressure of the HP fuel gas header is 530 psig; the minimum pressure is 490 psig.

The operating pressure of the LP fuel gas header is 60 psig.

#### 13.19.1.6 Fuel Gas Operating and Design Temperatures (minimum, normal, maximum), °F

The minimum operating temperature of the HP and LP fuel gas systems are approximately 40 °F and 0 °F, respectively.

The design temperature of the HP and LP fuel gas systems is 150 °F.

#### 13.19.1.7 Fuel Gas Operating and Design Densities (minimum, normal, maximum), specific gravity

The density of the HP and LP fuel gas are approximately 1.86 lb/ft3 and 0.24 lb/ft3, respectively.

#### 13.19.1.8 Fuel Gas Startup and Operation

A 6-in fuel gas line from PBU is utilized to provide initial fuel gas requirements for the GTP until Train 1 is commissioned and started up. The initial / black-start fuel gas line and filter are sized for the fuel gas rate required to operate one power generation turbine at minimum load, 100% of the building heat load, and the flare and drain purges.

#### 13.19.1.9 Fuel Gas Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.19.1.10 Fuel Gas Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.19.1.11 Fuel Gas Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.19.1.12 Fuel Gas Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.19.1.13 Fuel Gas Other Safety Features

Final details will be provided in detailed design.

#### 13.19.1.14 Fuel Gas Odorant System

The fuel gas for black start or normal operation of the GTP would not have odorizer added to the stream.

## 13.20 NITROGEN AND INERT GAS

### 13.20.1 Nitrogen Design

Nitrogen would be used continuously at the GTP for some tank and vessel blanketing (where oxygen in the blanket gas cannot be tolerated), small vessel purges, inert purging, and buffer gas for the dry compressor seals and intermittently at utility stations and to purge vessels for maintenance. The nitrogen for continuous use would be produced from compressed, dried air via separation from oxygen using a nitrogen membrane package or supplied by nitrogen bottle. Intermittent users (and peak continuous loads) would be supplied from liquid nitrogen trucked to the facility. The nitrogen system would be located in the common utilities area of the plant.

#### 13.20.1.1 Nitrogen Source

Nitrogen for continuous usage would be generated on site with a nitrogen membrane package that supplies nitrogen using compressed air from the common air compressor packages. Nitrogen would be generated with a minimum purity of 98 percent at 125 psi and 100 °F for distribution.

For large facility turnarounds, additional quantities of nitrogen would be trucked in to supply high-volume or pressure requirements.

##### 13.20.1.1.1 Number of Liquid Nitrogen Trucks and Truck Capacity, gal

Not applicable to the GTP

##### 13.20.1.1.2 Nitrogen Production System and Production Rate, gpm

Nitrogen for continuous usage would be generated on site with a nitrogen membrane package that supplies nitrogen using compressed air from the common air compressor packages. The niotrgen membrane package design flow rate is 2.95 MMSCFD of gas nitrogen.

#### 13.20.1.2 Nitrogen Distribution List of Continuous and Intermittent Users or Usage Factors, Including Leakage, and Usage Requirement by Equipment, scfm

The Utility Flow Diagram USAG-EC-PDUFD-60-000961-114 included in Appendix 13.E.3 provides details of the nitrogen distribution system.

#### 13.20.1.3 Number of Liquid Nitrogen Storage Tanks, Operating and Spare

Not applicable to the GTP.

#### 13.20.1.4 Liquid Nitrogen Storage Capacity, gal

Not applicable to the GTP.

#### 13.20.1.5 Number of Nitrogen Vaporizers, Operating and Spare

Not applicable to the GTP.

#### 13.20.1.6 Liquid Nitrogen Vaporizer Type

Not applicable to the GTP.

#### 13.20.1.7 Number of Nitrogen Receivers, Operating and Spare

1 x 100%

#### 13.20.1.8 Liquid Nitrogen Vaporizer Operating and Design Flow Rate Capacities, scfm

Not applicable to the GTP

#### 13.20.1.9 Nitrogen Receivers Operating and Design Storage Capacities, scf

The one x 100- percent nitrogen receiver located downstream of the nitrogen membrane package would supply 10 minutes of design flow rate as the pressure decreases from normal (125 pounds per square inch absolute [psia]) to the minimum (85 psia); to safely shutdown the Treated Gas, $CO_2$ and Refrigerant Compressors on loss of the nitrogen generation system without loss of nitrogen flow to seals.

The niotrgen membrane package design flow rate is 2.95 MMSCFD of gas nitrogenThe total demand of nitrogen for the three trains would be 2.95 MMSCFD.

#### 13.20.1.10 Nitrogen Receivers Operating and Design Storage Pressures (minimum, normal, maximum), psig

The normal operating pressure for the nitrogen distribution system would be 125 psi at 100 °F.

#### 13.20.1.11 Nitrogen Receivers Residence Times, Minutes

To be determined in detailed design

#### 13.20.1.12 Nitrogen System Startup and Operation

Membrane system designed for startup and operation.

#### 13.20.1.13 Nitrogen System Shutdown

Membrane system designed for shutdown

#### 13.20.1.14 Liquid Nitrogen Truck Loading

Not applicable to the GTP.

#### 13.20.1.15 Nitrogen System Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.20.1.16 Nitrogen System Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.20.1.17 Nitrogen System Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.20.1.18 Nitrogen System Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.20.1.19 Nitrogen System Other Safety Features

Final details will be provided in detailed design.

### 13.20.2 Inert Gas Design

Not applicable to the GTP.

#### 13.20.2.1 Inert Gas Distribution List of Continuous and Intermittent Users or Usage Factors, Including Leakage, and Usage Requirement By Equipment, scfm

Not applicable to the GTP.

#### 13.20.2.2 Inert Gas Compressors Type

Not applicable to the GTP.

#### 13.20.2.3 Number Of Inert Gas Compressors, Operating and Spare

Not applicable to the GTP.

#### 13.20.2.4 Number Of Inert Gas Receivers, Operating and Spare

Not applicable to the GTP.

#### 13.20.2.5 Inert Gas Source

Not applicable to the GTP.

#### 13.20.2.6 Inert Gas Specifications

Not applicable to the GTP.

#### 13.20.2.7 Inert Gas Compressor Operating and Design Flow Rate Capacities (minimum, normal/rated, maximum), scfm

Not applicable to the GTP.

#### 13.20.2.8 Inert Gas Compressor Operating and Design Discharge Pressures (minimum, normal/rated, maximum), psig

Not applicable to the GTP.

#### 13.20.2.9 Inert Gas Receivers Operating and Design Storage Capacities, scf

Not applicable to the GTP.

#### 13.20.2.10 Inert Gas Receivers Operating and Design Storage Pressures (minimum, normal, maximum), psig

Not applicable to the GTP.

#### 13.20.2.11 Inert Gas Receivers Residence Times, minutes

Not applicable to the GTP.

#### 13.20.2.12 Inert Gas Startup And Operation

Not applicable to the GTP.

#### 13.20.2.13 Inert Gas Isolation Valves, Drains, and Vents

Not applicable to the GTP.

#### 13.20.2.14 Inert Gas Basic Process Control Systems

Not applicable to the GTP.

#### 13.20.2.15 Inert Gas Safety Instrumented Systems

Not applicable to the GTP.

#### 13.20.2.16 Inert Gas Relief Valves and Discharge

Not applicable to the GTP.

#### 13.20.2.17 Inert Gas Other Safety Features

Not applicable to the GTP.

## 13.21 INSTRUMENT AND PLANT/UTILITY AIR

The GTP would include an air system that would be used to supply compressed, dry air to the following systems:

- Instrument air;
- Utility or service air;
- Breathing air; and
- Nitrogen Generation System.

The air compressors and dryers would be located in the common utilities area and air would be distributed to the process areas as required. A separate compressed air system would be supplied at the operations camp for equipment maintenance.

### 13.21.1 Instrument Air Design

Instrument air would be used at the GTP for operation of pneumatic valves.

Utility Flow Diagrams USAG-EC-PDUFD-60-000955-110 and USAG-EC-PDUFD-60-000952-112 included in Appendix 13.E.3 show the basic design of the GTP compressed air system and instrument air distribution.

#### 13.21.1.1 Instrument Air Distribution List of Continuous and Intermittent Users or Usage Factors, Including Leakage, and Usage Requirement By Equipment, scfm

The Utility Flow Diagram USAG-EC-PDUFD-60-000952-112 included in Appendix 13.E.3 provides details of the instrument air distribution system.

#### 13.21.1.2 Instrument Air Specifications, Dew Point, Particulates

Instrument air specifications are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

#### 13.21.1.3 Number of Filters, Operating and Spare

The Utility Flow Diagram USAG-EC-PDUFD-60-000955-110 included in Appendix 13.E.3 provides details of the air dryer package.

#### 13.21.1.4 Instrument Air Compressors Type

Compressed air for entire facility is supplied with three 50-percent electric-motor-driven air compressor packages. Separate headers would be used for each of the previously-referenced systems, and in case of loss of air pressure, the utility air system is closed off first, then the nitrogen separation unit feed, then instrument air.

#### 13.21.1.5 Number Of Instrument Air Compressors, Operating and Spare

Compressed air for entire facility is supplied with three 50-percent electric-motor-driven air compressor packages. The Utility Flow Diagram USAG-EC-PDUFD-60-000955-110 included in Appendix 13.E.3 provides details of the air compression system.

#### 13.21.1.6 Instrument Air Compressor Operating and Design Flow Rate Capacities (minimum, normal/rated, maximum), scfm

Each compressor package would provide oil-free air at a design rate of 7,933 actual cubic feet per minute (ACFM). With two compressors in operation, the total air capacity would be approximately 15,866 ACFM. The total air demand for the three trains (including common systems) is approximately be 15,000 SCFM.

#### 13.21.1.7 Instrument Air Compressor Operating and Design Discharge Pressures (minimum, normal/rated, maximum), psig

The normal operating pressures for the instrument air system is 145 psi at 100 °F.

#### 13.21.1.8 Instrument Air Drying System Type

A 1 x 100 percent mol sieve air dryer package with sufficient sparing to ensure 100-percent availability would provide dry air for the facility. The air dryer package would supply the instrument air at a dew point of -100 ºF (to minimize the freezing risk). Air provided to the dryers would be oil-free from the air compressor packages. Heated ambient air would be used for regeneration air for the spent dryer(s).

#### 13.21.1.9 Number Of Instrument Air Dryers, Operating and Spare

The air dryer package is one 100-percent mol sieve air dryer. Sufficient beds or bed capacity will be included to prevent interruption of air drying for a single point failure.

#### 13.21.1.10 Instrument Air Dryers Operating and Design Dew Point Temperatures, °F

The design instrument air dew point is -100 °F.

#### 13.21.1.11 Number Of Air Receivers, Operating and Spare

A one x 100 percent dry air receiver would supply compressed air to the overall facility in the event of the compressor or air dryer failure. Each train would include a secondary instrument air receiver located within the individual instrument air distribution headers. The common dry air receiver and dedicated instrument air receivers would each be sized to supply five minutes of continuous design air flow (from 130 psig to 90 psig) to the respective distribution headers (to safely shutdown the GTP upon loss of the air compression system).

The Mechanical Equipment List (USAG-EC-SRZZZ-00-000002-000) included in Appendix 13.M.1 provides details regarding the equipment design (design pressure, temperature, and flowrate).

#### 13.21.1.12 Air Receiver Operating and Design Storage Capacities, scf

The common dry air receiver and dedicated instrument air receivers would each be sized to supply five minutes of continuous design air flow (from 130 psig to 90 psig) to the respective distribution headers (to safely shutdown the GTP upon loss of the air compression system).

The total estimated continuous air requirement for the GTP is 15,000 SCFM which is the sum of the instrument air, air for the nitrogen generation system, service air, and breathing air to high $CO_2$ concentration areas.

#### 13.21.1.13 Instrument Air Receiver Operating and Design Storage Pressures (minimum, normal, maximum), psig

The minimum and normal operating pressures of the common dry air receiver and dedicated instrument air receivers is 90 psig and 130 psig, respectively. The design pressure of all the dry and instrument instrument air recievers is 155 psig.

#### 13.21.1.14 Air Receiver Residence Times, sec

The common dry air receiver and dedicated instrument air receivers would each be sized to supply five minutes of continuous design air flow.

#### 13.21.1.15 Instrument Air Startup and Operation

Startup and operating procedures for overall air compression system would be developed during detail engineering and included in the GTP operating manuals.

#### 13.21.1.16 Instrument Air Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.21.1.17 Instrument Air Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.21.1.18 Instrument Air Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.21.1.19 Instrument Air Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.21.1.20 Instrument Air Other Safety Features

Final details will be provided in detailed design.

### 13.21.2 Plant/Utility Air Design

Utility or service air would be used within the GTP in utility stations to provide motive power for pneumatic tools and equipment that may be used during maintenance activities at the site. The utility air would be taken downstream of the air dryer package and would be therefore provided as dry air for freeze protection. The Utility Flow Diagram USAG-EC-PDUFD-60-000951-111 included in Appendix 13.E.3 shows the basic design of the GTP utility/service air distribution system

#### 13.21.2.1 Plant/Utility Air Compressors Type

Compressed air for entire facility is supplied with three 50-percent electric-motor-driven air compressor packages. Separate headers would be used for each of the previously-referenced systems, and in case of loss of air pressure, the utility air system is closed off first, then the nitrogen separation unit feed, then instrument air.

#### 13.21.2.2 Number Of Plant/Utility Air Compressors, Operating and Spare

Compressed air for entire facility is supplied with three 50-percent electric-motor-driven air compressor packages. The Utility Flow Diagram USAG-EC-PDUFD-60-000955-110 included in Appendix 13.E.3 provides details of the air compression system.

#### 13.21.2.3 Plant/Utility Air Distribution List of Continuous and Intermittent Users or Usage Factors, Including Leakage, and Usage Requirement by Equipment, scfm

Each compressor package would provide oil-free air at a design rate of 7,933 actual cubic feet per minute (ACFM). With two compressors in operation, the total air capacity would be approximately 15,866 ACFM. The total air demand for the three trains (including common systems) is approximately be 15,000 SCFM.

The Utility Flow Diagram USAG-EC-PDZZZ-60-000951-112 included in Appendix 13.E.3 provides details of the Plant/Utility air distribution system.

#### 13.21.2.4 Plant/Utility Air Specifications

Plant/Utility air specifications are included in the Gas Treatment Plant Design Basis (USAG-PG-BBPDB-00-000002-000) included in Appendix 13.B.2.

#### 13.21.2.5 Plant/Utility Air Compressors Operating and Design Flow Rate Capacities (Minimum, Normal/Rated, Maximum), scfm

The total demand of utility air for the three trains would be approximaltey 450 SCFM.

#### 13.21.2.6 Plant/ Utility Air Compressors Operating and Design Discharge Pressures (minimum, normal/rated, maximum), psig

The normal operating pressures for the utility air system would be 145 psi at 100 °F.

#### 13.21.2.7 Number Of Plant/Utility Air Receivers, Operating and Spare

One 100-percent dry air receiver would supply compressed air to the overall facility in the event of the compressor or air dryer failure. A common dry air receiver will supply five minutes of continuous design air flow (from 130 psig to 90 psig) to the distribution headers (to safely shutdown the GTP upon loss of the air compression system).

The total estimated continuous air requirement for the GTP is 15,000 SCFM which is the sum of the instrument air, air for the nitrogen generation system, service air, and breathing air to high $CO_2$ concentration areas. The Mechanical Equipment List (USAG-EC-SRZZZ-00-000002-000) included in Appendix 13.M.1 provides details regarding the equipment design (design pressure, temperature, and flow rate).

#### 13.21.2.8 Plant/Utility Air Receivers Operating and Design Storage Capacities, scf

The common dry air receiver would be sized to supply five minutes of continuous design air flow (from 130 psig to 90 psig) to the distribution header (to safely shutdown the GTP upon loss of the air compression system).

The total estimated continuous air requirement for the GTP is 15,000 SCFM which is the sum of the instrument air, air for the nitrogen generation system, service air, and breathing air to high CO2 concentration areas.

#### 13.21.2.9 Plant/Utility Air Receivers Operating and Design Storage Pressures (minimum, normal, maximum), psig

The minimum and normal operating pressures of the common dry air receiver is 90 psig and 130 psig, respectively. The design pressure of the dry air reciever is 155 psig.

#### 13.21.2.10 Plant/Utility Air Receivers Operating and Design Residence Times, Minutes

The common dry air receiver would be sized to supply five minutes of continuous design air flow.

#### 13.21.2.11 Plant/Utility Air Startup and Operation

#### 13.21.2.12 Plant/Utility Air Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.21.2.13 Plant/Utility Air Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.21.2.14 Plant/Utility Air Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.21.2.15 Plant/Utility Air Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.21.2.16 Plant/Utility Air Other Safety Features

Final details will be provided in detailed design.

### 13.21.3 Breathing Air Design

Breathing air of suitable quality is needed to fill bottles used to escape from or respond to emergency situations such as a gas release that is isolated in a module. The air supply for filling bottles and cylinders would meet American National Standards Institute (ANSI) requirements and other recognized standards where applicable. A self-contained breathing apparatus breathing air conditioning package would provide clean, particulate-free, and oil-free air suitable for breathing. It would include compression, filtration, purification, pressure regulation, and manifolding to facilitate filling bottles and cylinders. Both the inlet filter and breathing air filter would be included in the Breathing Air Conditioning Package.

A hard-piped, centralized breathing air system would be provided to each module that contains high $CO_2$ inventories (i.e., $CO_2$ Compression). The centralized breathing air system would provide breathing air service for maintenance activities. The plant air would supply the air to the centralized breathing air system. A purification system to remove solid particulates, oil, CO and HC vapors that may occasionally be present in compressed air, as well as all breathing air monitoring, would be centralized in the common area.

The Utility Flow Diagram USAG-EC-PDUFD-60-000954-113 included in Appendix 13.E.3 shows the basic design of the GTP breathing air package and distribution system.

#### 13.21.3.1 Flow Rate, SCFM

The total demand of breathing air for the GTP would be approximately 300 SCFM.

#### 13.21.3.2 Pressure, psig

The normal operating pressures for the breathing air distribution system would be 145 psi at 100 °F.

## 13.22 UTILITY WATER AND OTHER UTILITIES

Other transfer pipelines would be necessary to supply the GTP, including the following:

- Fuel gas pipeline (approximately 2 miles of 6-inch pipe) delivering fuel gas from the PBU CGF to the GTP and GTP Operations Camp;
- Propane pipeline (approximately 1 mile of 2-inch pipe) taking propane from the PBU CGF to the GTP for use in the GTP refrigeration system;
- Putuligayuk River pipeline (approximately 1 mile of 14-inch pipe) delivering water from the Putuligayuk River to the reservoir; and
- Supply water pipeline (approximately 5 miles of 6-inch pipe) taking raw water from the reservoir to the GTP and GTP operations camp.

The PBU CGF to GTP pipelines would be supported on vertical support members (VSMs) in a new elevated pipeline system for much of the route between the PBU CGF and GTP. Resource Report No. 1 Appendix 13.E and Section 1.3.2.4 provide typical details of the aboveground pipe rack arrangement and description of VSMs. The PBTL, propane pipeline, and fuel gas pipeline would share the same route from the general area of the northwest corner of the PBU CGF to the general area of the northeast corner of the GTP.

### 13.22.1 Utility Water Design

The GTP water systems would provide water to various users in the GTP and operations camp including process makeup requirements, firewater, and potable water (see *Water Use Plan* located in Resource Report No. 2, Appendix L). Water supply to the GTP and Integrated Construction and Operations camp would originate from the Putuligayuk River. Due to the low flow in the winter and presence of fish within the river, year-round withdrawal of sufficiently large quantities is unlikely. To ensure year-round water supply, water from the river would be used to fill a reservoir during spring break-up when there is sufficient water runoff.

The preliminary reservoir design includes a footprint of approximately 45 acres with a depth in range of 35 to 55 feet. The reservoir is designed to provide year-round supply and is expected to form a surface ice pack of approximately 8 feet, which is not included in the net available capacity. Pump requirements, silt and salinity layers, side slope, ramp design, and other factors would affect the net available capacity in comparison to the total volume of the reservoir. The preliminary estimate for available capacity is 250 million gallons, a two-year water supply for the GTP that would support process and potable water demands. The water intake structure would be located on the Putuligayuk River and draw water during spring break-up at acceptable flow rates through protective fish screens.

#### 13.22.1.1 Utility Water Type (Service Water, Potable Water, Demineralized Water, Steam, Chemical Treatment. Scavengers)

Fresh water

#### 13.22.1.2 Utility Water Sources

Fresh water to the GTP would be supplied by the following pipeline system:

- 14-inch water pipeline would fill the GTP water reservoir once a year in the summer-season; this pipeline and associated equipment would run seasonally just in the summer during high Putuligayuk River flow; and

- Water from the Putuligayuk Reservoir to the GTP would flow continuously throughout the year, supplying both process and camp water needs.

#### 13.22.1.3 Utility Water Distribution List and Usage Requirement By Equipment, Gpm

The Utility Flow Diagram USAG-EC-PDUFD-60-000976-116, USAG-EC-PDUFD-60-000976-119 through 122 and USAG-EC-PDUFD-60-000683-118 included in Appendix 13.E.3 provide details of the GTP water distribution system.

#### 13.22.1.4 Utility Water Operating and Design Storage Capacities (Minimum, Normal, Maximum), gal

Together, theThe two raw water storage tanks provide two two-days' supply of potable water, service water, and two two-weeks' supply of process water. The tanks would operate at atmospheric pressure and have a working capacity of approximately 539,000 usg (17,120 bbls) each, based on a standard API tank size.

#### 13.22.1.5 Utility Water Operating and Design Flow Rate Capacities (Minimum, Normal, Maximum), gpm

The normal operating flow rate of the GTP raw water distribution system is 392 GPM.

#### 13.22.1.6 Utility Water Operating and Design Pressures (Minimum, Normal, Maximum), psig

The normal operating pressure of the GTP raw water distribution system is approximaltey 95 psig.

#### 13.22.1.7 Utility Water Startup and Operation

Water from the reservoir would be routed to the facility in a single line, but would be split near the pad to deliver raw water to the camp and the GTP separately. The line to the camp would flow to a potable water system that would include storage tanks, pumps, the treatment system, and distribution at the camp. The line to the GTP would flow to two raw water storage tanks at the GTP (truck connections are provided as a backup).

#### 13.22.1.8 Utility Water Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.22.1.9 Utility Water Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.22.1.10 Utility Water Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.22.1.11 Utility Water Relief Valves And Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.22.1.12 Utility Water Other Safety Features

Final details will be provided in detailed design.

### 13.22.2 Other Utilities Design

#### 13.22.2.1 Other Utilities Type (Amine Solutions, Water Glycol Solutions, Aqueous Ammonia, Etc.)

Raw Water

#### 13.22.2.2 Other Utility Distribution List And Usage Requirement By Equipment, Gpm

Raw water from the raw water storage tanks at the GTP would be distributed as described in the following list:

- Potable water: Raw water from the tanks would be routed to the Potable Water Treatment System (PWTS) at the GTP.

The Potable water system would supply water to the control room humidifiers, eye wash stations, safety showers, and restroom facilities at the GTP. The design flowrate of potable water for distribution to the GTP is 55 gpm at a pressure of 93 psi (3 x 50 percent potable water pumps);

- Utility/Service water: A portion of the raw water from the tanks would be made available for use as Service Water. Utility stations, strategically located around the facility, would be used to wash down equipment and surrounding areas when needed. The design flowrate of service water for distribution to the GTP would be 275 gpm at 110 psi (2 x 100 percent service water pumps); and

- Process water: Raw water coming to the GTP would be treated to meet the water quality requirements for makeup water in the AGRU. Process water would be used for makeup to the AGRU water wash system, AGRU Regenerator Reflux, and mixing with the fresh amine for solvent makeup. Process water can also be used for turbine wash water and Process Heat Medium makeup. The design flowrate of process water for distribution to the GTP would be 75 gpm at 210 psi (2 x 100 percent process water pumps).

#### 13.22.2.3 Other Utility Sources

Raw water storage tanks

#### 13.22.2.4 Number of Other Utility Truck Stations

Not applicable to the GTP.

#### 13.22.2.5 Other Utility Operating and Design Storage Capacities (Minimum, Normal, Maximum), gal

There will be two potable water tanks at the GTP pad. The storage capacity of each tank will be 35,815 usg (1,137 bbls) per tank.

There will be one process water storage tank at the GTP pad. The storage capacity of the tank will be 315,000 usg (10,000 bbls).

#### 13.22.2.6 Other Utility Operating and Design Flow Rate Capacities (Minimum, Normal, Maximum), gpm

#### 13.22.2.7 Other Utility Operating and Design Pressures (Minimum, Normal, Maximum), psig

#### 13.22.2.8 Utility Truck Scales

Not applicable to the GTP

#### 13.22.2.9 Utilities Startup and Operation

#### 13.22.2.10 Utilities Isolation Valves, Drains, and Vents

Isolation valves, drains, and vents are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.22.2.11 Utilities Basic Process Control Systems

Process controls are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.22.2.12 Utilities Safety Instrumented Systems

Safety instrumened systems are shown on the P&IDs included in Appendix 13.E.5, and the specifications in Appendix 13.F.3. Final details will be provided in detailed design.

#### 13.22.2.13 Utilities Relief Valves and Discharge

Relief valves are shown on the P&IDs included in Appendix 13.E.5. Final details will be provided in detailed design.

#### 13.22.2.14 Utilities Other Safety Features

Final details will be provided in detailed design.

### 13.22.3 Methanol System Design

Methanol would be used for hydrate inhibition or for hydrate mitigation where required (e.g., upstream of aerial coolers in wet gas service in low ambient temperatures conditions). The use of methanol would be a reactive measure; no storage, transfer, or injection equipment would be permanently installed as part of the GTP process. A portable system would be deployed when required to mitigate hydrate formations.

### 13.22.4 Diesel and Gasoline Fuel System Design

Arctic grade ultra-low sulfur diesel would be trucked to the GTP and stored for use on the GTP Pad and Operations Center Pad. The diesel fuel storage tank on the GTP Pad would have a nominal capacity of 19,500 gallons and be sized to hold two weeks of diesel for the emergency and essential generators, diesel firewater pumps, and diesel fuel for service vehicles. The majority of this volume would be for vehicle usage. Usage by the emergency and essential diesel generators and firewater system would be for emergency and testing purposes.

The diesel-driven firewater pumps, communication tower, and the camp emergency diesel generators would be located at the operations camp. The day tanks would be supplied directly via truck delivery to the operations camp.

A list and description of the fuel systems equipment is provided in Table 13.22.4.

TABLE 13.22.4

**Estimated GTP Fuel Systems Storage Size**

| Equipment | Gallons |
|---|---|
| Diesel Fuel Storage Tank | 19,500 |
| Diesel Fueling Station Storage Drum | 450 |
| Dormitory Emergency Diesel Generator Day Storage | 200 |
| Essential Diesel Generator Day Storage | 3,600 |
| Firewater Diesel Day Storage Drum (each – 3 drums total) | 350 |
| Communication Tower Diesel Generator | 24 hours of storage located in the base of the generator (gallons—to be determine or TBD) |
| Gasoline Storage | 10,000 |

Gasoline would be trucked to the GTP and stored for use at the GTP Operations Center. The gasoline storage tank would have a nominal capacity of 10,000 usg and would supply gasoline for service vehicles. The fuel systems would be designed and operated in compliance with all federal and state regulatory requirements and the *Spill Prevention, Control, and Countermeasure (SPCC) Plan* (Appendix M of Resource Report No. 2).

### 13.22.5 Chemical Storage

Storage for process chemicals would be provided on the GTP Pad. The chemical storage tanks would include storage for amine (130,000 gallons), TEG (26,500 gallons), and diesel (discussed previously). There would also be an additional empty tank with a capacity of 962,000 gallons to hold the amine from one train if it were to be taken out of service. A hydrocarbon holding tank would also be provided at the GTP Operations Center.

The hydrocarbon holding tank is designed to hold recyclable waste diesel, glycol, solvents, miscellaneous fuels, and lubricants. This tank would be emptied using a vacuum truck as needed and either recycled or transported to an existing approved handling facility. Sizing for the hydrocarbon holding tank would be confirmed during later stages of the Project design.

The chemical storage area would be designed and operated in compliance with Alaska Department of Environmental Conservation (ADEC) and EPA requirements. The Project-specific *SPCC Plan* (Appendix M of Resource Report No. 2) would address the measures described in Section 1.3.2.8.9.13 of Resource Report No. 1.

## 13.23 PIPING AND VALVES

### 13.23.1 Piping and Valve Design

The majority of the equipment and piping systems would be located in shop-fabricated modules. The equipment and piping systems would be arranged to achieve the most efficient process flow. Arrangements would provide maintenance and operation access along with any required platforms. Each module would have either a small pipe spool or single weld (“golden” weld) to make the final connection between modules. This “golden” weld would be radiographed to ensure the integrity of the weld. Final connection of trains would either be flanged or a welded. Details of these connections would be completed during a later phase of the Project.

Process-related piping systems at the GTP are designed in accordance with the Piping Design Basis (USAG-EC-LBDES-00-000001-000) included in Appendix 13.B.6 and the following Piping Specifications included in Appendix 13.F.2.

TABLE 13.23.1

**Piping Specifications for Process-Related Piping Systems at the GTP**

| Drawing Number | Description |
|---|---|
| USAI-PT-LSPDS-00-000001-000 | Piping Material Classifications Line Class 150 |
| USAI-PT-LSPDS-00-000002-000 | Piping Material Classifications Line Class 300 |
| USAI-PT-LSPDS-00-000003-000 | Piping Material Classifications Line Class 600 |
| USAI-PT-LSPDS-00-000004-000 | Piping Material Classifications Line Class 900 |
| USAI-PT-LSPDS-00-000005-000 | Piping Material Classifications Line Class 1500 |
| USAI-PT-LSPDS-00-000006-000 | Piping Material Classifications Line Class 2500 |

#### 13.23.1.1 Piping and Valve List

Piping and valves are shown on the P&IDs included in Appendix 13.E.5. A final piping and valve list will be provided in detailed design.

#### 13.23.1.2 Tie-In List

Tie-ins are shown on the P&IDs included in Appendix 13.E.5. A final tie-in list will be provided in detailed design.

#### 13.23.1.3 Isolation, Vent and Drain Philosophies

Preliminary configuration is shown on the P&IDs in Appendix 13.E.5. The Basis of Design is included in Appendix B.2 and the Flare, Relief, and Blowdown Philosophy is included in Appendix 13.B.9. Final configuration to be determined in detailed design.

#### 13.23.1.4 Car Seal and Lock Philosophy

Preliminary configuration is shown on the P&IDs in Appendix 13.E.5. Final configuration to be determined in detailed design.

#### 13.23.1.5 Piping Layout

The locations of major pipe racks at the GTP are shown in the general plot plans included in Appendix 13.A.1. Locations of individual pipe rack modules are provided in the Module Index Plot Plan (USAG-EC-LDLAY-00-001006-000) in Appendix 13.E.6.

#### 13.23.1.6 Pipe Supports and Pipe Racks

Design considerations for pipe rack structures are provided in Structural Design Basis (USAG-ECNBDES-00-000001-000) included in Appendix 13.B.5.

Typical piping support systems details are included in the major pipe rack cross sectional drawings included in Appendix E.8.

#### 13.23.1.7 Piping, Valve, Flange, and Insulation Design And Specifications

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.23.1.7.1 Conditions and Loads (E.G. Pressures, Temperatures, Vibration, Internal And External Corrosion, Etc.)

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.23.1.7.2 Material of Construction Temperature Limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.23.1.7.3 Material of Construction Allowable Stress Limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.23.1.7.4 Material of Construction Corrosivity Potential And Corrosion Allowance

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.23.1.7.5 Cathodic Protection

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

#### 13.23.1.8 Positive Material Identification Requirements*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.23.1.9 Post Weld Heat Treatment*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.23.1.10 Non-Destructive Examination (NDE)*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

##### 13.23.1.10.1 Weld Radiographic/Ultrasonic Testing

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

##### 13.23.1.10.2 Magnetic Particle or Liquid Penetrant Examination

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

##### 13.23.1.10.3 Pneumatic/Hydrostatic Leak Testing Medium and Pressure

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

##### 13.23.1.10.4 Other

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.23.1.11 Piping and Valve Preventive Maintenance*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

##### 13.23.1.11.1 Internal and External Examination

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

##### 13.23.1.11.2 Corrosion Under Insulation

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

##### 13.23.1.11.3 Metal thickness tests

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

## 13.24 PROCESS VESSELS

### 13.24.1 Process Vessel Design

#### 13.24.1.1 Process Vessel List

Process vessels are shown on the P&IDs included in Appendix 13.E.5. An equipment list is provided in Appendix 13.M.3. A final equipment list will be provided in detailed design.

#### 13.24.1.2 Process Vessel Layout

Process vessels are shown on the plot plans included in Appendix 13.E.6.

#### 13.24.1.3 Process Vessel Support

To be determined in detailed design. Support structures will be properly designed to support the necessary loads.

#### 13.24.1.4 Process Vessel and Insulation Design and Specifications

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.24.1.4.1 Conditions and Loads (e.g. Pressures, Temperatures, Vibration, Internal and External Corrosion, Etc.)

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.24.1.4.2 Material of Construction Allowable Stress Limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.24.1.4.3 Material of Construction Temperature Limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.24.1.4.4 Material of Construction Corrosivity Potential And Corrosion Allowance

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.24.1.4.5 Cathodic Protection

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

#### 13.24.1.5 NDE

Process vessel testing requirements will be performed in accordance with all applicable codes. The EPC contractor will provide testing requirements for all process vessels.

#### 13.24.1.5.1 Magnetic Particle or Liquid Penetrant Examination

To be determined in detailed design.

#### 13.24.1.5.2 Full or Spot Radiographic or Ultrasonic Testing

To be determined in detailed design.

#### 13.24.1.5.3 Pneumatic or Hydrostatic Leak Testing Pressure

To be determined in detailed design.

#### 13.24.1.6 Process Vessel Preventive Maintenance

Preventative maintenance will be performed in accordance with OSHA requirements. Maintenance will include inspections (visual and/or internal, where applicable) for corrosion, deterioration, or abnormal visual indications.

#### 13.24.1.6.1 Internal and External Examination

To be determined in detailed design.

#### 13.24.1.6.2 Corrosion Under Insulation

To be determined in detailed design.

#### 13.24.1.6.3 Metal Thickness Tests

To be determined in detailed design.

## 13.25 ROTATING EQUIPMENT

### 13.25.1 Rotating Equipment Design*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.25.1.1 Rotating Equipment and Drivers List

Rotating equipment is shown on the P&IDs included in Appendix 13.E.5. An equipment list is provided in Appendix 13.M.3. A final equipment list will be provided in detailed design.

#### 13.25.1.2 Rotating Equipment Layout

Rotating equipment is shown on the plot plans included in Appendix 13.E.6. An equipment list is provided in Appendix 13.M.3. A final equipment list and plot plan will be provided in detailed design.

#### 13.25.1.3 Rotating Equipment Support

To be determined in detailed design. Support structures will be properly designed to support the necessary loads.

#### 13.25.1.4 Rotating Equipment Design And Specifications

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.25.1.4.1 Conditions and Loads (e.g. Pressures, Temperatures, Vibration, Internal And External Corrosion, Etc.)

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.25.1.4.2 Performance Curves

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.25.1.4.3 Material Of Construction Allowable Stress Limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.25.1.4.4 Material Of Construction Temperature Limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.25.1.4.5 Material Of Construction Corrosivity Potential And Corrosion Allowance

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

##### 13.25.1.4.6 Cathodic Protection

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

#### 13.25.1.5 Machinery Monitoring System

Monitoring systems will be designed in accordance with all applicable codes and based on vendor requirements. Details of the machinery monitoring systems will be available in detailed design.

#### 13.25.1.6 Rotating Equipment Preventive Maintenance

Preventative maintenance will be performed in accordance with all applicable codes and based on vendor requirements. Equipment monitoring systems will have performance monitoring which will allow operators and vendors to identify deviations in typical equipment parameters. Details of the preventative maintenance plans will be available in detailed design.

##### 13.25.1.6.1 Performance Monitoring and Tests

Details of the preventative maintenance plans will be available in detailed design.

## 13.26 FIRED EQUIPMENT

### 13.26.1 Fired Equipment Design*

The Project Master Equipment List, which summarizes the major process equipment and applicable design conditions for the facility, is included in Appendix 13.M.3. There will be supplemental firing of waste heater recovery units for the $CO_2$ Compressor Turbines and Treated Gas Compressor Turbines.

#### 13.26.1.1 Fired equipment list

| Tag Number | Equipment Title |
|---|---|
| TBD | Treated Gas Compressor Heat Recovery Unit Supplemental Firing |
| TBD | CO2 Compressor Turbine Supplemental Firing |

#### 13.26.1.2 Fired equipment layout

Fired equipment is shown on the plot plans included in Appendix 13.E.6. An equipment list is provided in Appendix 13.M.3. A final equipment list and plot plan will be provided in detailed design.

#### 13.26.1.3 Fired equipment support

To be determined in detailed design. Support structures will be properly designed to support the necessary loads.

#### 13.26.1.4 Fired equipment design and specifications

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility.

##### 13.26.1.4.1 Conditions and loads (e.g. pressures, temperatures, vibration, internal and external corrosion, etc.)

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

#### 13.26.1.4.2 Duty

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

#### 13.26.1.4.3 Material of construction allowable stress limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

#### 13.26.1.4.4 Material of construction temperature limits

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

#### 13.26.1.4.5 Material of construction corrosivity potential and corrosion allowance

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

#### 13.26.1.4.6 Cathodic protection

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

### 13.26.1.5 Burner Management System

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

### 13.26.1.6 Fired equipment preventive maintenance

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the LNG Facility

#### 13.26.1.6.1 Performance monitoring and tests

Details of the performance monitoring plans will be available in detailed design.

## 13.27 BUILDINGS AND STRUCTURES

### 13.27.1 Buildings and Structures Design

New buildings and structures would be constructed to support the operation of the GTP. Major buildings and structures are described in this section.

New construction would be in accordance with code requirements consistent with the function of each building and structure. In general, construction would be primarily steel modules installed on adfreeze piles. Concrete would be minimized as much as practical and would likely only be used for the prefabricated steel warehouse slab on grade.

Preliminary plan and elevation drawings for the Control Building are included in Appendix 13.M.8. Enclosed process building modules drawings are included in Appendix 13.A.1.

#### 13.27.1.1 Operations Center

The Operations Center would be built on its own pad approximately 3,000 feet northwest of the GTP Pad off the main road. The Operations Center and GTP Pad would be connected by a raw water line, LP fuel gas, and gray water as well as a power supply cable run along T-supports paralleling the main road. The Operations Center would include the following facilities:

- Office space;
- Maintenance Shop/Warehouse;
- Utility building;
- Telecommunications;
- Waste management;
- Parking, truck loading/unloading; and
- Camp, including:
    - Living quarters;
    - Kitchen;
    - Dining; and
    - Lounge areas.

#### 13.27.1.2 Control Building

The control building would be located on the south side of the GTP Pad near the alternate entrance. Because this would be an occupied building, it would be designed and constructed as a blast resistant structure if the hazard analysis determined it is not sufficiently far enough away from hazards. A CCR, located within the control building with permanently-manned consoles, would be used to control the GTP. The ability to operate, monitor, and shutdown all units, packages, processes, and utilities would be available from the CCR. The control building would also have offices, restrooms, break room and a training area.

The control room layout, HMI consoles design, any control panels, and notification systems are designed with special emphasis on ergonomics. Consideration is given to design features that could lead to improvements in safety, reduction of human error, ease of maintenance, reduced operator fatigue, improved and/or reduced alarming, or risk reduction.

#### 13.27.1.3 Enclosed Process Building Modules

Mechanical equipment at the GTP would be built inside modules based on construction and operating restraints given the location of the facility. Equipment within modules is arranged efficiently compact for operations and maintenance. To the extent practicable, individual equipment and skids associated with unique process systems would be grouped in close proximity. The modules have a steel frame structure to support the piping, mechanical, electrical, and instrumentation equipment. Equipment with the associated components would be completely installed in the modules at the Module Fabrication Sites (MFSs) before being shipped to the GTP site.

The GTP Architectural Design Basis (USAG-EC-CBDES-00-000010-000) included in Appendix 13.B.4 provides the engineering specifications for the design of enclosed process buildings.

### 13.27.2 List of Buildings

Table 13.27.2 includes a list of the GTP buildings including enclosed process modules:

TABLE 13.27.2

**GTP Buildings and Enclosed Process Modules**

| Module Tag # | Description |
|---|---|
| 0A | COMMUNICATIONS BUILDING |
| 0R | INTEGRATED HOUSING UTILITIES |
| 0S | INTEGRATED HOUSING UTILITIES |
| 0T | HYDROCARBON HOLDING TANK |
| 0U | INTEGRATED HOUSING UTILITIES |
| 1A | ABSORBER TOWER BASE<br>(TRAIN 1) |
| 1B | AGRU ABSORBER/<br>FLASH DRUM<br>(TRAIN 1) |
| 1C | TREATED GAS COMPRESSION<br>(TRAIN 1) |
| 1D | TREATED GAS COMPRESSION STACK AND HRU<br>(TRAIN 1) |
| 1E | TREATED GAS COMPRESSION<br>(TRAIN 1) |
| 1F | TREATED GAS COMPRESSION STACK AND HRU<br>(TRAIN 1) |
| 1G | $CO_2$ & TREATED GAS DEHYDRATION<br>(TRAIN 1) |
| 1H | AGRU LEAN/RICH EXCHANGER<br>(TRAIN 1) |
| 1I | $CO_2$ GAS COMPRESSION<br>(TRAIN 1) |
| 1J | $CO_2$ GAS COMPRESSION STACK AND HRU<br>(TRAIN 1) |
| 1K | $CO_2$ GAS COMPRESSION<br>(TRAIN 1) |
| 1L | $CO_2$ GAS COMPRESSION STACK AND HRU<br>(TRAIN 1) |
| 1M | PROCESS HEAT MEDIUM<br>(TRAIN 1) |
| 1N | AGRU REGENERATION<br>(TRAIN 1) |

TABLE 13.27.2

**GTP Buildings and Enclosed Process Modules**

| **Module Tag #** | **Description** |
|---|---|
| 1P | $CO_2$ GAS COMPRESSION AIR INTAKE<br>(TRAIN 1) |
| 1Q | $CO_2$ GAS COMPRESSION AIR INTAKE<br>(TRAIN 1) |
| 1R | TREATED GAS COMPRESSION AIR INTAKE<br>(TRAIN 1) |
| 1S | TREATED GAS COMPRESSION AIR INTAKE<br>(TRAIN 1) |
| 1T | MAIN PIPE RACK W/ BATTERY LIMIT VALVES<br>(TRAIN 1) |
| 2A | ABSORBER TOWER BASE<br>(TRAIN 2) |
| 2B | AGRU ABSORBER/<br>FLASH DRUM<br>(TRAIN 2) |
| 2C | TREATED GAS COMPRESSION<br>(TRAIN 2) |
| 2D | TREATED GAS COMPRESSION STACK AND HRU<br>(TRAIN 2) |
| 2E | TREATED GAS COMPRESSION<br>(TRAIN 2) |
| 2F | TREATED GAS COMPRESSION STACK AND HRU<br>(TRAIN 2) |
| 2G | $CO_2$ & TREATED GAS DEHYDRATION<br>(TRAIN 2) |
| 2H | AGRU LEAN/RICH EXCHANGER<br>(TRAIN 2) |
| 2I | $CO_2$ GAS COMPRESSION<br>(TRAIN 2) |
| 2J | $CO_2$ GAS COMPRESSION STACK AND HRU<br>(TRAIN 2) |
| 2K | $CO_2$ GAS COMPRESSION<br>(TRAIN 2) |
| 2L | $CO_2$ GAS COMPRESSION STACK AND HRU<br>(TRAIN 2) |
| 2M | PROCESS HEAT MEDIUM<br>(TRAIN 2) |
| 2N | AGRU REGENERATION<br>(TRAIN 2) |
| 2P | $CO_2$ GAS COMPRESSION AIR INTAKE<br>(TRAIN 2) |
| 2Q | $CO_2$ GAS COMPRESSION AIR INTAKE<br>(TRAIN 2) |
| 2R | TREATED GAS COMPRESSION AIR INTAKE<br>(TRAIN 2) |
| 2S | TREATED GAS COMPRESSION AIR INTAKE<br>(TRAIN 2) |
| 3A | ABSORBER TOWER BASE<br>(TRAIN 3) |

TABLE 13.27.2

**GTP Buildings and Enclosed Process Modules**

| Module Tag # | Description |
| --- | --- |
| 3B | AGRU ABSORBER/<br>FLASH DRUM<br>(TRAIN 3) |
| 3C | TREATED GAS COMPRESSION<br>(TRAIN 3) |
| 3D | TREATED GAS COMPRESSION STACK AND HRU<br>(TRAIN 3) |
| 3E | TREATED GAS COMPRESSION<br>(TRAIN 3) |
| 3F | TREATED GAS COMPRESSION STACK AND HRU<br>(TRAIN 3) |
| 3G | $CO_2$ & TREATED GAS DEHYDRATION<br>(TRAIN 3) |
| 3H | AGRU LEAN/RICH EXCHANGER<br>(TRAIN 3) |
| 3I | $CO_2$ GAS COMPRESSION<br>(TRAIN 3) |
| 3J | $CO_2$ GAS COMPRESSION STACK AND HRU<br>(TRAIN 3) |
| 3K | $CO_2$ GAS COMPRESSION<br>(TRAIN 3) |
| 3L | $CO_2$ GAS COMPRESSION STACK AND HRU<br>(TRAIN 3) |
| 3M | PROCESS HEAT MEDIUM<br>(TRAIN 3) |
| 3N | AGRU REGENERATION<br>(TRAIN 3) |
| 3P | $CO_2$ GAS COMPRESSION AIR INTAKE<br>(TRAIN 3) |
| 3Q | $CO_2$ GAS COMPRESSION AIR INTAKE<br>(TRAIN 3) |
| 3R | TREATED GAS COMPRESSION AIR INTAKE<br>(TRAIN 3) |
| 3S | TREATED GAS COMPRESSION AIR INTAKE<br>(TRAIN 3) |
| 3T | MAIN PIPE RACK W/ BATTERY LIMIT VALVES<br>(TRAIN 3) |
| 3U | MAIN PIPE RACK EXPANSION LOOP |
| 5A | PTU GAS INLET K.O. DRUM |
| 5B | REFRIGERATION COMPRESSOR & CHILLERS |
| 5C | ELECTRICAL SWITCHGEAR FOR REFRIGERATION |
| 5D | HP/LP FLARE KO DRUMS |
| 5E | FUEL GAS HEATERS |
| 5G | PROPANE CONDENSORS & TREATED GAS PIPERACK |
| 5H | TREATED GAS PIPE RACK |
| 5J | ELECTRICAL RACK |

TABLE 13.27.2

**GTP Buildings and Enclosed Process Modules**

| **Module Tag #** | **Description** |
|---|---|
| 5K | TREATED GAS/OUTLET METERING |
| 5L | FLARE PIPERACK |
| 5M | WEST FLARE STACKS |
| 5N | EAST FLARE STACKS |
| 5P.1 | ELECTRICAL TRANSFORMER |
| 5P.2 | ELECTRICAL TRANSFORMER |
| 5T | WEST FLARE BLOWCASE |
| 5U | EAST FLARE BLOWCASE |
| 5V | SOUTH FLARE EXPANSION LOOP |
| 5W | NORTHWEST FLARE EXPANSION LOOP |
| 5X | NORTHEAST FLARE EXPANSION LOOP |
| 6A | UTILITY PIPERACK W/ UTILIDOR |
| 6B | UTILITY PIPERACK W/ UTILIDOR |
| 6C | STORAGE TANK PUMPS & FILTERS |
| 6D | AGRU & TEG STORAGE TANKS |
| 6E | DIESEL STORAGE TANK |
| 6F | RAW WATER |
| 6G | WATER TREATMENT |
| 6H | UTILITIES |
| 6I | UTILITY PIPERACK W/ UTILIDOR |
| 6J | HEAT MEDIUM UTILITIES HEATERS |
| 6P | CONTROL ROOM/OPERATIONS CENTER |
| 6Q.1 | ELECTRICAL TRANSFORMER |
| 6Q.2 | ELECTRICAL TRANSFORMER |
| 7A | WATER RESERVOIR PUMP |
| 7B | PUT RIVER PUMP INTAKE |
| 7C | ELECTRICAL TRANSFORMER |
| 8A | POWER GENERATION |
| 8B | POWER GENERATION |
| 8C | POWER GENERATION |
| 8G | UTILITY & ELECTRICAL RACK W/ UTILIDOR |
| 8H | UTILITY & ELECTRICAL BRIDGE RACK W/ UTILIDOR |
| 8I | ESSENTIAL DIESEL GENERATOR |
| 8J.1 | ELECTRICAL TRANSFORMER |
| 8J.2 | ELECTRICAL TRANSFORMER |
| 8J.3 | ELECTRICAL TRANSFORMER |

TABLE 13.27.2

**GTP Buildings and Enclosed Process Modules**

| Module Tag # | Description |
|---|---|
| 8J.4 | ELECTRICAL TRANSFORMER |
| 8J.5 | ELECTRICAL TRANSFORMER |
| 8J.6 | ELECTRICAL TRANSFORMER |
| 8K | UTILITY & ELECTRICAL BRIDGE RACK W/ UTILIDOR |
| 8Q | POWER GENERATION EXHAUST STACK |
| 8R | POWER GENERATION EXHAUST STACK |
| 8S | POWER GENERATION EXHAUST STACK |
| 8T | POWER GENERATION EXHAUST STACK |
| 8U | POWER GENERATION EXHAUST STACK |
| 8V | POWER GENERATION EXHAUST STACK |

#### 13.27.2.1 Building and Structure Design and Specifications

Appendix 13.F includes preliminary specifications for the GTP. A list of specifications to be developed in detailed design is included in Appendix 13.F which includes building and structure design specifications.

#### 13.27.2.2 Building Layout and Siting

A building list is provided in Appendix 13.M.6 of Resource Report 13. Layouts of the buildings are shown on the plot plan in Appendix 13.E.6 of Resource Report 13. Final configurations will be determined in detailed design.

### 13.27.3 Lighting

The GTP modules, tower, and stack lighting would meet regulatory requirements, codes, and standards for lighting for overall site operations/maintenance, safety, and security.

In addition, lighting would be designed to address guidance provided by the U.S. Fish and Wildlife Service (USFWS) as practicable to reduce potential impacts on birds and other wildlife.

To the extent practical, lighting design for the GTP would minimize projection outward to avoid impacts to wildlife. Final location, number of lights, and shielding installation would be determined as engineering progresses through later stages of the Project.

### 13.27.4 Telecommunications Tower

The GTP communication tower would be located at the Operations Camp and would be approximately 150 feet tall. The required height for the GTP tower would be determined in later stages of the Project design. The tower would require lights for aviation safety, but would be designed to address guidance provided by USFWS as practicable to reduce potential impacts on birds and other wildlife.

### 13.27.5 Permanent Operations Camp

When construction is complete, the onsite construction camp would remain as a permanent operations and turnaround accommodation facility. On a normal operating basis, the operations camp facility would accommodate approximately 125 personnel. During maintenance turnaround activities, the operations camp facility would accommodate a maximum capacity of up to 1,680 beds if required. The permanent camp would include offices, dormitories, kitchen, dining, recreation, and medical and aid facilities.

## 13.28 ELECTRICAL

### 13.28.1 Electrical System Design

The GTP electrical power would be supplied by the Electrical Power Generation System, which uses six gas turbines. Electric power generated by each unit would be tied to a common 13.8kV split bus with current (Is) limiters bus before being redistributed to the overall GTP electrical grid. At peak power demand, there would be an equivalent of one spare Power Generation Turbine between the six operating units (OUs) to allow for planned and unplanned outages of a single unit.

The Power Generation turbines would not include WHRU.

The major electrical power loads at the GTP would be primarily from process and utility equipment. A second group of loads would be imposed by building HVAC systems, facility and process lighting, operations facilities, and electric heat tracing requirements.

Power would be generated at 13.8 kV and distributed from the 13.8kV split buses to the overall GTP electrical grid. The 13.8kV would be used to power the large compressor motors and for additional in-plant power distribution at the 4.16kV and 480V levels via step-down transformers. The 13.8kV, 4.16kV and 480V switchgears would be arranged in a Secondary Selective System configuration to provide high level power system flexibility and reliability.

The fresh water supply pipeline from the Put River Water Reservoir to the GTP would not be insulated or heat-traced. There is a local equipment module near the Put River Reservoir that would provide power for this facility from a 13.8kV power cable, routed along the pipeline, and then minimized to 480V inside the facility module.

#### 13.28.1.1 Power Requirements

The following electrical load summaries for the GTP are provided in Appendix 13.N.1.

TABLE 13.28.1.1

**Electrical Load Summaries for the GTP**

| Drawing Number | Description |
|---|---|
| USAG-EC-ELLSC-00-001001 | Summer Case Electrical Load List |
| USAG-EC-ELLSC-00-001002 | Winter Case Electrical Load List |
| USAG-EC-ELLSC-00-001003 | Black Start Electrical Load List |

#### 13.28.1.2 Main Power Supply, Utility/Generated

The main power generation for the facility would be through six power generator natural gas turbines. Electric power generated by each unit would be tied to a common bus before being redistributed to the overall GTP electrical grid.

#### 13.28.1.3 Electrical Equipment Layout Drawings*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.28.1.4 Cable Routing Drawings*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.28.1.5 Main Power Generators, type

Power generation gas turbine

#### 13.28.1.6 Number of Main Ppower Generators, Including Any Black Start Generators

Only five of the six normal power generators would be required for normal operations, and any one of the six normal power generators would be able to provide power to the essential loads that include all building heating, UPS, operations center, control room, living quarters, electrical heat tracing, and critical equipment. This power system configuration, having the power generators and the main split bus located in three separate modules, would provide built-in redundancy and operational flexibility of the electrical system. Therefore, there would not be a separate essential power generation system.

The black start power would be provided by one 2.5 MW, 0.8 process flow (PF), and 13.8 kV diesel generator.

#### 13.28.1.7 Main Power Supply Voltage, kilovolt (kV)

Each power generation gas turbine would be rated (ISO) to 33.1 megawatts (MW) and would produce power at 13.8 kV. Power is distributed from three 13.8 kV split buses (two gas turbine generators tied to a common 13.8 kV split bus) to the overall GTP electrical grid.

#### 13.28.1.8 Main Power Supply Capacity, kilovolt ampere (kVA)

The total operating load for the summer case is 115,286 kVA. The total operating load for the winter case is 103,728 kVA.

#### 13.28.1.9 Emergency Power Supply, Utility/Generated

Critical power loads would be supplied from the UPS system. These loads such as PCS and SIS equipment, safety systems, instrumentation, etc., are normally supplied through the UPS system and, in the event of failure of the normal power supply, continue to operate from the UPS system batteries without interruption.

Essential power would be provided by one of the six normal power generators (as described in the preceding paragraph) to the UPS as a backup to allow continuous service while conserving battery capacity.

#### 13.28.1.10 Emergency Power Generators, type

Emergency power will be supplied from diesel generators.

#### 13.28.1.11 Number of Emergency Power Generators, No.

An emergency diesel generator, located at the GTP Operations Center, would provide backup power to the GTP Operations Center. Another emergency diesel generator would be provided at the Communications Building to provide backup power.

#### 13.28.1.12 Emergency Power Voltage, kV

0.480 kV

#### 13.28.1.13 Emergency Power Capacity, kVA

The Dormitory Emergency Diesel Generator is rated for 250KW and the Essential Diesel Generator is rated for 2.5MW.

#### 13.28.1.14 UPS Services, Voltage, Size and Capacity, V, kVA, hr

Emergency power would be provided to supply illumination and/or power to designated areas and equipment in the event of failure of the normal power supply. Emergency Uninterruptible Power Supply (UPS) systems are supplied throughout the process and utilities plant areas as well as the operations facilities areas to provide emergency egress lighting. A 250 kilowatt (kW) emergency diesel generator in the operations center area would provide backup power to the communications building during a black-out. This generator would be required to provide power within 10 seconds of failure of the normal power supply. Primary backup power for the communications building equipment would be a UPS battery power system. The diesel generator would provide backup power to the UPS system to extend the operational time for the communications system. Emergency loads would normally be powered from the normal power system but would be automatically switched to power backed up by the emergency generator upon failure of the normal power system.

UPS output would be 120 VAC, 1 phase. UPS systems would be equipped with wet cell batteries. Batteries would be installed in battery rooms. Battery duration depends on facility needs and would be defined in a later stage of the Project.

#### 13.28.1.15 Transformer Type, dry/oil

Dry and oil filled tranformers would be used. See 13.28.1.16.

#### 13.28.1.16 Number of Transformers

The following is a summary of details for the transformers that would serve the GTP.

TABLE 13.28.1.16

**Transformer List with Tag Number, Size, and Location**

| **Transformer List** | | | |
|---|---|---|---|
| **Equipment Tag** | **Description** | **Area** | **Module No.** |
| USAG-XFR823062 | Power Transformer<br>13.8kV-480/277V Dry Type Transformer, 1000/1333kVA, Z=5.75% | 0 | 0R |
| USAG-XFR823059 | Power Transformer<br>13.8kV-480/277V Dry Type Transformer, 750kVA, Z=5.75% | 0 | 0S |
| USAG-XFR823058 | Power Transformer<br>13.8kV-208/120V Dry Type Transformer, 750kVA, Z=5.75% | 0 | 0U |
| USAG-XFR823121 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1C |
| USAG-XFR823122 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1C |
| USAG-XFR823133 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1E |
| USAG-XFR823134 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1E |
| USAG-XFR823123 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1G |
| USAG-XFR823124 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1G |
| USAG-XFR823125 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1G |
| USAG-XFR823126 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1G |
| USAG-XFR823127 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1H |
| USAG-XFR823128 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1H |
| USAG-XFR823131 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1I |
| USAG-XFR823132 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1I |
| USAG-XFR823129 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1M |
| USAG-XFR823130 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 1 | 1M |
| USAG-XFR823221 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2C |
| USAG-XFR823222 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2C |
| USAG-XFR823233 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2E |
| USAG-XFR823234 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2E |
| USAG-XFR823223 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2G |
| USAG-XFR823224 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2G |
| USAG-XFR823225 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2G |

TABLE 13.28.1.16

**Transformer List with Tag Number, Size, and Location**

| Transformer List | | | |
|---|---|---|---|
| **Equipment Tag** | **Description** | **Area** | **Module No.** |
| USAG-XFR823226 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2G |
| USAG-XFR823227 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2H |
| USAG-XFR823228 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2H |
| USAG-XFR823231 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2I |
| USAG-XFR823232 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2I |
| USAG-XFR823229 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2M |
| USAG-XFR823230 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 2 | 2M |
| USAG-XFR823321 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3C |
| USAG-XFR823322 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3C |
| USAG-XFR823333 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3E |
| USAG-XFR823334 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3E |
| USAG-XFR823323 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3G |
| USAG-XFR823324 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3G |
| USAG-XFR823325 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3G |
| USAG-XFR823326 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3G |
| USAG-XFR823327 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3H |
| USAG-XFR823328 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3H |
| USAG-XFR823331 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3I |
| USAG-XFR823332 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3I |
| USAG-XFR823329 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3M |
| USAG-XFR823330 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 3 | 3M |
| USAG-XFR823521 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5B |
| USAG-XFR823522 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5B |
| USAG-XFR823523 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5C |

TABLE 13.28.1.16

**Transformer List with Tag Number, Size, and Location**

**Transformer List**

| Equipment Tag | Description | Area | Module No. |
|---|---|---|---|
| USAG-XFR823524 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5C |
| USAG-XFR823533 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5D |
| USAG-XFR823534 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5D |
| USAG-XFR823527 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5G |
| USAG-XFR823528 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5G |
| USAG-XFR823531 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5G |
| USAG-XFR823532 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 5 | 5G |
| USAG-XFR823645 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6G |
| USAG-XFR823646 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6G |
| USAG-XFR823653 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6H |
| USAG-XFR823654 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6H |
| USAG-XFR823621 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6P |
| USAG-XFR823622 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6P |
| USAG-XFR823651 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6P |
| USAG-XFR823652 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 6 | 6P |
| USAG-XFR823611 | Power Transformer<br>13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 6 | 6Q |
| USAG-XFR823612 | Power Transformer<br>13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 6 | 6Q |
| USAG-XFR823721 | Distribution Transformer<br>13.8kV-480/277V Dry Type Transformer, 225kVA, Z=5.75% | 7 | 7A |
| USAG-XFR823711 | Power Transformer<br>13.8kV-4.16kV Oil Filled Transformer, 3MVA, Z=5.5% | 7 | 7C |
| USAG-XFR823722 | Distribution Transformer<br>13.8kV-480/277V Dry Type Transformer, 225kVA, Z=5.75% | 7 | 7C |
| USAG-XFR823141 | Unit Auxiliary Transformer<br>13.8kV/480V Dry Type Transformer, 500kVA, Z=5.75% | 8 | 8A |
| USAG-XFR823142 | Unit Auxiliary Transformer<br>13.8kV/480V Dry Type Transformer, 500kVA, Z=5.75% | 8 | 8A |
| USAG-XFR823143 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8A |
| USAG-XFR823144 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8A |

TABLE 13.28.1.16

**Transformer List with Tag Number, Size, and Location**

| **Transformer List** | | | |
|---|---|---|---|
| **Equipment Tag** | **Description** | **Area** | **Module No.** |
| USAG-XFR823148 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8A |
| USAG-XFR823149 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8A |
| USAG-XFR823241 | Unit Auxiliary Transformer<br>13.8kV/480V Dry Type Transformer, 500kVA, Z=5.75% | 8 | 8B |
| USAG-XFR823242 | Unit Auxiliary Transformer<br>13.8kV/480V Dry Type Transformer, 500kVA, Z=5.75% | 8 | 8B |
| USAG-XFR823243 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8B |
| USAG-XFR823244 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8B |
| USAG-XFR823248 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8B |
| USAG-XFR823249 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8B |
| USAG-XFR823341 | Unit Auxiliary Transformer<br>13.8kV/480V Dry Type Transformer, 500kVA, Z=5.75% | 8 | 8C |
| USAG-XFR823342 | Unit Auxiliary Transformer<br>13.8kV/480V Dry Type Transformer, 500kVA, Z=5.75% | 8 | 8C |
| USAG-XFR823343 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8C |
| USAG-XFR823344 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8C |
| USAG-XFR823348 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8C |
| USAG-XFR823349 | Power Transformer<br>13.8kV/480V Dry Type Transformer, 2/2.66MVA, Z=5.75% | 8 | 8C |
| USAG-XFR823111 | Power Transformer 13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 8 | 8J |
| USAG-XFR823112 | Power Transformer<br>13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 8 | 8J |
| USAG-XFR823211 | Power Transformer<br>13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 8 | 8J |
| USAG-XFR823212 | Power Transformer<br>13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 8 | 8J |
| USAG-XFR823311 | Power Transformer<br>13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 8 | 8J |
| USAG-XFR823312 | Power Transformer<br>13.8/4.16kV Oil Filled Transformer, 10/12.5MVA, Z=5.5% | 8 | 8J |

### 13.28.1.17 Electrical Distribution System

The following single line diagrams for the GTP are provided in Appendix 13.N.3.

| TABLE 13.11.3-2<br><br>**GTP Single Line Diagrams** | |
|---|---|
| **Drawing Number** | **Description** |
| USAG-EC-EDSLD-00-001001-001 | Overall Generation and Main Power System Distribution |
| USAG-EC-EDSLD-00-001003-001 | Operations Facilities Power System Distribution |
| USAG-EC-EDSLD-80-001001-001 | Generation Area Power System Distribution |
| USAG-EC-EDSLD-10-001001-001 | Train Area Power System Distribution (Sheet 1) |
| USAG-EC-EDSLD-10-001001-002 | Train Area Power System Distribution (Sheet 2) |
| USAG-EC-EDSLD-50-001001-001 | Refrigeration Area Power System Distribution |
| USAG-EC-EDSLD-60-001001-001 | Utilities Area Power System Distribution |

### 13.28.1.18 Distribution and Voltage Levels

The voltage levels of the power system would be selected from the Nominal Service Voltages listed in the subsequent table.

| TABLE 13.28.1.18<br><br>**Nominal Service Voltage Selection Options** | |
|---|---|
| **Voltage** | **System/Equipment** |
| 13.8 kV, 3 phase, 3 wire | • Normal Power Distribution to plant area substation switchgears and operations facilities area power loops;<br>• Medium Voltage motors above 4,000 HP;<br>• Turbine Generators; and<br>• Diesel Generators. |
| 4.16 kV, 3 phase, 3 wire | • Medium Voltage motors 250 HP through 3,500 HP. |
| 480 V, 3 phase, 3 wire | • Motors (1/2HP through 200 HP);<br>• UPS and Battery Charger input power;<br>• Welding receptacles;<br>• In plant distribution to packaged equipment; and<br>• Emergency power distribution in the operations center area. |
| 480/277V, 3 phase, 4 wire | • Process, utilities, and generation areas indoor lighting;<br>• Outdoor lighting; and<br>• Process, utilities and generation areas emergency lighting. |
| 120/208V, 3 phase, 4 wire | • Building lighting;<br>• Convenience receptacles;<br>• Small motor (less than ½ HP);<br>• Electric heat tracing; and<br>• AC control power equipment (MCC control, local control stations, etc.). |
| 120V, 1 phase, 2 wire | • UPS loads. |
| 125V DC | • Switchgear control power; and<br>• Gas turbine oil pump emergency supply. |
| 24V DC | • Instrumentation. |
| Other voltages | • As required by special applications (e.g., telecom system). |

The 13.8kV, three-phase, three-wire power distribution system would distribute power to motors that are 4000 HP and larger, lower voltage transformers (4.16kV and 480V), and operations facilities power loops. The 13.8kV systems would be low resistance grounded with 400A resistors rated for 10 seconds.

The 4.16kV, three-phase, three- wire power distribution system would distribute power to medium voltage motors that are 250 HP through 3500 HP and the buy-back gas heater panels. The 4.16kV system would be low resistance grounded with 400A resistors rated for 10 seconds. Motors fed from the 4.16kV system would be rated at 4,000V.

#### 13.28.1.19 Uninterruptible Power Supply, Battery Backup System

Critical power loads would be supplied from the UPS system. These loads, such as PCS and SIS equipment, safety systems, instrumentation, etc., would normally be supplied through the UPS system. In the event of failure of the normal power supply, the loads would continue to operate from the UPS system batteries (rated for 45 minutes of service) without interruption. UPS output would be 120VAC. UPS systems would be equipped with wet cell batteries. Batteries would be installed in battery rooms.

Switchgear control power would be supplied from 125VDC systems with redundant battery chargers. Batteries are wet cell type and would be sized for eight hours of service. Batteries would be installed in battery rooms.

Gas turbine oil pump emergency supply would be provided from a dedicated 125VDC battery system, supplied with the turbine.

F&G systems would have dedicated battery chargers and batteries for those systems.

Emergency lighting would be supplied from dedicated UPS systems. The lighting UPS systems would provide power in accordance with UL 1778 and UL 924 standards. The UPS would have battery systems rated for 90 minutes of operations. Batteries would be wet cell batteries and would be installed in battery rooms. Approximately 5–10 percent of the lighting fixtures along the egress routes would be rapid start fluorescent, LED, or incandescent type lighting fixtures.

#### 13.28.1.20 Electrical Cable Schedule/List*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.28.1.21 Electrical Cable Design and Specification

All power, instrument, and fiber-optic cables would be specified for the cold temperatures (-50 °F) at the North Slope. Cables would be rated for the ambient temperature (Arctic service) and would also pass the cold bend tests and the cold impact tests per Canadian Standards Association (CSA) standards.

The 13.8kV and 4.16kV medium voltage cables would be multi-conductor, copper, shielded, type MC-HL armored cable. The 480V cables would be multi-conductor, copper, non-shielded, type MC-HL.

The instrument cables would be single-pair, multi-pair and triad armored cables.

Fiber-optic cables would be provided throughout the facility to interconnect the local electrical rooms and electrical modules. A dedicated redundant fiber-optic cable system would be provided for ICSS communications at the GTP. A second redundant fiber optic system would be provided for other communication functions (closed-circuit television [CCTV], PAGA, voice-over internet protocol [VoIP], etc.). The topography for both systems would be "star" with single mode fibers used between modules and multimode fibers used within modules.

Power cables between switchgear units, switchgear to transformers, and from switchgear to MCCs would be cable bus or bus duct assemblies. Cables for critical services within fire hazard zones would be fire-proofed cables or mineral insulated (MI) cables.

In general, cables running between modules would be installed in cable trays. A very limited number of cables would be installed underground, buried in the granular material pad. Cable trays would be segregated by voltage levels and signal types. Intrinsically safe wiring systems would be segregated from all other wiring systems in separate cables, raceways, and cable trays.

#### 13.28.1.22 Cathodic Protection

Provisions for cathodic protection will be determined during detail engineering.

#### 13.28.1.23 Hazardous Area Classifications

The classification of hazardous areas and the selection of electrical equipment for use in hazardous areas would be in accordance with API RP 500 "Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Division 1, and Division 2" and Article 500 of the National Electrical Code (NFPA 70).

Hazardous area locations and requirements are defined using two distinct classification systems: Division classification or Zone classification. The Division classification system is used most commonly for existing facilities on the North Slope and maintaining the use of the Division classification system for the new GTP would provide a consistent design approach with the adjacent facilities and fewer difficulties with implementation. In addition, the major cost advantages of using the Zone classification system are in Zone 1 (Division 1) areas but there are a very limited number of these Zone 1 (Division 1) areas in the proposed GTP.

The following electrical area classification drawings for the GTP are provided in Appendix 13.N.5:

TABLE 13.28.1.23

**GTP Electrical Classification Drawings**

| Drawing Number | Description |
|---|---|
| USAG-EC-EDHAC-00-001001-001 | Area Classification Plan Process and Utilities |
| USAG-EC-EDHAC-00-001002-001 | Area Classification Plan Aerial Coolers |
| USAG-EC-EDHAC-00-001003-001 | Area Classification Notes and Details |

#### 13.28.1.24 Ignition Control Setbacks and Separation

Designed in accordance with NFPA 70.

#### 13.28.1.25 Electrical Pass-through Seals and Vents to the Atmosphere

Not applicable to the GTP.

## 13.29 PLANS AND PROCEDURES

### 13.29.1 Operation and Maintenance Plans

#### 13.29.1.1 Operation Procedure Development

The plant would be designed to operate in the following operating modes:

**Normal operation mode** – Each train would operate continuously producing nominally up to 1.1 BSCFD of treated gas to support the baseload operation of the Liquefaction Facility.

**GTP turndown -** Each train would have the ability to turndown to at least 40 percent of normal capacity. The limiting items are the AGRU Absorber and the TEG Contactor, which can be turned down to 40 percent of the design gas rate while still meeting the treated gas specifications.

Further GTP turndown could be achieved by shutting down one or two trains. The maximum turndown for the facility would be one train operating at turndown to 40 percent of its design capacity, which equates to approximately 13 percent of the GTP overall capacity, or 440 MMSCFD of treated gas.

Procedures for the operation of the GTP would be developed to comply with the applicable OSHA requirements, in particular:

- OSHA 29 C.F.R. 1910.119(f) – Operations. This would include policies for operating procedures, monitoring of operations, emergency procedures, personnel safety, and investigation of failures, communication systems, and operating records.

- OSHA 29 C.F.R. 1910.119(g) –Training. The training would include emphasis on the specific safety and health hazards, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks.

- OSHA Process Safety Management (PSM) requirements, including:

    - Process Safety Information
    - Employee Involvement
    - Process Hazard Analysis
    - Operating Procedures
    - Training
    - Contractors
    - Pre-Startup Safety Review

- Mechanical Integrity
- Hot Work
- Management of Change
- Incident Investigation
- Emergency Response
- Compliance Audits

#### 13.29.1.2 Safety Procedures

Prior to construction, the EPC Contractor will develop safety procedures and plans to be implemented during the construction phase.

During detailed design, safety procedures will be developed for the operational phase of the facility and will be implemented once the facility goes into operation. Safety procedures for the operation of the GTP would be developed to comply with the applicable OSHA requirements, in particular:

- OSHA Process Safety Management (PSM) requirements, including:
  - Process Safety Information
  - Employee Involvement
  - Process Hazard Analysis
  - Operating Procedures
  - Training
  - Contractors
  - Pre-Startup Safety Review
  - Mechanical Integrity
  - Hot Work
  - Management of Change
  - Incident Investigation
  - Emergency Response
  - Compliance Audits

#### 13.29.1.3 Maintenance Plan and Procedure Development

During detailed design, maintenance procedures will be developed for the operational phase of the facility and will be implemented once the facility goes into operation. These procedures would include all maintenance requirements to ensure safety and reliability of the GTP and would comply with all applicable codes and standards.

#### 13.29.1.4 Operations and Maintenance Structure

The GTP would be operated on a permanent 24-hour basis and would be staffed accordingly. On a normal operating basis, the operations camp facility would accommodate approximately 125 personnel.

Finized details on the operating and maintenance staffing structure will be provided in detailed design.

#### 13.29.1.5 Number of Operation and Maintenance Personnel*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.29.1.6 Location of Operation and Maintenance Personnel*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.29.1.7 Operation and Maintenance Personnel Training*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.29.1.8 Training Plans and Procedures*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.29.1.9 Management Procedures (E.G., Alarm Management, Shift Procedures/Fatigue Management, Management of Change Procedures, Etc.)*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

### 13.29.2 Commissioning Plan

This section describes the commissioning phases and resources required to accomplish site activities within the time frame specified on the Project schedule.

Commissioning would be carried out using a Systems Completion Team (SCT) approach made up of experienced commissioning professional representatives. The SCT would include representatives from both the Contractor organization and the Project organization, including Project Operations personnel.

The Project philosophy, strategies, plans, schedules, and procedures required for planning and executing the GTP Commissioning activities for execution at the Module Fabrication Sites (MFS) and at the GTP would be developed in accordance with Project requirements and contractual obligations.

#### 13.29.2.1 Commissioning Plan Summary

Commissioning activities for the GTP process units would involve the following plans:

- Mechanical completion verification and sign-off;
- Mechanical completion punch list generation;
- Mechanical completion walk-down;
- Pre-commissioning activities;
- Commissioning; and
- Start-up.

#### 13.29.2.2 Mechanical Completion Verification and Sign-Off

Mechanical Completion is the stage when the construction and installation of equipment, piping, instrumentation, cabling, electrical equipment, etc., have been demonstrated as physically complete and in accordance with project specifications, drawings, applicable codes and regulations, but are not energized. All inspection, testing, and documentation requirements have been completed by an Engineering, Procurement and Construction (EPC) contractor and the completed Systems/Sub-Systems are ready for handover to the commissioning group for pre-commissioning activities.

#### 13.29.2.3 Mechanical Completion Punch List

Punch list items are a listing of defect in materials, workmanship, or engineering identified during the inspection of the installation. The EPC contractor would complete all punch list items satisfactorily before Start-Up, unless there are agreed exception items.

#### 13.29.2.4 Mechanical Completion Walk-Down

Mechanical completion walk-downs would be conducted by the EPC contractor, Construction, the SCT, and the Project Operations Team. The purpose of this walk-down is to verify the completion of the System/Sub-System and to agree on a list of unsatisfactory or incomplete items, if any. Upon successful completion of the walk-down a consolidated punch list is agreed between all parties as record for follow-up.

#### 13.29.2.5 Pre-commissioning Activities

Pre-commissioning is the preparation and conditioning of plant facilities required before introduction of normal plant operating fluids. Relatively safe fluids such as compressed air, nitrogen, and clean or purified water are typically used for Pre-commissioning activities.

Cleaning, testing, and excitation of equipment items is conducted in this phase, first individually and then collectively to verify the controls and equipment interfaces. Controls are tuned under 'dry' conditions as much as possible. Upon completion of pre-commissioning activities, the individual systems are reinstated, inspected, and accepted for subsequent operations.

Ready for Commissioning (RFC) is achieved upon completion of all the pre-commissioning operations listed previously.

#### 13.29.2.6 Commissioning

Commissioning is defined as bringing the System or Sub-System as close as practical to operational status prior to the introduction of hydrocarbons to ensure safe and stable operational function following approval to introduce hydrocarbons.

Commissioning activities would be carried out in accordance with purpose-written commissioning procedures, with the involvement of equipment designers/suppliers/manufacturers as required. Commissioning of equipment and systems would be in accordance with the commissioning procedures.

#### 13.29.2.7 Start-up

Preparation for the start-up of a process unit would commence after the start-up of the utility systems is complete. To ensure a smooth start-up and initial operation of the facility, a Start-Up Plan would be developed by the EPC contractor and the SCT for all sections of the GTP. This plan would include a Pre-Startup Safety Review and other industry best practices.

## 13.30 INSTRUMENTATION AND CONTROLS

### 13.30.1 Design of Integrated Control Safety System (ICSS)

The GTP would have its own dedicated Integrated Control Safety System (ICSS) designed to allow centralized monitoring and control of the facilities from the Central Control Room (CCR) under normal and upset conditions with minimum operating and support staff.

The ICSS would facilitate:

- Sufficient online event monitoring and control capabilities to ensure continuous, safe, reliable and efficient operation;
- Alerting operators in a timely manner of any abnormal conditions requiring manual intervention;
- Bringing the plant or equipment to a safe state for any abnormal conditions; and
- Tools to support Maintenance and Engineering activities.

The GTP ICSS would be able to communicate with other facilities including the PBU, PTU Gas Expansion, Mainline, and LNG/Marine.

The ICSS would consist of following sub-systems listed below:

- Process Control System (PCS):
  - PCS functions;
  - Electrical Control and Management System (ECMS);
  - Load Shedding functions; and
  - Process Fire and Gas System.
- Safety Instrumented System (SIS):
  - Process Shutdown (PSD) system;
  - Emergency Shutdown (ESD) system; and
  - Process Module Fire & Gas Detection/Protection System (FGDS).
- Instrument Assets Management System (IAMS);
- Alarm Management System (AMS);
- Facility Data Historian (FDH);

- Operator Training Simulator (OTS);
- Process Information Management Systems (PIMS);
- Laboratory Information Management Systems (LIMS);
- Interface to Custody Transfer Metering Systems;
- Interfaces to Third Party Packages Control Systems;
- Interface to occupied building Fire & Gas (Life Safety F&G) monitoring and alarm system;
- Interface to HVAC control system;
- Interface to Public Address and General Alarm System (PAGA);
- Interface to Upstream Health Monitoring Systems (UEHM);
- Interface to Power Management System (PMS);
- Interface to Motor Control Centers(MCC)/Switchgear;
- Load Shedding System (LSS);
- Interfaces to PTU (feed gas HIPPS), PBU, Mainline and LNG/Marine;
- Interface to Supervisory Control and Data Acquisition Systems (SCADA);
- Interfaces to Third Party Packages Control Systems; and
- Additional sub-systems and interfaces as determined during design stages.

The Project Integrated Control and Safety System Design Basis (USAG-EC-IBICS-00-000001-000) included in Appendix 13.B.7 provides further details of the GTP control systems.

#### 13.30.1.1 Instrument List

Instruments are shown on the P&IDs included in Appendix 13.E.5. A final instrument list will be provided in detailed design.

#### 13.30.1.2 Instrumentation Design and Specifications

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

Field instrumentation would be composed of smart electronic devices, utilizing 4-20 miliampere (mA) signals, with superimposed HART 7 protocol data communication. HART 7 protocol would be the Project basis for efficient management of instrumentation.

Field instrumentation would use smart configurable I/O boxes for PCS and SIS, the majority of which would be installed inside climate-controlled areas. Any device installed outside of climate-controlled areas would be suitable to operate under environmental conditions described in Section 3.3 of this document, or be supplied with heated enclosures. Separate SIS and PCS instruments/sensors would be required and related sensors would not share process taps with the PCS sensors. Devices installed inside of electrically classified areas would comply with the corresponding area classification.

Wireless instrumentation would be evaluated in a later stage of the Project for non-critical monitoring applications or temporary measurement of process parameters during commissioning and start-up. Wireless would not be used for safety and control applications.

#### 13.30.1.3 BPCS Philosophy

The PCS would provide the normal regulatory control and monitoring functions that provide for the normal operation of the plant processes. A separate, independent SIS would be provided to implement SIFs to protect personnel and equipment from: mechanical equipment failures, process upset conditions, field instrument failures, PCS failures, fire, high gas levels in the Process Facilities, and other unsafe conditions that could result in human injury or capital losses.

In general, package control would be performed by the package programmable logic controller (PLC). If entire package control is required from the facility PCS, it would be reviewed and approved by the Project. Each package would be provided with a local HMI. HMI would typically follow vendor standard and would include sufficient graphics for normal operation, system diagnostics, and troubleshooting (e.g., Sequence of Events (SOE), first out, start-up interlock).

Standard and Simplified Third-party Package Interface to PCS would be provided. Data sufficient for the operator to monitor and control (as necessary) the package from the CCR, and respond to alarms and start-up/shutdown the package under normal conditions would be provided. The CCR operator would be provided access to view the process variables essential to the reliable operation of the package. Process flows in and out of the package as well as key utility parameters should be available to the CCR operator.

Both the PCS design and package unit design would have the capability to be interfaced together.

Control Systems (CSs) would be capable of communicating with Machinery Control Panels via redundant data links using standard protocols (e.g., OPC, Modbus RTU, Allen Bradley Control Net).

#### 13.30.1.4 BPCS Architecture

The PCS would be based on a scalable distribution control technology (DCS) technology. DCS technology describes a system that permits data acquisition and control functions to be performed at remote locations (for example, LERs, Local Instrument Rooms [LIRs] or Remote Instrument Enclosures [RIEs]) while providing the capability to monitor and control distributed functions from a central control facility.

The PCS systems would be designed such that control functions are distributed on a modular basis to minimize the risk of losing large numbers of control loops. The controllers would be linked by a redundant communication highway that allows transfer of data between controllers, and monitoring of the total facilities' control scheme through a single window.

The PCS would use HART technologies imposed on conventional 4-20 mA analog signal to improve diagnostics for the PCS.

To support the modular construction of the plant and simplify engineering electronic marshalling I/O would be used. Intelligent MCCs would use a bus technology suited to monitor and control discrete control elements.

The ICSS architecture diagram (USAG-EC-IDBLK-00-000002-000) is included in Appendix 13.P.2.

#### 13.30.1.5 BPCS Design and Specifications

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

#### 13.30.1.6 Number of Servers, Operating and Backup

To be determined based on vendor selection in detailed design.

#### 13.30.1.7 Number of Historians, Operating and Backup

To be determined based on vendor selection in detailed design.

#### 13.30.1.8 Distributed Control Systems (DCS) Block Diagrams

The Integrated Control and Safety System block diagram (USAG-EC-IDBLK-00-000001-000) is included in Appendix 13.Q.2.

#### 13.30.1.9 PLC and DCS Software

To be determined based on vendor selection in detailed design.

#### 13.30.1.10 Control Communication Types

Acceptable network protocols include Highway Addressable Remote Transducer (HART), Modbus, Allen Bradley Control Net, TCP/IP, and OLE for Process Control (OPC). A standard computing platform would be used for HMI Operator Workstations.

#### 13.30.1.11 Number of Lines of Communication to Control Room, Operating and Backup

To be determined in detailed design.

#### 13.30.1.12 Control Power Sources, Operating and Backup

Control power supply for the PCS would be from the uninterruptible power source (UPS) system and in the event of failure of the normal power supply would continue to operate from the UPS system batteries without interruption; UPS output would be 120 volts alternating current (VAC). Section 13.11 provides a list of nominal voltages available from the GTP power distribution system.

#### 13.30.1.13 Human Machine Interface (HMI) Local and Control Room Displays, type

To be determined based on vendor selection in detailed design.

#### 13.30.1.14 Number of HMI Control Room Displays

To be determined based on vendor selection in detailed design.

## 13.31 SAFETY INSTRUMENTED SYSTEMS

### 13.31.1 Safety Instrumented System Design

The SIS would be independent and segregated from the PCS but interfaced to it through redundant data links that allow the operator to monitor SIS data from the CCR using the same HMI. The SIS would serve to protect personnel, environment, and equipment from abnormal and hazardous conditions without operator intervention, by activating defined SIFs when the PCS is not capable of maintaining the plant within its defined normal and safe operating envelope.

The SIS implements safety instrument functions (SIF) for PSD, Emergency Shutdown (ESD) System and FGDS. The SIS hardware would be selected, engineered, installed, and interconnected to achieve a high level of performance, availability, and reliability in accordance with the plant safety integrity level (SIL) evaluation. It would provide detection, logic sequencing, and actuation of devices to place the system or facility in a safe state. The SIS would be designed to allow changes or upgrades to the system without a process shutdown. Acceptable spurious trip rates for any SIF would satisfy the availability rate planned for the facility.

The process facility fire and gas (F&G) detectors would interface with the SIS system through direct integration for F&G monitoring and executive actions (such as process shutdown, emergency depressurization, HVAC shutdown/recirculation, and suppression system activation as appropriate). Non-process building F&G (i.e., Life Safety F&G) are designed in accordance with NFPA 72 with an Underwriters' Laboratories (UL)-approved controller and supervised circuits and integrated into the SIS via redundant data links. Manual Pull Stations located in both occupied areas and process modules would be connected to the Life Safety F&G system via supervised circuits. F&G Sensors (fire detectors, gas monitors) would be selected according to Project specs, regulatory requirements, fire hazard assessments, and gas dispersion studies. The Process Facility and Life Safety Fire and Gas Detection Systems would send separate hardwired signals to the PAGA System for confirmed fire or gas alarms. The PAGA system would be used to annunciate fire and gas emergency conditions, audibly and visibly where required. Additionally, the F&G systems would activate the beacons/horns in the process areas to notify personnel of the F&G alert. Hardwired pushbuttons at the Critical Actions Panel or at the PCS console in the CCR would be provided for manual fire and foam pump control.

The PCS and SIS would be integrated to provide an ICSS. The ICSS system would be supplied by a qualified Automation provider and would maintain the facility within the safe operating limits. The ICSS would deliver F&G Detection/Protection where such protection is required.

#### 13.31.1.1 SIS, FGS, ESD and Depressurization Philosophies

The SIS would have completely independent hardware, wiring systems, and field instrumentation. The components of the SIS consist of sensors, logic solvers, and final control elements. It is anticipated that several other proprietary systems would be provided with mechanical equipment packages such as: gas turbine generators, centrifugal compressors, and fired heater equipment. Safety interlocks would be implemented in protective systems supplied by the manufacturer. Interfaces between the manufacturer's packaged system and the SIS would provide protection for external upset conditions that require shutdown of the mechanical equipment.

The SIS would consist of the following components:

- PSD;
- ESD; and
- FGDS.

#### 13.31.1.1.1 PSD System

Process shutdowns would be activated through the PSD system. Specific shutdowns are outlined in the cause and effect diagrams. Examples of process shutdowns include:

- High-high pressure, liquid level, or temperature;
- Low-low pressure, liquid level, or temperature; and
- Gas detection.

Shutdown devices would use independent process equipment connections and transmitters from the normal operational transmitters used for control functions. Switches would not be used for protective systems. In all cases where a device would cause a shutdown, a pre-alarm would be provided to alert the operators to a problem before a shutdown occurs. The ultimate over-pressure protection would be a mechanical relief valve (PSV).

#### 13.31.1.1.2 ESD System

The GTP would be equipped with an ESD system that is designed to protect personnel, the environment, and the facility in the event of upset emergency conditions such as fire (local or plant-wide), combustible or toxic fluid leak, mechanical failure of equipment, etc. In these events, depending on the severity of the emergency, the whole or part of the plant would be isolated remotely by the closing of process and utility stream isolation valves to and from the plant/area, and may initiate shutdown of critical running equipment.

In general, the GTP ESD system would have three ESD levels that would perform shutdown/isolation of the entire facility or a specific train or system within the GTP. Activation of a specific ESD shutdown/isolation would be a separate and distinct action. If blowdown is subsequently required, the blowdown would be initiated as a separate and distinct action.

#### 13.31.1.1.3 FGD System

The FGDS would be provided to monitor the facility for detection of fire and combustible/flammable and toxic gas, the initiation of alarms, and the discharge of fixed fire protection systems and equipment. The system would automatically and reliably alert personnel to the existence and location of such conditions, and initiate prescribed control actions.

Non-process buildings (outside of the process area) and LERs have Fire Alarm Control Panels (FACPs) that comply with the requirements of NFPA 70 and 72. FACPs send summary output signals to the SIS. Process area alarm beacons, alarm horns, and manual alarm call (MAC) points are integrated with the Local Equipment Room (LER) FACPs.

Process areas (hydrocarbon processing) and utility areas would be protected by the FGDS. The process area FGDS would be segregated from the PCS and integrated into the SIS. Any turbine enclosures would be protected by a standalone vendor-supplied FGDS, which would provide outputs to the SIS. The FACPs and SIS would also interface with the heating and ventilation system and the PAGA system.

A Fire and Gas Detection Philosophy (USAG-EC-FBDES-00-000005-000) has been developed, which is included in Appendix 13.B.8, with the purpose of establishing the general philosophy outline of the FGDS and defining the requirements of particular areas as determined by applicable industry standards, codes, and regulations. This philosophy would be updated and finalized during detailed design.

#### 13.31.1.2 SIS and FGS Architecture

The ICSS architecture diagram (USAG-EC-IDBLK-00-000002-000) is included in Appendix 13.P.2.

#### 13.31.1.3 SIS, FGS, and ESD Cause and Effect Matrices

GTP Cause and Effect Matrices are included in Appendix 13.Q.1.

#### 13.31.1.4 SIS, FGS, and ESD Design and Specifications

A list of specifications to be developed in detailed design is included in Appendix 13.F. Appendix 13.F includes preliminary specifications for the GTP.

#### 13.31.1.5 Number of SIS and FGS Servers, Operating and Backup*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.31.1.6 Number of SIS and FGS Historians, Operating and Backup*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.31.1.7 SIS and FGS Block Diagrams

The Integrated Control and Safety System block diagram (USAG-EC-IDBLK-00-000001-000) is included in Appendix 13.Q.2.

#### 13.31.1.8 SIS and FGS Software*

An asterisk (*) indicates information that may become available during final design and is not expected at the time of application. If requested by FERC, this information can be provided in detailed design.

#### 13.31.1.9 List of ESD Valves

ESD valves are shown on the P&IDs included in Appendix 13.E.6. A final valve list will be provided in detailed design.

#### 13.31.1.10 ESD Valve Spacing*

An asterisk (*) indicates information that may become available during final design and is not expected at the time of application.  If requested by FERC, this information can be provided in detailed design.

#### 13.31.1.11 ESD Closure Times*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

#### 13.31.1.12 SIS, FGS, and ESD Safety Integrity Levels (SIL)*

An asterisk (*) indicates guidance is optional and will be provided in detailed design.

## 13.32 SECURITY PLANS

### 13.32.1 Physical Security Plans

Physical security plans including security fencing and access control drawings are listed in the table below.

TABLE 13.32.1

**Security Fencing and Access Control Plan Drawings**

| Drawing Number | Description |
|---|---|
| USAG-EC-LDLAY-00-001016-000 | Security Plot Plan |

#### 13.32.1.1 Security Plan Development

The proposed design for the security systems premised for the GTP is based on current North Slope security practices and requirements of the current PBU operator.

As the Project moves forward into the later phases, a review of Security Risk Assessments for the PBU would be performed to further define the individual threats and vulnerabilities for the GTP.  As part of this assessment process, credible scenarios that could lead to a security incident would be developed and would form the basis for determining the facilities security design that would be further progressed and in development of a site security program.

In parallel to this effort, there would be a review of what would be required to meet federal, state, and local regulation for where the facility would be located.  This information would also be reflected in the security design that goes forward into the later stages and in the site security program.

The site security program would be further developed as the facility moves through the later phases and into Operations.  Activity associated with this process would include development of a site security plan, the need for any protective enclosures, access control, monitoring, lighting, communications, emergency response, security staffing requirement, training, drills, inspections, and auditing.

#### 13.32.1.2 Lighting

Escape lighting would be provided in locations where lighting would be necessary immediately following loss of the main power supply to allow personnel to reach a place of safety. These light fittings would be provided with integral battery backup.

UPS systems would be supplied throughout the process and utilities plant areas as well as the operations facilities areas to provide emergency egress lighting.

#### 13.32.1.3 Physical Barriers

Will be designed based on current North Slope security practices.

#### 13.32.1.4 Site and Onsite Access Control

The GTP would be constructed within the boundaries of the existing PBU. Access to PBU area would be controlled by the PBU operator (BP), and access to the GTP would be via existing PBU roads and would follow established PBU security processes through existing security checkpoints. No GTP-specific fencing would be provided (consistent with existing PBU practice) due to the extremely remote location.

Access to the GTP camp would also be consistent with current North Slope practices. These include requiring pre-arranged approved travel plans, and primary registration and check-in at the GTP camp. Security at the camp would consist of security personnel and video surveillance. No unescorted travel to the GTP process facilities is currently planned. Access to the process facilities would be controlled via card reader, and the access control system would be capable of being monitored at a centralized and other designated locations and would interface with one another including the camera system to create a fully integrated and functional security system.

#### 13.32.1.5 Intrusion Monitoring

Closed Circuit Television (CCTV) systems would be provided for the monitoring designated sections of the plant, and selected areas of the GTP site, primarily for process safety and personnel monitoring.

The CCTVs would use a combination of fixed and pan/tilt/zoom features to provide 100 percent coverage of designated areas. Controls and monitoring for the camera system would be located in a centralized location but would also allow remote monitoring at various locations via the security network.

#### 13.32.1.6 Inntrusion Detection

The CCTV systems would provide for intrusion detection at the GTP.

#### 13.32.1.7 Site Security Communication

Will be designed based on current North Slope security practices.

#### 13.32.1.8 Site Security Service and Number of Site Security Personnel

Will be designed based on current North Slope security practices.

#### 13.32.1.9 Site Security Use of Force

Will be designed based on current North Slope security practices.

#### 13.32.1.10 Site Security Training

Will be designed based on current North Slope security practices.

#### 13.32.1.11 Setbacks, Blast Walls, Hardened Structures, and Blast Resistant Designs

Not applicable to the GTP.

### 13.32.2 Cybersecurity Plans

The GTP would be designed to prevent cybersecurity breaches and would include appropriate controls and firewalls. Final details will be developed in detailed design.

#### 13.32.2.1 Cybersecurity Plan Developments

Cybersecurity plans will be developed throughout detailed design.

#### 13.32.2.2 Physical Access to Control Systems

Access points would be minimized to essential personnel only. Final details will be developed in detailed design.

#### 13.32.2.3 Computer and Network Access Controls

Final details will be developed in detailed design.

#### 13.32.2.4 Intrusion Monitoring

The system would include intrusion monitoring. Final details will be developed in detailed design.

#### 13.32.2.5 Intrusion Detection

The system would include intrusion detection. Final details will be developed in detailed design.

#### 13.32.2.6 Cybersecurity Personnel and Response Teams

Final details will be developed in detailed design.

#### 13.32.2.7 Cybersecurity Awareness and Training

Employees would be trained in awareness and appropriate measures to minimize potential cybersecurity attacks. Final details will be developed in detailed design.

#### 13.32.2.8 Air Gaps, Waterfalls, and Firewalls

Final details will be developed in detailed design.

## 13.33 RELIEF VALVE AND FLARE/VENT SYSTEMS

### 13.33.1 Relief Valves and Flare/Vent Systems Design

Four flare systems would be provided for the GTP: High pressure (HP) hydrocarbon flare, low pressure (LP) hydrocarbon flare, HP $CO_2$ flare, and LP $CO_2$ flare. The flares would be located such that there are minimal radiant heat impacts on the facilities. Additionally, the flares would be placed to minimize downwind personnel exposure resulting from the prevailing wind direction.

Two 100-percent redundant sets of flare stacks would be provided enabling stack, tip, pilot, and flame sensing elements maintenance without necessitating full plant outage.

The unit plot plan for the east and west flares (USAG-EC-LDLAY-00-001005-002) is included in Appendix 13.E.6.

Separate HP and LP hydrocarbon flares enable more efficient design by allowing low pressure gas to enter its own flare system with no interference from high pressure gas sources. HP and LP $CO_2$ services would be segregated to keep water out of the high pressure $CO_2$ system.

Relief streams sent to flare from the three trains and common areas would feed into the appropriate flare header (i.e., HP hydrocarbon flare header, LP hydrocarbon flare header, HP $CO_2$ flare header or LP $CO_2$ flare header). Isolation valves located downstream of the KO Drums enable one of the two separate set of flare stacks to remain operational, while the other flare stacks are held in standby mode. This would allow the entire plant to continue operating when any single flare is out of service for maintenance or inspection.

The $CO_2$ stream would normally be sent to the PBU for reinjection. Disposal systems for $CO_2$ would be flares, not vents. Flaring would be required to ensure adequate destruction of the $H_2S$ and dispersion of the $CO_2$ to comply with the personnel safety and Alaska Ambient Air Quality Standards (AAAQS) for sulfur species.

Common area sources would be routed to the appropriate flares (e.g., propane refrigeration would be routed to the HP Hydrocarbon Flare System).

The design of the GTP facilities would not generate any continuous process or utility flow sources to flare or vent, except from limited pilot/purge streams. The flare system is for start-up, emergency, pre-commissioning, commissioning, shutdown, or upset conditions. In general, protection systems would be designed to minimize potential flaring/venting flow rates to reduce impacts. Details of the flare arrangement are provided in the Flare and Ops Plot Plan (USAG-EC-LDLAY-00-001005-002) included in Appendix 13.A.1.

**HP Hydrocarbon Flare**

The HP hydrocarbon flare system would handle fluids relieving from high pressure safety valves (PSVs) and from the blowdown valves (BDVs) in hydrocarbon services. The following units relieve or blowdown to the HP Flare System:

- GTP Inlet;
- AGRU – Absorber through Flash Drum;
- Treated Gas Dehydration;
- Contactor Treated Gas Compression;
- Refrigeration Unit;
- Treated Gas Chilling; and
- HP Fuel Gas System.

In general, the HP hydrocarbon flare would receive relief streams from equipment or piping with a design pressure greater than or equal to 175 psig with a heating value greater than 200 BTU/SCF.

For relief valves and blowdown valves that produce freezing or hydrate conditions, methanol may be injected downstream of the valve. The methanol would be injected on an as-needed basis.

The Utility Flow Diagram for the HP hydrocarbon flare system (USAG-EC-PDUFD-50-000612-060) included in Appendix 13.E.3 provides details of the HP hydrocarbon relief and blowdown system and associated equipment.

**LP Hydrocarbon Flare**

The LP Flare System would handle fluids relieving from LP PSVs in hydrocarbon service from the following units:

- Treated Gas Dehydration Flash Drum and Regeneration;
- AGRU Drain Drums;
- LP Fuel Gas System;
- Closed Drain Drums; and
- TEG Drain Drums.

In general, the LP hydrocarbon flare would receive relief streams from equipment or piping with a design pressure less than 175 psig with a heating value greater than 200 British thermal unit/standard cubic feet (BTU/SCF).

The Utility Flow Diagram for the LP hydrocarbon flare system (USAG-EC-PDUFD-50-000613-062) included in Appendix 13.E.3 provides details of the LP hydrocarbon relief and blowdown system and associated equipment.

**HP $CO_2$ Flare**

The HP $CO_2$ flare would receive dehydrated gas, process blowdown and PSV discharge from any $CO_2$ sources that could tolerate significant back-pressure on the flare header. Composition of the gas would be primarily $CO_2$ with up to 900 ppmv $H_2S$.

The HP $CO_2$ flare is designed to handle relieving and blowdown fluids from the $CO_2$ compression, third and fourth stages (including intercoolers and KO Drums).

In general, the HP $CO_2$ Flare would receive relief streams from equipment or piping with a design pressure greater than 300 psig with a heating value less than 200 BTU/SCF. The design of this flare may require multiple tips, depending on the tip design velocity limit and would be defined during a later phase of the Project.

The Utility Flow Diagram for the HP $CO_2$ Flare system (USAG-EC-PDUFD-50-000612-061) included in Appendix 13.E.3 provides details of the HP$CO_2$ relief and blowdown system and associated equipment.

**LP $CO_2$ Flare**

The LP $CO_2$ flare would receive wet gas, blowdown and PSV discharges from any $CO_2$ source that cannot tolerate high back-pressure on the flare header, or is wet. Composition of the flare gas would be primarily $CO_2$ with up to 900 ppmv $H_2S$, and would contain water.

The LP $CO_2$ flare would handle relieving fluids from the following units:

- AGRU Regenerator;
- $CO_2$ Dehydration Unit (including TEG Contactor); and
- $CO_2$ Compression, first and second stages (including intercoolers and KO Drums).

In general, the LP $CO_2$ flare would protect equipment and piping services with wet $CO_2$ streams that have a heating value less than 200 BTU/SCF. The design of this flare may require multiple tips, depending on the tip design velocity limit and will be defined during a later stage of the Project.

The Utility Flow Diagram for the LP $CO_2$ flare system (USAG-EC-PDUFD-50-000613-063) included in Appendix 13.E.3 provides details of the LP $CO_2$ relief and blowdown system and associated equipment.

### 13.33.1.1 List of Relief Valves

Relief valves are shown on the P&IDs included in Appendix 13.E.6. A final relief valve list will be provided in detailed design.

### 13.33.1.2 Relief Valve Philosophy

Relief valve selection and sizing shall be in accordance with API 520 Parts I and II.

For sizing the flare relief systems, it is assumed that PSV installations shall be modulating pilot-operated type valves.

Since the GTP is at a remote location, PSV design shall include considerations to maximize on-stream time during routine maintenance. Many PSVs shall have installed spares for testing and inspection to facilitate online maintenance.

#### 13.33.1.3 Relief Valve Studies

To be determined in detailed design.

#### 13.33.1.4 Vent Stack Philosophy

Not applicable to the GTP.

#### 13.33.1.5 Vent Stack Type

Not applicable to the GTP.

#### 13.33.1.6 Number of Vent Stacks

Not applicable to the GTP.

#### 13.33.1.7 Vent Stack Height and Diameter

Not applicable to the GTP.

#### 13.33.1.8 Vent Stack Studies

Not applicable to the GTP.

#### 13.33.1.9 Vent Sources

Not applicable to the GTP.

#### 13.33.1.10 Vent Stack Operating and Design Flow Rate Capacities (minimum, normal/rated, maximum), MMscfd

Not applicable to the GTP.

#### 13.33.1.11 Vent Stack Operating and Design Pressures (minimum, normal/rated, maximum), psig

Not applicable to the GTP.

#### 13.33.1.12 Vent Stack Operating and Design Temperatures (minimum, normal, maximum), °F

Not applicable to the GTP.

#### 13.33.1.13 Vent Stack Operating and Design Densities (minimum, normal, maximum), specific gravity

Not applicable to the GTP.

#### 13.33.1.14 Flare Philosophy

The flare system design and operating philosophy is described in section 13.33.1.

#### 13.33.1.15 Flare Type

Elevated flares are preferred for the GTP, based on minimizing radiant heat impacts, ease of maintenance, cost-effectiveness, and previous experience on the North Slope.

#### 13.33.1.16 Number of Flares

Four

#### 13.33.1.17 Flare Height and Diameter

**TABLE 13.33.1-1**

**Flare Height and Diameter**

| | Height (ft) | Diameter (ft-in) |
|---|---|---|
| **HP Hydrocarbon Flare** | 200’ | 3’-2” |
| **HP $CO_2$ Flare** | 220’ | 2’-6” |
| **LP Hydrocarbon Flare** | 220’ | 1’-8” |
| **LP $CO_2$ Flare** | 220’ | 4’-0” |

#### 13.33.1.18 Flare Studies

To be determined in detailed design.

#### 13.33.1.19 Flare Sources

Table 13.33.1.19 details the flare scenarios that are expected to result in significant loads that were studied to identify governing scenarios for flare system sizing. A comprehensive study of the flare system sizing would be completed during a later phase of the Project.

TABLE 13.33.1.9

**Flare Scenario Load Summary**

| Flare | Description | Rate (MMSCFD) |
|---|---|---|
| **HP HC** | One train start-up | 525 |
| | One train upset (relieve/vent full rate) | 1,305 |
| | **Including start-up of one train** | **1,830** |

TABLE 13.33.1.9

**Flare Scenario Load Summary**

| Flare | Description | Rate (MMSCFD) |
|---|---|---|
| | Gas blow-by from AGRU absorber to solvent flash drum | 370 |
| | *Without credit for amine circulation* | 1,140 |
| | *Including start-up of one train (without amine circulation credit)* | 895 (1,665) |
| | Blowdown treated gas inlet and absorber | 500 |
| | Blowdown treated gas TEG contactor | 95 |
| | Blowdown treated gas Chiller + Refrig. Unit | 420 |
| | Blowdown treated gas compression | 410 |
| | Train blowdown | 1,005 |
| **LP HC** | **HP to LP fuel gas blow-by** | **100** |
| | Gas blow by – Treated Gas Dehy. contactor to flash drum | 24 |
| **HP $CO_2$** | **One train blocked-in** | **159** |
| | 1 train $CO_2$ HP compression blowdown – gas detection | 143 |
| **LP $CO_2$** | **Unannounced blocked-in $CO_2$ injection line** | **486** |
| | Announced blocked-in $CO_2$ injection line | 477 |
| | $CO_2$ compressor trip (relief at AGRU regen) | 162 |
| | $CO_2$ compressor trip (relief at $CO_2$ TEG contactor) | 159 |
| | 1 train $CO_2$ LP compression blowdown | 25 |
| | Blow-by from $CO_2$ TEG contactor to flash drum | 10 |
| | Blow-by from AGRU flash drum to AGRU regen | 120 |

Considerations for the design of the flare, relief, and blowdown system, including governing sizing scenarios, are detailed in the Flare, Relief, and Blowdown Philosophy (USAG-EC-PBDES-00-000018-000) included in Appendix 13.B.9.

### 13.33.1.20 Flare Operating and Design Flow Rate Capacities (minimum, normal/rated, maximum), MMscfd

Maximum design flowrates and operating conditions for each of the flare systems are provided in Table 13.33.1.20.

TABLE 13.33.1.20

**Flare Load Summary**

| Flare System | Max Flowrate (MMSCFD) | Min Operating Temperature (°F) | Max Operating Temperature (°F) | Operating Pressure (psia) |
|---|---|---|---|---|
| HP HC Flare | 1,830 | -150 | 110 | 115 |
| LP HC Flare | 100 | 36 | 86 | 20 |
| HP $CO_2$ Flare | 200 (Note 1) | -150 | 102 | 35 |
| LP $CO_2$ Flare | 600 (Note 2) | -150 | 245 | 20 |

TABLE 13.33.1.20

Flare Load Summary

| Flare System | Max Flowrate (MMSCFD) | Min Operating Temperature (°F) | Max Operating Temperature (°F) | Operating Pressure (psia) |
|---|---|---|---|---|

**Notes:**

1. 160 MMSCFD $CO_2$ (max $CO_2$ flowrate basis – one train blocked outlet) + 40 MMSCFD fuel gas
2. 486 MMSCFD $CO_2$ (max $CO_2$ flowrate basis – blocked-in $CO_2$ injection line) + 114 MMSCFD fuel gas

#### 13.33.1.21 Flare Operating and Design Pressures (minimum, normal/rated, maximum), psig

See Table 13.33.1.20.

#### 13.33.1.22 Flare Operating and Design Temperatures (minimum, normal, maximum), °F

See Table 13.33.1.20.

#### 13.33.1.23 Flare Operating and Design Densities (minimum, normal, maximum), specific gravity

Operating and design details for the flare system are provided in the mechanical equipment flare data sheets included in Appendix 13.M.4.

#### 13.33.1.24 Flare Operating and Design Radiant Heat (maximum), Btu/ft2-hr

Operating and design details for the flare system are provided in the mechanical equipment flare data sheets included in Appendix 13.M.4.

#### 13.33.1.25 Flare Operating and Design Decibel (maximum), Decibels on the A-weighted Scale

Operating and design details for the flare system are provided in the mechanical equipment flare data sheets included in Appendix 13.M.4.

## 13.34 SPILL CONTAINMENT

### 13.34.1 Spill Containment System Design

The GTP would use a number of chemicals and produces streams that need to be stored, and handled with care. These include: AGRU Solvent, TEG, diesel fuel and hydrocarbon waste products.

Tank storage facilities and process infrastructure (e.g., process loading/unloading, petroleum storage, and hazardous material storage) would be designed to protect against soil, groundwater, and surface water contamination in accordance with EPA 40 C.F.R., state, and local regulations. Examples of protection methods include drip pans, paving, and provide secondary containment areas.

- Secondary containment areas would be designed to contain the sum of the following:
    - 110 percent of the largest tank capacity; and

- Precipitation from a 25-year, 24-hour rainfall event.

The GTP would include open and closed drain systems. The open drain system (oily-water drains) would capture utility station spent water (i.e., wash water), as well as any leaks and spills within the modules. The closed drain system would receive waste process liquids from each train, which would be disposed via onsite Class 1 industrial disposal wells.

Spill containment sections and details are provided in the following documents included in Appendix 13.E.6:

TABLE 13.34.1

**Spill Containment Sections and Details**

| Drawing Number | Description |
|---|---|
| USAG-EC-LDEQL-6E-001003-001 | Diesel Storage Tanks – Module 6E – plan and sections |
| USAG-EC-LDEQL-6D-001002-001 | AGRU and TEG Storage Tank – Module 6D – plan and sections |
| USAG-EC-LDEQL-0T-001003-001 | Hydrocarbon Holding Tank – Module 0T – plan and sections |
| USAG-EC-LDEQL-0R-001001-001 | GTP Housing Utilities – Module 0R – plan and sections |

#### 13.34.1.1 Spill Containment Philosophy

Tank storage facilities and process infrastructure (e.g., process loading/unloading, petroleum storage, and hazardous material storage) would be designed to protect against soil, groundwater, and surface water contamination in accordance with EPA 40 C.F.R., state, and local regulations. Examples of protection methods include drip pans, impermeable membranes, and providing secondary containment areas

Secondary containment areas would be designed to contain the sum of the following:

- 110 percent of the largest tank capacity; and,
- Precipitation from a 25-year, 24-hour rainfall event;

#### 13.34.1.2 Spill Locations and Flows

Both open and closed drains would be provided for each train and for the common areas. The open drain system drains would capture utility station spent water (e.g., wash water) as well as any leaks and spills within the modules. Open drain liquids would be collected via sloped floors and drain trenches to sumps. The sump liquids would be pumped to the closed drain collection system.

The closed drain system collects liquids and solvents from process equipment and piping that is generated during normal operation and drained from the system during maintenance activities. The closed drain system would be separated into three separate closed drain systems to facilitate recovery and reuse of solvents: (1) process closed drain system for process fluids such as hydrocarbons and water; (2) tri-ethylene glycol drain system for draining the treated gas dehydration and $CO_2$ dehydration systems; and (3) the AGRU solvent drain system for draining amine from the AGRU.

The liquids from the closed drain system (approximately 190 gpm) would be piped to one of two Class 1 industrial injection wells located on the GTP pad for disposal. The wells would be approximately 6,000 to 7,000 feet of vertical depth. Design provisions would be made such that fluids from the open drain, tri-ethylene glycol drain, and AGRU solvent drain can be injected into these wells through the process drain system.

Waste streams from each train and the common area would be collected in the common closed drain collection drum. The drum would receive continuous flow from the following:

- Grey water from wastewater treatment plant (approximately 59 percent of continuous flow);
- Reverse osmosis reject water (approximately 8.5 percent of continuous flow);
- Backwash water from potable water treatment (approximately 6.5 percent of continuous flow); and
- Process water from all three gas processing trains (approximately 26 percent of continuous flow). This stream is greater than 99 percent water with trace quantities (ppm) of hydrocarbons, $CO_2$, $H_2S$, and tri-ethylene glycol.

The common closed drain collection drum would also be connected to other process waste streams that have intermittent flow. These waste streams would contain substances intrinsically derived from operations associated with the production of natural gas including oily water, sour water, amine, tri-ethylene glycol, hydrocarbons, and trace amounts of $CO_2$ and $H_2S$ (i.e., Resource Conservation and Recovery Act [RCRA] exempt). Liquid waste from the open drain system would be delivered to the common closed drain collection drum. Liquid waste from the common closed drain collection drum would be injected into the disposal well(s). Accounting for these estimated intermittent flows, the liquid waste would be injected at a rate up to 225 gallons per minute and pressure up to 2,000 psig. Although the injection wells are configured to be spares to each other, both would normally operate. To prevent freezing in the wells, diesel, a mixture of methanol/water or other fluid that is miscible with disposal fluids may be injected into the inactive well during winter.

The injection wells would be permitted under the United States Environmental Protection Agency (EPA) jurisdiction as Class I industrial injection wells for injection of non-hazardous and RCRA-exempt liquid waste streams.

#### 13.34.1.3 Impoundment Volumetric Capacities

Appendix 13.S.3 includes a Secondary Containment of Tanks Report (USAG-EC-MRRSK-00-000001-000), which includes details of secondary containment features considered for the GTP to prevent pollution of soil and water in the event of a spill or leak, typically consisting of dikes or toe walls constructed of earth, masonry, or concrete.

#### 13.34.1.4 Trench and Trough Volumetric Flow Capacities

Not applicable to the GTP.

#### 13.34.1.5 Downcomer Volumetric Flow Capacities

Not applicable to the GTP.

#### 13.34.1.6 Impoundment System Water Removal

The facility design includes two disposal wells at the GTP Pad to dispose of continuous and/or non-continuous waste streams including waste water and sewage streams from GTP camp. To provide the redundancy required, one well is assumed to be a spare. Both injection wells would be assumed to be permitted as Class I Industrial Underground Injection Control (UIC) Wells pending verification during a later stage of the Project.

#### 13.34.1.7 Storm Water Flow Design Basis

#### 13.34.1.8 Storm Water Drainage Calculations

Surface water discharges would be in accordance with 18 Alaska Administrative Code (AAC) 70 (Water Quality Standards) and 18 AAC 75 (Oil and Other Hazardous Substances Pollution Control) as regulated by the ADEC. Surface waters of the state are protected by water quality criteria (18 AAC 70.020).

Stormwater conveyance would be accomplished with the use of sheet flow on the pad. Culverts would be used at road crossings and other areas where the natural surface drainage is blocked.

As part of the existing Alaska North Slope Oil & Gas General National Pollutant Discharge Elimination System (NPDES) Permit, the stormwater is allowed to infiltrate on the pad with some runoff to the tundra. Snow melt water and firewater are also considered stormwater and have the potential to create larger volumes than rainfall and to produce runoff. The runoff likely would pond on the tundra and may infiltrate eventually. Modules would have hydrocarbon drain systems for process and oily wastewaters.

#### 13.34.1.9 Impoundment System Snow and Ice Removal

Uncontaminated snow is to be removed from the pad with conventional equipment such as front end loaders, snow plows, etc.

#### 13.34.1.10 Snow and Ice Load Basis of Design and Removal

Snow loading will be calculated in accordance with 2012 IBC.

All equipment are to be designed for a snow load of 50 PSF.

Uncontaminated snow / ice is to be removed from the pad with conventional equipment such as front end loaders, snow / ice plows, etc. and typically pushed over the edge of the pad and left there to melt during the following summer. To dispose of snow / ice in this manner, a snow / ice and ice base must be built up on the pad to prevent mixing gravel into the snow / ice as it is not permitted to be pushed onto the tundra with the snow / ice. If any contamination to the snow / ice occurs, such as gravel entrainment, the snow / ice is to be stockpiled and left to melt during the following summer. Contaminated snow / ice may have to be inspected for contaminants prior to snow / ice push (including gravel). As part of the existing ANS Oil

& Gas General National Pollutant Discharge Elimination System (NPDES) Permit, snow / ice melt water and are also considered stormwater and is allowed to infiltrate on the pad with some runoff to the tundra.

## 13.35 PASSIVE PROTECTION SYSTEMS

### 13.35.1 Passive Protection Design

The primary considerations employed throughout layout development are outlined in the following list:

- Safety (e.g., access/egress, overpressure/dispersion analysis, separation distances, prevailing wind direction and flare location);
- Environmental impact (e.g., minimize footprint and waterbody conflicts);
- Cost (e.g., one process train would be designed and the remainder would be identical), integrate piperacks into utility and process modules);
- Phased start-up (e.g., Train 1 would be operating during the installation of Train 2, etc.);
- Arctic conditions (e.g.; general design, utilidors/walkways for personnel travel);
- Process efficiency (e.g., module design and arrangement, integrate);
- Constructability (e.g. module installation, site offices, laydown/warehousing, transportation/accommodation, fabrication and brownfield construction/simultaneous operations);
- O&M (e.g., unit and process train isolation philosophy, reliability, access, material/equipment handling, and personnel/vehicle travel); and
- Logistics (e.g., module sizes, truckable vs. sealifted camps).

#### 13.35.1.1 Passive Protection Philosophy

Refer to 13.35.1

#### 13.35.1.2 Cryogenic Structural Protection

Not applicable to the GTP.

#### 13.35.1.3 Vapor Barriers

Not applicable to the GTP.

#### 13.35.1.4 Equipment Layout Setbacks and Separation

Refer to 13.35.1

#### 13.35.1.5 Blast Walls, Hardened Structures, and Blast Resistant Design

Refer to 13.35.1

#### 13.35.1.6 Fire-proofing, Firewalls, and Radiant Heat Shields Design

Not applicable to the GTP.

#### 13.35.1.7 Other Passive Protection (e.g. mounding, elevated heating, ventilation, and air conditioning [HVAC] intakes; foam glass blocks; etc.)

Not applicable to the GTP.

## 13.36 HAZARD DETECTION SYSTEMS

### 13.36.1 Hazard Detection System Design

The FGDS would be provided to monitor the facility for detection of fire and combustible/flammable and toxic gas. Upon confirmation of these conditions, the FGDS is designed to initiate alarms, and initiate isolation and blowdown of systems as applicable. The system would automatically and reliably alert personnel to the existence and location of such conditions, and initiate prescribed control actions. Non-process buildings (outside of the process area) and Local Equipment Rooms (LERs) have Fire Alarm Control Panels (FACPs) that comply with the requirements of NFPA 70 and 72.

Hazard detector layout plans for the GTP are provided in the following documents included in Appendix 13.S.6:

TABLE 13.36.1

**Hazard Detector Layout Plans**

| Drawing Number | Description |
|---|---|
| USAG-EC-FDFGS-00-001004-000 | Fire & Gas Devices - Process Modules LL |

#### 13.36.1.1 Hazard Detection Philosophies (selection, layout, alarm, activation, and/or shutdown setpoints, voting logic, voting degradation logic)

The FACPs send summary output signals to the SIS. Process area alarm beacons, alarm horns and Manual Alarm Call (MAC) points would be integrated with the LER FACPs. Process areas (hydrocarbon processing and utility areas) would also be protected by the FGDS. The process area FGDS would be segregated from the process control system and integrated into the SIS. Any turbine enclosures would be protected by a standalone, vendor-supplied FGDS, which provides outputs to the SIS. The FACPs and SIS also interface with the heating and ventilation system and the PAGA system. The Fire and Gas Detection Philosophy (Document No. USAG-EC-FBDES-00-000005-000) is included in Appendix 13.B.8, a summary of which is provided as follows.

The FGDS would be designed to the following requirements:

- An automatic system that would determine if a possible fire or unsafe accumulation of combustible or toxic gas is present on the facility. The FGDS would be fault tolerant and available 100 percent of the time. The system would be designed to minimize spurious shutdowns caused by the FGDS;
- Continuously monitor all areas of the installation where either a fire hazard may exist or an accumulation of flammable or toxic gas may occur;
- Integrated with the ICSS, fire protection system, and mechanical ventilation system;
- Equipment would be suitable for the electrical area classification in which it would be installed. Equipment components such as control panels, junction boxes, and devices would be installed in accordance with the National Electrical Code (NEC) requirements;
- Equipment and instrumentation associated with the FGDS would be UL listed or have other approved Nationally Recognized Testing Laboratories (NRTL) certification;
- Automation of the GTP FGDS would be maximized and manual intervention into the FGDS actions would be by exception only and would require approval of the Owner's Loss Prevention Engineer. The only manual intervention allowed once the FGDS has been activated would be manual shutdown of the fire water or water mist pumps, where provided. Manual bypass of gas and fire detectors would be allowed only during scheduled maintenance, calibration, and testing as required by NFPA 72.

#### 13.36.1.2 Hazard Detection Design and Performance Criteria (e.g., minimum detector spacing, maximum detection time, etc.)

The FGDS will be fault tolerant and available 100% of the time. The system will be designed to minimize spurious shutdowns caused by the FGDS. Automation of the GTP FGDS will be maximized and manual intervention into the FGDS actions will be by exception only and will require approval of the Owner's Loss Prevention Engineer. The only manual intervention allowed once the FGDS has been activated is manual shutdown of the fire water or water mist pumps, where provided. Manual bypass of gas and fire detectors will be allowed only during scheduled maintenance, calibration, and testing as required by NFPA 72.

#### 13.36.1.3 Low Temperature Detectors

Not applicable to the GTP.

#### 13.36.1.4 Oxygen Deficiency Detectors

To be determined in detailed design.

#### 13.36.1.5 Toxic Gas Detectors

$CO_2$ and $H_2S$ are the primary components that can be found in potentially toxic concentrations which will warrant Toxic gas detection. Toxic gas detectors are located within modules in the process area (including utilities modules and any E&I rooms) where high concentrations of toxic gas could be present. Detectors are also being located at all HV or HVAC unit air intakes in the process area.

The toxic gas detection system provides two levels of alarm—a "toxic gas" alarm and a "confirmed toxic gas" critical alarm. Each level is assigned audible and visual alarms, as well as executive actions appropriate to the hazards in the area.

#### 13.36.1.6 Flammable/Combustible Gas Detectors

Separate gas detection would be provided for each individual hazard. The design for the detection of flammable gases and toxic gases would use detectors specifically listed for the type of gas anticipated. Non-process modules would be provided with flammable or toxic gas detection in the HVAC inlet.

In process areas (hydrocarbon processing and utility areas including Local Equipment Rooms), gas detection as part of FGDS would be provided by gas detectors based on the gas hazard identified in the area and integrated with the ICSS. Multiple gas detectors for each hazard classification would be provided within the process areas to allow for voting and verification. Any turbine enclosures that would be protected by standalone vendor-supplied gas detection would provide outputs to the ICSS. Upon confirmation of these conditions, the FGDS is designed to initiate alarms, and initiate isolation and blowdown of systems as applicable.

#### 13.36.1.7 Flame Detectors

Fire detection would be accomplished through the use of thermal detectors and flame detectors. For non-process areas, fire detection would be provided in areas where smoke detection would normally be used, but the ambient conditions are prohibitive to using smoke detection. Fire detection would be provided in locations where an open flame may be present, such as torch cutting or welding. Within the process areas, fire detection would be provided in areas where enough energy, present or generated, exists to ignite hydrocarbons that may be released in the vicinity. Where appropriate, fire detection would be placed near the seals of rotating equipment, pumps handling hydrocarbons, compressors, and valve stations.

#### 13.36.1.8 Heat Detectors

Not applicable to the GTP.

#### 13.36.1.9 Smoke/Products of Combustion Detectors

Photoelectric, ionization, or air aspiration smoke detection may be used to detect combustion particles. Smoke detection would be provided in all non-process buildings. Smoke detection would be provided in electrical buildings and electrical/MCC rooms.

#### 13.36.1.10 Manual Pull Stations

Not applicable to the GTP.

#### 13.36.1.11 Audible and Visual Notification Systems for Field, Control Room, Plant Wide, and Offsite

For the GTP, external visual beacons will be installed in addition to the beacons and alarms internal to the process modules.

#### 13.36.1.12 Other Hazard Detectors (e.g., rate of rise temperature detectors, acoustic leak detectors, closed-circuit television [CCTV] detectors, carbon monoxide, etc.)

Not applicable to the GTP.

## 13.37 HAZARD CONTROL SYSTEMS

### 13.37.1 Hazard Control System Design

The Project's primary Health, Safety and Environmental (HSE) objective is to provide a safe and healthy working environment for all personnel present in the facility and the safety and security of the public in neighboring areas. It is aimed to achieve these objectives through the application of proven Hazard Management Systems and practices through all phases of Project design, construction, and operations.

Design and operating principles being implemented in the design and development of the GTP are as outlined in the following list:

- Facilities would be laid out in accordance with the requirements of 40 C.F.R. Part 68, OSHA regulation 29 C.F.R. 1910.119;
- Separation distances have been determined to minimize the potential impact of accidental releases, and risk of incidents escalating or propagating within the facility; and
- The design of the facilities would minimize the number of sources for hydrocarbon release as far as reasonably practicable. Measures include selection of equipment based on proven reliability, use of inherently corrosion-resistant materials, and minimization of flanged connections in hazardous fluid services.

#### 13.37.1.1 Hazard Control Philosophies (selection, layout, activation)

Clean agent fire extinguishing systems will be evaluated in FEEDduring detail engineering to protect critical electrical equipment e.g. MCCs, electrical modules, and the control building rack room. Further analysis will be initiated during FEED to identify additional required fire protection equipment needs.

#### 13.37.1.2 Performance Criteria (e.g., minimum flow and capacity, maximum travel distance/spacing, etc.)

To be determined in detailed design.

#### 13.37.1.3 Portable Fire Extinguishers Design and Layout with reference to drawings in Appendix 13.S

Refer to the layout drawings in Appendix 13.S.7.

#### 13.37.1.4 Fixed Dry Chemical Systems Design and Layout with reference to drawings in Appendix 13.S

Refer to the layout drawings in Appendix 13.S.7.

#### 13.37.1.5 Clean Agent Systems Design and Layout with reference to drawings in Appendix 13.S

Refer to the layout drawings in Appendix 13.S.7.

#### 13.37.1.6 Carbon Dioxide Systems Design and Layout with reference to drawings in Appendix 13.S

Refer to the layout drawings in Appendix 13.S.7.

#### 13.37.1.7 Other Hazard Control Systems (e.g., nitrogen snuffing, dispersive fans, building ventilation, etc.) design and layout with reference to drawings in Appendix 13.S

Refer to the layout drawings in Appendix 13.S.7.

## 13.38 FIRE WATER SYSTEM

### 13.38.1 Fire Water Design

The GTP would include three identical firewater systems at the Operations Camp. In each system, firewater would be supplied from the firewater storage tank using an electric-motor-driven firewater pump with a diesel-engine-powered backup. This would provide a reliable supply of water for fire protection of the normally occupied, non-process support buildings (i.e., the Operations Center and associated housings, shops and warehouses).

Fire protection for the GTP process and utility modules would be accomplished by using zoned Fine Water Mist (FWM) systems. FWM protection systems would be provided to protect high fire potential equipment and combustible hazards in the process modules. In addition, clean agent fire extinguishing systems would be evaluated in a later stage of the Project to protect critical electrical equipment, e.g., Motor Control Centers (MCCs), electrical modules, and the control building rack room. Further analysis would be initiated during a later stage of the Project to identify additional required fire protection equipment needs. Gas turbines would be protected with a vendor-supplied suppression system.

There would be three identical firewater systems at the operations camp for fire protection of the normally occupied, non-process support buildings (i.e., the Operations Center and associated housings, shops, and warehouses).

The FWM system would be composed of:

- Mist nozzles;
- Water Tank; and
- Pumps.

Each of three identical fire water systems at the Operations Camp include:

- Fire water storage tank;
- Electric motor-driven firewater pump; and
- Diesel-engine powered backup firewater pump.

Appendices B.2 and B.8 address the basis of design for fire protection service for the GTP and the Codes and Standards that form the basis of design. Specifically, Appendix 13.S.10 includes the Fine Water Mist System Summary (USAG-EC-FRZZZ-00-001001-000), which includes detail of FWM systems for pumps moving flammable liquids and areas expected to contain greater than 100 gallons of flammable or combustible hydrocarbon liquid. It also includes the Building and Fire Code Analysis (USAG-EC-FRZZZ-00-001003-000) detailing building and fire code requirements essential for design consideration of the GTP. Appendix 13.S.10 includes the Fine Water Mist Plans for process (USAG-EC-FDFGS-00-001002-001).

The following FWM plans included in Appendix 13.S.10 provide details of the process modules/equipment protected by this system.

TABLE 13.28.1-1

**Firewater Coverage Plans**

| Drawing Number | Description |
|---|---|
| USAG-EC-FDFGS-00-001002-001 | Fine Water Mist - Process Modules Plan |
| USAG-EC-FDFGS-00-001002-002 | Fine Water Mist - Storage Pumps/Filter Module |

The following P&IDs for the Operations Camp firewater system are included in Appendix 13.E.5:

TABLE 13.28.1-2

**Firewater P&IDs**

| Drawing Number | Description |
|---|---|
| USAG-EC-PDZZZ-00-000411-121 | Camp Firewater Pumps – System 1 |
| USAG-EC-PDZZZ-00-000412-132 | Camp Firewater Tank – System 1 |
| USAG-EC-PDZZZ-00-000412-140 | Camp Firewater Tank – System 2 |
| USAG-EC-PDZZZ-00-000411-141 | Camp Firewater Pumps – System 2 |
| USAG-EC-PDZZZ-00-000412-142 | Camp Firewater Tank – System 3 |
| USAG-EC-PDZZZ-00-000411-143 | Camp Firewater Pumps – System 3 |

#### 13.38.1.1 Fire Water Philosophy

The Fine Water Mist System (FWM) would be provided for high fire potential equipment in the process modules handling flammable and combustible materials. The FWM system design is based on zoned local application, which is zoned to provide system activation independently. Each zone would be provided with its own detection and activation components. Manual activation of the system would be accomplished remotely from the Main Control Room, or locally from a release station near the protected area. All fire alarm and trouble alarm signals would be transmitted to the Main Control Room for notification and acknowledgement.

No standpipe, hydrant, fire monitor, foam, or hose equipment would be installed at the GTP. Hand-held portable fire extinguishers would be available throughout each module, as well as strategically placed wheeled extinguishers. The use of fire extinguishers during the initial stages of a small fire would be part of the emergency response to safeguard the facility. The travel distance to the nearest extinguisher as well as the location of fire hazards are taken into consideration when locating extinguishers; however, at least one extinguisher would be provided inside, near each door exiting the module or building.

#### 13.38.1.2 Fire Water System Design Cases, Demands, Calculations, and Basis of Sizing

Design criteria for the FWM system including coverage areas, approximate nozzle counts, and protected equipment would be provided in the Fine Water Mist Plans for Process Modules (USAG-EC-FDFGS-00-001002-001) and Storage Pumps/Filter Module (USAG-EC-FDFGS-00-001002-002) included in Appendix 13.S.10.

Design criteria for the firewater systems at the Operations Camp are as follows:

- Estimated Required Capacity for single fire event: 15,000 barrels (660,000 gallons);
- Firewater supply must be replenished in eight hours;
- Firewater pump capacity is determined by the worst case demand (warehouse) in accordance with NFPA 13 extra hazard group 1 that requires 0.30 gpm/sf over 2,500 sf + 500 gpm hose allowance = 1,250 gpm. Next standard pump size is 1,500 gpm; and
- Each tank is sized to store four hours of firewater at 1,500 gpm.

#### 13.38.1.3 Main Fire Water Supply and Back Up Supply (e.g., fire water tank, pond, ocean, wells, city, etc.)

Water for FWM system would be supplied by the Operations Camp potable water system. The feed to the potable water system would be the Putuligayuk River reservoir. The camp firewater tanks would include a truck connection as a backup source to refill the system as required.

Details of the Operations Camp firewater system would be provided in the utility flow diagrams USAG-EC-PDUFD-00-000411-117 and USAG-EC-PDUFD-00-000412-124 included in Appendix 13.E.3.

#### 13.38.1.4 Fire Water Supply Pressure, psig

The rated shaft horsepower of each pump would be 165 horsepower (Hp).

#### 13.38.1.5 Fire Water Storage Type and Capacity, gal

Firewater would be stored in an atmospheric storage tanks; the volume of each camp firewater storage tank would be 270,616 usg (8,591 bbl.).

In each firewater system for the operations camp, firewater would be supplied from the firewater storage tank using an electric-motor-driven centrifugal firewater pump with a diesel-engine powered backup. Each system would include dedicated centrifugal jockey pumps to maintain system pressure.

#### 13.38.1.6 Main Fire Water Pumps and Driver Type

For the operations camp firewater system, the motor-driven pumps would be designated as the primary operating pumps; the diesel engine pumps would be the standby pumps. A diesel fuel storage tank would be used to store enough diesel to operate each diesel engine firewater pump for eight hours.

#### 13.38.1.7 Number of Main Fire Water Pumps, operating and standby

#### 13.38.1.8 Main Fire Water Pumps Operating and Design Flow Rate Capacities (minimum, rated, maximum), gpm

The rated capacity of each firewater pump would be 1,500 gpm at a discharge pressure of 165 psi.

The pump capacity was determined by the worst case demand (warehouse) in accordance with National Fire Protection Association (NFPA) 13 extra hazard group 1 that requires 0.30 gpm/sf over 2,500 sf + 500 gpm hose allowance = 1,250 gpm. The next standard pump size is 1,500 gpm.

#### 13.38.1.9 Main Fire Water Pumps Operating and Design Pressures (minimum, rated, maximum)

The rated capacity of each firewater pump would be 1,500 gpm at a discharge pressure of 165 psi.

#### 13.38.1.10 Jockey/Make Up Water Source

Potable water from the potable water treatment system at the operations camp would be available as makeup firewater to the camp firewater storage tank.

#### 13.38.1.11 Jockey/Make Up Water Operating and Design Flow Rate Capacities (minimum, rated, maximum), gpm

The rated capacity for the jockey pumps would be 100 gpm at a discharge pressure of 175 psi.

Makeup water for the firewater storage tanks would be available at 750 gpm (firewater supply must be replenished in eight hours).

#### 13.38.1.12 Jockey/Make Up Water Operating and Design Pressures (minimum, rated, maximum), psig

The rated capacity for the jockey pumps would be 100 gpm at a discharge pressure of 175 psi.

Makeup water for the firewater storage tanks would be available at 52 psi.

#### 13.38.1.13 Fire Water Piping Design and Layout with reference to drawings in Appendix 13.S

Refer to layout drawings in Appendix 13.S.10.

#### 13.38.1.14 Fire Water Hydrants Design and Layout with reference to drawings in Appendix 13.S

Not applicable to the GTP.

The FWM plans included in Appendix S13..10 provide details of the process modules/equipment protected by the FWM system and the approximate number of water mist nozzles for each coverage area.

#### 13.38.1.15 Fire Water Monitors Design and Layout with reference to drawings in Appendix 13.S

Not applicable to the GTP.

The FWM plans included in Appendix 13.S.10 provide details of the process modules/equipment protected by the FWM system and the approximate number of water mist nozzles for each coverage area.

#### 13.38.1.16 Hose Reels Design and Layout with reference to drawings in Appendix 13.S

Not applicable to the GTP.

The FWM plans included in Appendix 13.S.10 provide details of the process modules/equipment protected by the FWM system and the approximate number of water mist nozzles for each coverage area.

#### 13.38.1.17 Water Screens and Deluge Systems Design and Layout with reference to drawings in Appendix 13.S

There would be no water screens or deluge systems at the GTP. A FWM system would be provided for high fire potential equipment in the process modules handling flammable and combustible materials

The FWM plans included in Appendix 13.S.10 provide details of the process modules/equipment protected by the FWM system and the approximate number of water mist nozzles for each coverage area.

#### 13.38.1.18 Expansion Foam Philosophy

Not applicable to the GTP.

#### 13.38.1.19 Expansion Foam System Design Cases, Demands, Calculations, and Basis of Sizing

Not applicable to the GTP.

#### 13.38.1.20 Expansion Foam Water Supply

Not applicable to the GTP.

#### 13.38.1.21 Expansion Foam Supply

Not applicable to the GTP.

#### 13.38.1.22 Expansion Foam Type (e.g. low expansion Aqueous Film-Forming Foam [AFFF], high expansion foam, etc.)

Not applicable to the GTP.

#### 13.38.1.23 Expansion Foam Concentration, percent volume

Not applicable to the GTP.

#### 13.38.1.24 Expansion Foam Storage Type and Capacity, gal

Not applicable to the GTP.

#### 13.38.1.25 Expansion Foam Pumps and Driver Type

Not applicable to the GTP.

#### 13.38.1.26 Number of Expansion Foam Pumps, operating and standby

Not applicable to the GTP.

#### 13.38.1.27 Expansion Foam Pumps Operating and Design Flow Rate Capacities (minimum, rated, maximum), gpm

Not applicable to the GTP.

#### 13.38.1.28 Expansion Foam Pumps Operating and Design Pressures (minimum, rated, maximum)

Not applicable to the GTP.

#### 13.38.1.29 Expansion Foam Piping Design and Layout with reference to drawings in Appendix 13.S

Not applicable to the GTP.

#### 13.38.1.30 Expansion Foam Generators Design and Layout with reference to drawings in Appendix 13.S

Not applicable to the GTP.

#### 13.38.1.31 Expansion Foam Hose Reels Design and Layout with reference to drawings in Appendix 13.S

Not applicable to the GTP.

#### 13.38.1.32 External Impact Protection (bollards)

To be determined in detailed design.

## 13.39 EMERGENCY RESPONSE PLAN

### 13.39.1 Emergency Response Plan

A combined Emergency Response Plan (ERP) would be developed to incorporate not just the Liquefaction Facility and GTP, but also the Mainline System that is part of this overall Project development. Within this combined plan would be individual ERPs that would meet all regulatory requirements and address the site-specific nature of the covered facilities.

The combined ERP would be developed using the nationally recognized Federal Emergency Management Agency (FEMA) guidelines and use the National Incident Management System (NIMS) as the methodology with the Incident Command System (ICS) organizational structure. The combined and individual plans would be prepared in consultation with stakeholders to ensure that all actions to emergencies are coordinated and understood by emergency responders, local community leaders, the government, and the general public.

Individual ERPs would be site-specific and identify the types of emergencies that would require notification to appropriate agencies. The individual ERPs would contain the response organization and resources (e.g., diagrams, maps, plans, and procedures) necessary to respond adequately. The ICS is the common emergency response tool used by industry and local emergency response agencies. The Project's ICS would link to plans maintained by other affected response agencies or third parties and thus help to ensure appropriate communications, understanding, and cooperation are in place.

In accordance with the FERC Draft Guidance for Terminal Operator's Emergency Response Plan (ERP), the ERP would be prepared in consultation with the state and local agencies, and the Project representatives would request FERC approval prior to the commencement of construction.

The GTP ERP would include details for:

- Description of response to fire and deployment of resources;
- Organizational chart for emergency response and fire fighting;

- Number of emergency response personnel;
- Number and type of emergency response apparatus;
- Response to emergencies and deployment of resources;
- Public and onsite notification and communication;
- Access and egress locations and roadways, internal and external to site;
- Proposed frequency and type of security and emergency response training and drills for onsite personnel and emergency responders;
- Contact and communications with the State Fire Marshal;
- Contacts and communications with all other appropriate agencies;
- Preliminary Cost Sharing Plans with any state and local agencies and responders to fund security, emergency management, and training costs; and
- Schedule for any future actions, studies, or meetings to develop the Emergency Response Plan and Cost Sharing Plan

#### 13.39.1.1 Incident Command System Organizational Chart for Emergency Response

The GTP ERP would include a description of the ICS organizational chart that would identify the primary job roles that would exist in the operations phase and who would be expected to fill these roles in an event of an emergency. The ICS would also be used to coordinate with local emergency response agencies to provide appropriate communications, understanding, and cooperation is in place. This would help ensure that the ERPs would be appropriately linked to plans maintained by other affected response agencies or third parties.

The individual ERPs would be supported by various Emergency Operations Centers (EOCs). There would also be a backup EOC in the event that the primary EOC is not operational. The purpose of the EOCs would be to provide coordinated support for field personnel and other emergency services following a system emergency, and to mobilize operations resources to work with local first responders to secure the incident site and control/contain the emergency event.

#### 13.39.1.2 Proximity of Emergency Response, Fire Brigades/Departments, Mutual Aid, and Local Law Enforcement

The GTP would be constructed within the boundaries of the existing PBU. The Greater Prudhoe Bay Fire Department (GPBFD) is managed by the PBU Operator, with both full-time leadership and volunteer responders that are certified by the State of Alaska.

The GPBFD is the third largest registered fire department in the state and is responsible for all emergency response (fire, EMS, hazmat, and rescue) onsite at PBU and responds to emergencies in Deadhorse and along the most northern stretch of the Dalton highway on a Good Samaritan basis.

The GPBFD has two fully equipped, primary fire stations, and a 24-hour trauma center. Emergency medevac services are also available in Deadhorse. The GTP would be self-sufficient for first response fire, medical, and hazmat emergencies, and would be integrated into existing PBU emergency response plans for advanced support. Advanced GPBFD support would be the subject of negotiation with the PBU operator and working interest owners, in consultation with the NSB during subsequent stages of the Project.

#### 13.39.1.3 Number of Emergency Response Personnel

As the GTP design develops in the later phases of the Project, hazard analyses would be performed to further define the type and scope of incidents that could occur during operations. Emergency response scenarios would then be developed for various incidents and would detail the type of response required and resources to be deployed. These emergency response scenarios would be developed in consultation with the relative fire prevention, law enforcement, and emergency response agencies in determining an appropriate plan of action. Each scenario would then describe how the facility would coordinate with these agencies to support the emergency response required.

#### 13.39.1.4 Number and Type of Emergency Response Apparatus

These hazard analyses would also be used to design the various detection and response processes or systems to address these incidents. These processes or systems would provide notification back to the main control room when there is a hazard to be addressed. Based on the type of hazard detected, a notification process would be in place to provide that appropriate action is taken to inform affected personnel both onsite and offsite.

#### 13.39.1.5 Response to Emergencies and Deployment of Resources

The ERP would detail protocals for responding to emergencies and how resources would be deployed.

#### 13.39.1.6 Public and Onsite Notification and Communication

The ERP would also identify the types of emergencies that would provide notification to appropriate agencies and would detail the response organization and resources (e.g., diagrams, maps, plans, and procedures) necessary to respond adequately. It would include designated contacts with state and local emergency response agencies and procedures for notification of local officials and emergency response agencies.

#### 13.39.1.7 Multiple Access and Egress Locations and Roadways, Internal and External to Site

The ERP would describe and include drawings that identify access and egress locations and roadways, both internal and external, to be used in an emergency.

At this phase of the Project, provisional escape routes within the facilities have been identified and these would be further refined in future engineering and planning.

The external evacuation routes adjacent to GTP would be further defined as the consultation process advances with the various agencies and support groups that would be involved in reviewing the various emergency response scenarios and how they would be managed.

#### 13.39.1.8 Preliminary Evacuation Routes Within and Adjacent to Plant and LNG Vessel Route

The emergency response plan would include evacuation routes within the GTP and adjacent to the GTP facility.

#### 13.39.1.9 Proposed Frequency and Type of Security and Emergency Response Training and Drills for Onsite Personnel and Emergency Responders

The emergency scenarios identified would also be used to determine the training and emergency drills that would occur internally and with external agencies/stakeholders. The frequency and type of training and drills would be developed in consultation with emergency responders and then reflected in the ERP.

#### 13.39.1.10 Contact and Communications with the Coast Guard, Including LOI and Submittal of Preliminary Waterway Suitability Assessment (at time of pre-filing), and Submittal of a Follow-on Waterway Suitability Assessment (at time of application)

Not applicable to the GTP.

#### 13.39.1.11 Contact and Communications with the State Fire Marshal

At this stage of the Project, consultation with the Alaska State Fire Marshal have not commenced as they relate to the ERPs. As this Project develops, further dialogue would occur with these groups to understand their capacity to support emergencies that may occur at the facility, how they would interact with the facility for emergency response, and how mutual aid support would occur with other industry in the area. Mutual Aid Agreements and processes for securing additional assistance from non-company resources would be established as needed.

#### 13.39.1.12 Contacts and Communications With All Other Appropriate Agencies

At this stage of the Project, consultation with the other appropriate agencies or support groups have not commenced as they relate to the ERPs. As this Project develops, further dialogue would occur with these groups to understand their capacity to support emergencies that may occur at the facility, how they would interact with the facility for emergency response, and how mutual aid support would occur with other industry in the area. Mutual Aid Agreements and processes for securing additional assistance from non-company resources would be established as needed.

#### 13.39.1.13 Preliminary Cost-Sharing Plans With Any State And Local Agencies And Responders To Fund Security, Emergency Management, And Training Costs

At this stage in the Project, any preliminary cost sharing plans have not been discussed or developed.

#### 13.39.1.14 Schedule For Any Future Actions, Studies or Meetings To Develop The Emergency Response Plan and Cost-Sharing Plan

During the FERC NEPA process, the Project will start coordination with appropriate entities to proceed development of the Emergency Response Plan and Cost Sharing Plans. Consultations will go throughout detailed design and a finalized Emergency Response Plan and Cost Sharing Plan will be complete prior to the Project going into service.